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Review Article

Review on Milk Production Performance of Dairy Cattle in Ethiopia

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Abstract

This review paper is aims to overview the Milk Production Performance of Dairy Cattle in Ethiopia to recommend strategic intervention for improving milk production performance that match the population growth and strengthen the contribution of the dairy industry in Ethiopia's national economy. Dairy production systems were categorized into 2 main systems: rural or traditional dairy production system which includes (pastoralists, agro- pastoralists, and mixed crop–livestock producers) and urban and peri-urban dairy systems. In Ethiopia, dairy production is based on subsistence smallholder farmers and most of the production comes from local dairy cattle, which results in low production and productivity and does not meet with the growing demand for milk. To commensurate milk production with the demand local dairy cow breeds are being improved through crossbreeding with exotic breeds. Crossbred dairy cows have more milk production performances than local breeds due to heterosis effect. Indigenous breed cows which produces low milk yield, contributes the main milk production that account for ninety seven percent of the total milk production of Ethiopia. The average lactation length for local breeds is six months, while the average lactation length of exotic breeds is 305 days and results in higher milk yields under intensive management. However, milk production performance of the cows is being affected by poor quality and unaffordable feed resources, animal diseases like mastitis and climatic stresses.

Keywords

Milk Yield, Indigenous Dairy Cows, Extensive System, Performance Indicators, Breed, Production Systems

1. Introduction

Agriculture is considered to be the pillar of the economy of developing countries. In sub-Saharan African countries the livestock sector contributes significantly to food security, creates jobs for many rural poor people, serve as a vital source of income and provides critical nutritional benefits not readily available in other foods through producing high-protein animal source foods such as meat and milk [38]. Livestock is the largest agricultural sector which is the backbone of Ethiopia`s economy and producing products such as meat, hides and milk. It has substantial role in the Ethiopian national economy, by generating 16.5 percent of national Gross Domestic Product, 35.6 percent of agricultural GDP and thirty percent of agricultural employment, and sixteen to nineteen percent of the total foreign currency earnings of the Ethiopia [6]. Additionally, it helps in ensuring food security for farmers through livestock products, creating vast employment opportunities and improving the livelihood of farmers [25]. Dairy farming is one of the oldest and most vital components of agricultural systems in

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Ethiopia. Ethiopia has the largest livestock population in Africa having about 58 million cattle of which 1.2 million crossbred dairy cattle [31], 42.9 million sheep, 52.5 million goats and 8.1 million camels [6]. Despite the large population of cattle, the milk production of livestock genetic resources is in general, low and its direct contribution to the national economy is not commensurate with the number of livestock [25]. Milk is among the most crucial products from the dairy industry [28]. In Ethiopia, the main milk production comes from cows which contributes 83.4 percent of the total milk yield per year of the country [1]. Dairy products can improve the country`s nutritional system and eradicate poverty as it is contributing significantly to improving the income of smallholder farmers and becoming a promising source of employment [30]. Dairy products are often more affordable than other source foods and are chief source of essential nutrients used for growth and health [39]. Dairy production in Ethiopia is mainly produced for family consumption, it is not market oriented, and local cattle are raised with poor genetic potential and depends on communal grazing for feeding as well as poor management under extensive production system, resulting in low yield and productivity. In Ethiopia, about ninety-five to ninety-seven percent of the country`s milk production is gained from local breed [2, 21].

In 2009, average milk production in Ethiopia was 1.86 liters per animal per day from dairy cows, with total production in the country estimated at around 4.06 billion liters, indicating that a per capita milk consumption of approximately 16 kg/year, resulting in very low when compared to the continent which was 27 kg/year and of the world`s 100 kg/year [25]. This shown that per capita milk consumption in Ethiopia is estimated to be about eleven percent of the WHO recommended levels (22 L s vs. 205 L) [28]. In Ethiopia, milk production was grows to approximately 4.4 billion liters in 2018, from this, 3.08 billion liters (70%) were for human consumption; of that, 57% was used for family consumption in the rural areas and 43% was processed and marketed via supply chains and the remaining 1.32 billion liters were wasted (20%) or consumed by calves (10%) [15].

The population growth in Ethiopia is higher than the annual rate of increase in milk production, resulting in the supply and demand for fresh milk are not balanced [25]. To solve this problem through the introduction of exotic and crossbred dairy cattle with combination of other interventions the government of Ethiopia plans to increase milk production fourfold by 2031 [27, 28]. Although genetic improvement programs for dairy livestock production have been launched in Ethiopia since the Italian colonial period, the desired results have not been achieved due to many reasons such as practical, structural and socio-economic constraints [1]. Despite ongoing efforts to improve productivity of dairy sector, the milk production and milk supply are very low, to solve this problem it is necessary to identify and analyze the milk production systems, the country's milk production potential and the factors affecting milk production. Therefore, the main purpose of this review is to overview the Milk Production Performance of Dairy Cattle in Ethiopia and recommend strategic intervention aimed at improving milk production performance that match the population growth and strengthen the role of the dairy sector in Ethiopia's food and nutrition security.

2. Literature Review

2.1. Dairy Production Systems in Ethiopia

Depending on agro-ecology, ways of life of the population and type and breed of animals used for milk production dairy production system can be categorized into two major systems: These are rural dairy system which includes pastoralists, agro-pastoralists, and mixed crop–livestock producers and the second category is urban and peri-urban dairy systems [4, 20].

2.1.1. Rural/Traditional Dairy Production System

According to [30] classification the rural dairy production system consists pastoralists, agro-pastoralists and mixed crop livestock producers. The pastoral system practiced in the lowlands of Ethiopia, which account for around ten percent of the country's population size [25], where livestock production is the primary way of life of the society's without crop cultivation. The population lives at altitudes below 1500 m. a.s.l and estimated cover 50-60% of the entire area [25]. The area is characterized by highly seasonal and erratic nature of the rainfall pattern, dairy farming system is traditional or small scale, which is dominated by indigenous local Zebu breeds (30% of the cattle population), contributing ninety-seven to ninety-eight percent of the total milk production per year of the country [1]. The rural dairy production system characterized by subsistence farming system and the products are not for sale and most of the milk produced is kept for family consumption [20], about eighty-five percent of the milk produced by pastoral farmers is used as a supplementary food for children and the elderly in pastoral families since it is the chief source of essential nutrients [1], the left over is provided for urban markets and stored to process it into other products through fermentation [30] with the proportion being marketed less than 7% [1]. In pastoralist system the demand for milk by the families and its neighbors, the performance of milk production in terms of cattle population size and production season, and market accessibility are factors that determines the level of milk surplus [4]. In this system Milk is used mainly for family consumption and stored in the form of fermented milk to make butter and *ititu,* a social food commonly reserved for guests for a longer term (for up to 30 to 60 days) [30]. Milk marketing is challenging in pastoral society due to lack of access to market outlets for dairy products and poor infrastructure such as absence of facilities to collect, chill and process milk resulting in about 20 to 35% of Postharvest milk and dairy product losses in the Ethiopia [21].

Agro-pastoralism is a subsistence system focused on coordinating crop production and livestock production, practiced among settled, nomadic and trans human communities and the system has similar but gradually sedentary ecological characteristics and livestock types [13]. Culture, climate, environment, topography, geography, and hydrology are factors that determines type of livestock reared in this production system. In agro-pastoral although its specific identification depends on type of animal reared, it is common to convert pasture land into crop production for the expansion of agricultural land, and the cereal crop residues and leftover from crop production serve as a source of animal feed in the area in addition to grazing land available as common for all grazers [30]. As compared to the pastoralist system, the system focuses on the milk market and it has better access of additional inputs including animal veterinary facilities and concentrates which are used as feed supplements from industrial by products and cultivation of improved grasses to calves and milking cows near to the newly started farm land to some extent [13]. In addition to being way of life of rural societies, agro-pastoralism plays important role in preventing and mitigating climate changes (according to the UNCCD). It helps in improving soil fertility, reduce soil erosion caused by overgrazing, and enhance nutrient utilization and water-holding capacity. On the other hand, agro-pastoralism plays major role in rehabilitation and land-based environmental air pollution mitigation by reducing grazing pressures elsewhere.

Mixed Crop-livestock production system is the other system of dairy production in which milk production is an integral part of the production system of smallholder, non- commercial subsistence-farms which represent among the 83.9 percent of the population and are contributes about 98 percent of the whole milk produced and 75 percent liquid milk produced for commercial purposes [13, 30]. The system was the typical dairy production system mainly practiced in the rural parts of the Ethiopian country and the periphery of the town by performing crop production and animal production in integrated form or in segregated form [20]. The system is characterized by rearing indigenous stock generally have low reproduction and production traits. The average age at first calving of 1590 days, average calving intervals of 750 days and average lactation yield of 524 liters, and extensive animal production system are practiced that is, the animals are mostly expected to feed for themselves through scavenging, mainly on natural grazing pastures and crop leftovers [30]. In mixed crop Livestock production, Livestock supports crop production by providing services like land ploughing, transportation of crops from production site to houses and their manure used as fertilizer, while crop Residues and aftermath contributes as an important source of animal feed [20].

2.1.2. Peri Urban and Urban Dairy Production System

Per-urban milk production system is the small to medium-sized farms practiced in areas having high demographic density and decreasing agricultural land size owing to urbanization around major cities like the capital city of Ethiopia. This sector is characterized by rearing mainly improved dairy breeds having blood level of 50% crosses to high grade Friesian and produces not more than two percent of the total milk production of the country [4, 13]. Most of the improved dairy breed animals in Ethiopia is used for per urban type production system [34]. The main feed sources for animals in this systems is improved forages purchased from locals, grass hay, agricultural by products and concentrate feeds and the system is known by having improved dairy farm facilities and inputs and services including AI, health services and extension from both public and private input and service providers [21].

Urban dairy farming is a more specialized farming developed in state sector and very few individuals on commercial basis, mostly concentrated in and around Addis Ababa and the herd is dominated with improved/crossbred or exotic pure bred stock dairy cattle [4, 25]. [13] emphasized that the average number of crossbred dairy cattle was smaller in per urban areas than in urban dairy cattle production systems. The production system is intensive management system in which animals are housed in pens and are fed a commercial ration of forage, feed supplements, or various agro-industrial by-products through a trough [25]. This production system is when compared to other systems have relatively better access to production factors and facilities like feed, artificial insemination, veterinary services and market outlets thus, milk production is for sale [4]. [33] reported that among the total urban milk production 73 percent is sold, 10 percent is kept for family consumption, 9.4% for calves and 7.6% is fermented and changed into butter and ayib or cottage cheese. Informal marketplaces are used that is fluid milk is sold by arranging through direct contact between farmers and end users, and/or involves wholesalers/ processors, cooperatives, and retailers and characterized by limited supply of milk due to small volume of milk produced in this system [4, 25].

2.2. Milk Production Performance Indicators

2.2.1. Daily Milk Yield (DMY)

Milk production per day is a significant measure of production performances, as it combines total milk production with a period of lactation length. Cows produce more milk at a lower cost if their daily milk production is higher during lactation period, thus, achieve greater cumulative milk yield [28]. Based on average milk production throughout the lactation period it is possible estimating of milk yield per day of lactation length (MY/DLL) without considering of adjustment for the initial low yield, peak production, or the declining phase at the end of lactation [40].

Daily milk yield will be influenced by breeds of animals. [28], reported substantial variation in daily milk yield among breeds and the highest and lowest mean daily milk yields were recorded as 8.8 and 8.2 L for HF crosses and pure HF breeds,

respectively, and 4.5 and 4.2 L for HF × Fogera and Jersey × Horro (Jersey crosses with other local breeds), respectively. Daily milk yield (DMY) variation also reported for local and crossbred in Gondor town, average daily milk yield of Zebu breeds cows was 2.8 litres per day per cow while 5.2 litres per day per cow for crossbred dairy cows [5]. [40] reported substantial differences in daily milk yield due to agro- ecology impacts on feed access in their study area. Production system also influences the average daily milk yield of dairy cattles [2].

Table 1. *Milk Production Performances of Different Dairy Cattle Breeds in Ethiopia.*

No	Breed of Cattle	Average Daily milk yield (ADMY) (in Liters)	Lactation length (in days)	Av. Lactation milk yield (in Liters)	References
1	Fogera cattle	1.98±0.2	243±0.3	489 ±7.50	[23]
2	Boran cattle (Central)	1.7±0.1	298.24	507±39	[22]
3	Kereyu cattle	1.8±0.84	295	531	[18]
4	highland Zebu (Gojam)	1.6±0.5	297	475.2	[32]
5	Barka/Barca cattle	2.98±0.69	279± 24	672±196	[36]
6	Arsi cattle	2.7	299.62	809	[26]
7	Fresian cross Zebu cattle	2.8	303	929	[26]
8	Boran cattle	2.8±0.15	193±6	529±65	[14]
9	Horro cattle (Bedele)	2.2±0.5	190	418	[17]
10	HF cross Borena	6.9 ± 2.56	345.5 ± 34.01	2221.3 ± 510.13	[28]
11	HF cross Arsi	6.1 ± 2.15	312.3 ± 51.89	2177.7 ± 407.06	[28]
12	HF cross Fogora	4.5	310.9	1399.05	[28]
13	HF cross Barka	6.1 ± 0.86	332.9 ± 43.41	1925.7 ± 369.77	[28]
14	Jersey cross Borena	5.1 ± 0.07	336.4 ± 27.64	1733.2 ± 311.20	[28]
14	Jersey cross Arsi	5.212	334.0	1741.0	[28]

2.2.2. Lactation Length

Lactation Length (LL) is the duration for which a cow continues to give milk production in one parturition. Lactation length (LL) is a major production performance indicator in dairy cattle, as it directly concerned with farm milk production efficiency. It is highly affected by breeds of animals, the average lactation length of exotic breeds is 305 days and results in higher milk yields generally in crossbred cows and pure exotic breeds under intensive management [28], while low lactation length results in low milk production for indigenous cows, that is the average lactation period for local cows in Ethiopia is estimated to be about 180 days [2] and (Table 1). For example, in Gondar town and nearby kebeles the overall lactation length of 10.27 months was reported for both local cows and crossbred cows, indicating the estimated average lactation length for local cows was 297 days and the average lactation length of cross bred dairy cow in Gondar town was 12.15 months [5]. A lactation length of 305 days is often considered the baseline in modern dairy farming [23].

2.2.3. Lactation Milk Yield (LMY)

In Ethiopia indigenous breeds produces very low milk yield as compared to exotic breeds and this is influenced by parity, repetition of milking, persistency of yield, Breed of cows, season of lactation and husbandary practices [2]. In our country, crossbred dairy cows have more milk production performances than local breeds due to heterosis effect [7]. Despite their low milk yield Local cows are known by contributing the main of milk production of the country that account for approximately 97% of the total milk production in Ethiopia [2, 19]. According to [8] in modern dairy production a good average milk yield per cow for a year should at least range between 2900 to 3600 liters. For instance, Friesian cows under intensive management expected to produce an average milk yield of 3,825 liters per year with an average lactating period of 305 days. [29] reported that the highest mean lactation milk yields were observed in Holstein-Friesian (HF), HF crosses with other breeds, and HF × Borena crosses, with mean values

of 3,191.7, 2,613.2, and 2,221.3 L per cow per lactation, respectively. However, the lowest mean values were reported for Jersey × Barka (1675.5 L), Jersey × Arsi (1741.0 L), and Jersey × Borena (1733.2 L) crossbred cows. [5] observed the overall average lactation yield of local and cross bred cows was 1365.6 litres of which 781.2 litres were for local cows and 1950 litres per lactation for cross bred respectively in Gondor and surrounding kebeles.

2.3. Factors Affecting Milk Production Performance

2.3.1. Breed

Breed of cows significantly affects milk yield. The differences between breeds can leads to variation both in amount of and contents of milk [3]. Ethiopian dairy cattle are better suited to the country`s agro ecology and are disease resistant but they produce low milk yield per lactation. There is large variation between these local breeds in lactation milk yield and lactation length, for example some local breeds such as Begait and Borana demonstrated good potential for milk production [21]. Due to low productivity of local cattle's, currently the country`s dairy industry is unable to meet the increasing demand for milk production in the country [31]. To match this demand and supply of milk and milk products in Ethiopia, there is a need to improve cattle productivity through genetic improvement [22, 31]. The 50% blood level F1 and 75% first generation crossbred as dairy cows were preferred for producers in actual milk production in Ethiopia, as there were no excessive performance differences on the long-term experiment on station condition [8], This indicates that Crossbred cows with fifty to seventy-five percent blood level able to gives better milk production whereas, reproduction traits declines as exotic blood level exceeds beyond 50% [19]. In Ethiopia Improved or crossbred's cows contributes 3% of overall milk production of the country [34].

2.3.2. Age of the Animals

Age of the animal significantly affect their milk yield as it determines lactation length and milk production potential. As the age of animal increases hormone secretion of the animal body, metabolic activity, secretory cells and nutrient intake increases resulting in increases of milk yield [3]. According to [29], reports milk production increases with age at a decreasing rate until peak production is reached at around 6 to 8 years, Production then declines with advancing age. As the age of cattle advances their energy-corrected milk (ECM) yield also decreases, contributing negative effects on the performance of offspring [35].

2.3.3. Feed Resources and Nutrition

Feed is a bottleneck for the dairy sector because it determines the milk yield and quality [8]. In Ethiopia the major source of animal feed is grazing on communal natural pastures [9]. [25] reported that natural grazing provides 73 percent of the feed, crop residues 14 percent, improved forages 0.2 percent, and the remaining 12.08 percent is gained from other feed sources. Both roughage and concentrate feeds are either inadequate in quantity or poor quality and unaffordable to improve dairy production [4]. The total amount of feed produced does not meet the demand of feed by animals under traditional management in developing countries for example the quantity of dry matter required by animals is estimated to 7% less than what is needed by the animals [21, 25]. Lack of soil fertility and limited seasonal rainfall have substantial impact on feed availability and nutritional quality, particularly during the dry season in Ethiopia [25].

2.3.4. Animal Health and Disease

In Ethiopia the major diseases that affecting livestock production and productivity by decreasing reproduction, milk production, milk quality and causing mortality and morbidity are mastitis, trypanosomiasis, internal and external parasites, bloating, anthrax and black leg [4]. These diseases are expanding due to shortage of animal health experts, inadequate and unaffordable medicines and lack of adequate transport services in the country. Tick-borne diseases like East Coast Fever, anaplasmosis, babesiosis (Red water fever) and heart water disease, are great killers of cows, particularly exotic ones [8]. According to [10], Mastitis a disease mainly concerned with poor management is a common and significantly affecting milk production with losses of about 5% in subclinical cases to 50% in severe cases [12] and animal welfare. It also resulting in deterioration in milk quality, decreasing revenue for farmers due to decreased milk production, increased discarded milk, higher costs for antibiotics, and increased cow culling [10, 16]. In addition to its deterioration in product yield and an overall decrease in milk production among affected animals, it also contributing to the global warming (GW) through greenhouse gas (GHG) production [16]. Keeping the farms clean, tick control, vaccinating animals against common diseases, and traffic control through fencing is necessary to control diseases in dairy farming [8]. Reducing the risk of mastitis contributes not only for enhancing production levels but also diminishes environmental impact [16].

2.3.5. Environmental and Climatic Factors

Dairy sector in developing countries is vulnerable to climate change and variability through increased temperatures and variation in rainfall patterns that creates influences on animal health and breeds, the access to feed and water, and milk yield [24]. A thermal environment substantially affects milk production in dairy cows, primarily high-yielding cows. The combined effect of accumulated heat from the environment and heat generated during the metabolic processes associated with maintenance and milk production makes animals susceptible to heat stresses in the tropics [37]. Heat stress can reduce milk production by affecting the number and size of the mammary glands during the dry season, resulting declining of milk

yield of about 10%-15% and 40%-50% on farms that use cooling procedures, and farms do not use cooling procedure respectively [11]. Thus, necessitating protecting dairy cows from climate change impacts.

3. Conclusion and Recommendation

3.1. Conclusion

Dairy farming is an important pillar of the national economy in Ethiopia, contributing as source of essential nutrition and livelihoods for millions of small-scale households in rural and urban area of the country. Dairy production systems are traditional and most of the cattle breeds used in the system are indigenous breeds which have poor genetic potential that yield low amount of milk per lactation. In Ethiopia rural dairy production system contributes about 97%–98% of the total milk production per year of the country and most of the milk produced is used for family consumption, since the farming system is not market oriented. About 20 to 35% of Postharvest milk and dairy product losses occurs in the pastoral areas of the country due to inadequate milk markets access and poor infrastructure like transportation and road. In Urban dairy production system there is improved facilities like feed, artificial insemination services, animal health clinics and market outlets than the traditional dairy production system in the rural areas thus, milk production is market oriented and 73% of milk produced is provided for markets. Despite large cattle population (about 58 million heads) and favorable climatic conditions, the self-sufficiency in milk production was not yet attained in Ethiopia due to increasing population, rising income and urbanization. This is aggravated by low milk production potential of indigenous cows and low success rate of cross breeding program for genetic improvement [31]. Even though, in Ethiopia crossbreeding indigenous cows with exotic breeds such as Holstein Friesian and Jersey was introduced in the 1930s to improve milk production, milk production performance is inconsistent and inefficient [28]. Milk production performance of dairy cattle are mainly affected by breeds of animals, age of the cows, quantity and quality of feeds, diseases and climatic factors. It is necessary to address these problems and improve productivity to ensure that the dairy sector makes an effective contribution to food security and the national economy.

3.2. Recommendation

In Ethiopia the following strategic interventions are recommended to improve milk production performance and enhancing its contribution to the country`s food security and national economy:

1) Productivity of local animals should be improved trough targeted crossbreeding programs using adaptable exotic breeds like Holstein Frisian and Jersey cattle.
2) Developing feeding and nutritional innovation that enhances availability and quality of feed through improved forage development, efficient use of agricultural by products and crop residues, practicing feed supplementation during dry season.
3) Paying attention to animal health services, it is necessary to expand and strengthen animal health service institutions in terms of trained human resources, provide adequate supply of medicines and improve the awareness of farmers, above all, vaccination and hygiene should be given priority to prevent diseases, and treatment should be practiced if they occur.
4) Government and all stake holders should participate in enhancing productivity in rural systems through introducing improved management systems particularly in pastoral and mixed crop livestock where most of milk production is obtained, but productivity is low.
5) Enhancing peri urban and urban milk production by providing sufficient inputs like Artificial insemination, feed and veterinary services to boost milk production performances.
6) Promoting climate smart dairy production system to overcome challenges of climate stress impacts and to reduce livestock production contribution to climate changes and global warming.

Abbreviations

AI	Artificial Intelligence
GDP	Gross Domestic Product
DY	Daily Milk Yield
GG	Greenhouse Gases
HF	Holstein Frisian
LL	Lactation Length
LY	Lactation Milk Yield

Author Contributions

Ediris Abdulkadir Meko: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Supervision, Visualization, Writing – original draft, Writing – review & editing

Conflicts of Interest

The author declares no conflicts of interest.

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