Economic, Social, and Environmental Aspects of Dairy Farming in sub-Saharan Africa: A Literature Review

Abstract:

This literature review on dairy cattle rearing in sub-Saharan Africa aims to provide an in-depth analysis of the current situation of this activity in the region. It examines the various dimensions of dairy farming, such as its economic importance, its impact on food security and its role in poverty reduction. The review also looks at existing farming systems, factors influencing dairy cow productivity, constraints and challenges faced by farmers, good practices and innovations, environmental impacts, and policies and programmes to support dairy cow farming. The aim of this review is to provide valuable information for improving this activity in the region.

Keywords: dairy cows, sub-Saharan Africa, farming practices, constraints and challenges

1. Introduction

Dairy farming in sub-Saharan Africa plays a crucial role in the region's agricultural and food economy, providing livelihoods and significantly contributing to both local and national economies. This sector is vital for food security and job creation in rural areas(FAO, 2010). This literature review aims to consolidate existing knowledge on dairy farming in the region, better understand farming practices, identify challenges faced by farmers, and explore potential solutions to enhance the productivity and profitability of this sector[55-58].

1.1.Objective of the literature review

The aim of this literature review is to synthesize available information on dairy farming in sub-Saharan Africa, analyze the related issues, and highlight opportunities and challenges. It also seeks to identify gaps in current knowledge and propose recommendations for future research and interventions.

1.2.Methodology

To carry out this literature review, we conducted an in-depth search for relevant sources, consulting specialized books, scientific articles, government reports, case studies, and academic databases to gather accurate and reliable information on dairy farming in sub-Saharan Africa. We critically analyzed these sources and selected the most relevant and up-to-date information for this review, providing a comprehensive overview of the region's dairy farming situation.

2. Economic and social importance of dairy farming

Dairy farming significantly contributes to the local economy in sub-Saharan Africa, being a major income source for many rural households. It not only provides milk for consumption and sale but also creates direct and indirect employment, promoting local economic development.

2.1.Contribution to the local and national economy

Agricultural sector contributes significantly to the GDP of most SSA'countries and taken as priority in their development agenda. Over the past decades smallholder dairy farming made important contribution to the increase of 37% in milk yield and is projected to rise at an annual average growth rate of 2.5% (OECD/FAO, 2016). The livestock subsector accounts for about 5% of the total gross domestic product (GDP) in sub-Saharan Africa.According to Tadesse et al., (2017), in Ethiopia, milk and milk products contributes 63 percent to gross value of ruminant livestock production. The GOE has been underestimating the contribution of livestock and especially milk to the agriculture gross domestic product for the country (Land, 2010).

2.2.Job creation and income generation

The dairy sector offers direct employment for farmers and indirect employment in the value chain, including transport, processing, and marketing of milk. According to FAO (2010), 12 to 14% of the world population (an estimated 750 to 900 million people) lives on dairy farms or

within dairy farming households. For instance, around 1.6 million households in Tanzania rely on dairy production for their livelihoods (Otte & Upton, 2005).Employment and income from dairy will vary between and within production systems because of differences such as feed sources, management systems, herd sizes, form of milk disposal patterns and access to or use of technology. In Ethiopia, traditional smallholder mixed farming systems generate several times more employment but low income per unit of milk produced compared with urban and peri-urban dairy systems because of low productivity of animals in the former. In both systems, over two-third of the labour requirement is provided by children as they usually do the herding. Mostly women are involved in traditional milk processing and marketing (Yilma, 2011). Haile, (2009) estimated that labour use in various dairy processing and marketing activities in different production systems and scales of operation in Ethiopia totalled an equivalent of 174, 000 full-time jobs in 2004. Staal et al., (1998) reported that the urban/peri-urban system creates annually 4.4 million person days of work or 16, 400 full-time jobs, while the small-scale mixed farming systems create 166 million person days of work, equivalent to 553, 500 full-time jobs. The production of one million litres of milk per year on small-scale dairy farms creates approximately 200 on-farm jobs. In 2010, dairying created an estimated 588, 000 full-time on-farm jobs in the country (FAO, 2010).

2.3.Multiplier effects on the economy

Milk-producing households often reinvest their income in local goods and services, thereby stimulating the rural economy. This reinvestment can have a multiplicative effect, as the money circulates within the community, promoting overall economic growth. For instance, in Kenya, profits from milk are frequently used to cover educational expenses for children, which enhances human capital and opens up future economic opportunities for the next generation (Wambugu, Kirimi, & Opiyo, 2011). Additionally, these profits are often invested in improving housing conditions, leading to better living standards and health outcomes for the households involved. Furthermore, milk income is used to purchase additional livestock, which not only diversifies income sources and reduces financial risk but also increases agricultural productivity and food security. This cycle of reinvestment highlights the critical role that dairy farming plays in enhancing the livelihoods and resilience of rural communities (Wambugu, Kirimi, & Opiyo, 2011).

2.4.Income diversification and risk reduction

Dairy farming also makes it possible to diversify the sources of income of farming households, thereby reducing their vulnerability to economic and climatic shocks. By diversifying their economic activities, farmers are able to better manage the risks associated with crop price fluctuations and adverse weather conditions. (Thornton & Herrero, 2010).

2.5.Development of rural infrastructure

Rural infrastructure is often improved by the development of the dairy sector. Transporting fresh milk to urban markets, for example, can encourage the creation and maintenance of rural roads. According to Duteurtre & Corniaux (2013), milk collection centres and processing units play a role in improving local infrastructure.

3. Impact on food security and poverty reduction

3.1.Improving food safety

Dairy farming plays a crucial role in improving food security and reducing poverty in sub-Saharan Africa. It provides a regular source of nutritious dairy products and generates stable income, enabling households to diversify their diets and invest in better living conditions. According to Tadesse (2017), livestock, milk and milk products play an important role in the food security status in both highland and pastoral communities. In pastoralist regions, livestock are owned by a large percentage of the population. According to Staal, Pratt, & Jabbar (2008), in many sub-Saharan African countries, dairy products form a significant part of the diet of rural households. In Kenya, milk is an important source of nutrition for children and adults, contributing to household food security.

3.2.Generating stable income

Farm households benefit from a stable source of income through the sale of milk and dairy products. This income enables families to purchase other foods, thus diversifying their diet and improving overall food security. According to Otte and Upton (2005), in Uganda, milk production enables households to earn a steady income throughout the year, even during periods of drought when crops may fail.

3.3.Poverty reduction

Dairy farming plays a crucial role in reducing poverty by offering economic opportunities to poor households. Income generated from the sale of milk can be used to improve living conditions, access education and healthcare, and invest in other economic activities.

Kristjanson et al (2010) have shown that households that own livestock, including dairy cows, often have a higher standard of living and are less likely to live in extreme poverty. According to Thornton and Herrero (2010), households involved in dairy production in Tanzania have been able to improve their living conditions thanks to the income generated by the sale of milk.

3.4.Empowering women

Dairy farming also has a positive impact on women's empowerment. In many countries in sub-Saharan Africa, women play a central role in managing dairy cows and selling milk. This activity enables them to generate income and strengthen their socio-economic position within the community. Njarui et al (2011) found that women involved in dairy production in Uganda and Kenya were able to access financial resources and improve their participation in family and community decision-making. This empowerment contributes not only to poverty reduction, but also to improved food security.

3.5.Strengthening local food systems

Dairy farming helps to strengthen local food systems by creating links between producers, processors and consumers. Local dairy products are often more accessible and affordable for rural communities, improving food security. Duteurtre & Corniaux (2013) have shown that in certain regions of West Africa, local dairy systems play a crucial role in supplying local markets with fresh dairy products. These systems support not only food security, but also the local economy by creating jobs and stimulating economic activities.

4. Existing dairy farming systems in sub-Saharan Africa

Dairy farming systems in sub-Saharan Africa vary based on resources and traditional practices. Extensive farming relies on abundant grazing resources, semi-intensive farming combines traditional and modern techniques, and intensive farming, though less common, is found in urban areas with high milk demand.

4.1.Extensive farming systems

Extensive dairy farming in sub-Saharan Africa is widely practised in areas with abundant grazing resources. In this system, the cows are reared freely and feed mainly on grass and wild plants. The animals often have limited access to concentrated feed, which affects their milk productivity. Extensive livestock farming can be a viable option in areas where grazing land is extensive and farmers have limited means of purchasing feed. Nomadic or semi-

nomadic pastoralists, such as the Maasai in Tanzania and Kenya, practise extensive livestock farming using large tracts of land for grazing (Duteurtre & Corniaux, 2013). These systems rely on the mobility of herds to access pasture and watering points, which helps to maintain livestock productivity despite difficult climatic conditions.

Apart from extensive livestock farming, there are other livestock farming systems such as semi-intensive livestock farming.

4.2.Semi-intensive farming systems

Semi-intensive livestock farming systems are generally practised in peri-urban and rural areas of regions with moderate rainfall. These systems combine traditional husbandry techniques with modern practices to improve productivity. Cattle are often kept in paddocks and fed a combination of natural pastures, fodder crops and feed supplements. In Uganda, for example, small-scale dairy farmers use semi-intensive systems to increase milk production while reducing production costs (Moll & Kaganzi, 2008). These systems also enable better management of natural resources and a reduction in the environmental impact of livestock farming.

In addition, there is also a third farming system, which is intensive farming.

4.3.Intensive farming systems

Intensive farming systems are less common in sub-Saharan Africa because of the high costs and infrastructure requirements, but they do exist in some urban and peri-urban areas where demand for milk is high. In these systems, cows are kept in barns and fed balanced rations to maximise milk production. According to Bebe et al (2003), some large dairy farms in Kenya are opting for intensive systems incorporating modern technologies such as mechanical milking, computerised herd management and advanced animal nutrition techniques. These systems offer the potential for high and consistent milk production, but require significant investment in capital and skills.

5. Factors influencing farming systems

Several factors influence dairy farming systems in sub-Saharan Africa, including the availability of natural resources, market access, government policies, and breeders' knowledge and skills. Climate variations and proximity to urban markets play significant roles in determining the profitability and sustainability of farming systems.

5.1.Availability of natural resources

The availability of water and pasture resources is directly affected by climatic variations, such as prolonged droughts and floods, which have a direct impact on livestock productivity. According to Thornton et al (2011), severe droughts can cause significant livestock losses due to pasture and water scarcity, increasing the vulnerability of livestock keepers. Due to global climate change, these extreme weather conditions are becoming increasingly common, requiring robust adaptation strategies for livestock farming communities (Herrero et al., 2010).Another major problem is soil deterioration, caused by overgrazing and erosion, which reduces the availability of quality feed for animals and has an impact on their health and productivity. In addition, according to the FAO (2018), it is essential to implement irrigation systems, build reservoirs and manage water resources in an integrated manner in order to ensure an adequate water supply for animals.

5.2.Market access

Access to markets is crucial for marketing dairy and other livestock products. According to Staal et al (2008), inadequate transport infrastructure, such as poorly maintained or non-existent roads, restricts this access and hampers marketing, resulting in lower incomes for livestock farmers. The development of transport infrastructure and local markets can facilitate access to markets and increase income opportunities for livestock production. In addition, the difficulty of obtaining credit and financial services restricts farmers' ability to invest in innovative practices and technologies. According to Nyariki &Amwata (2019), microfinance institutions and subsidy programmes can play an essential role in providing the resources needed to integrate innovations and increase productivity.

5.3.Government policies

There are various forms of government subsidy, such as direct aid for the purchase of agricultural machinery and equipment, subsidies for animal feed and tax benefits for dairy farmers. For example, financial support for animal feed helps to reduce production costs, which is of vital importance in times of drought or fodder shortages (Duteurtre & Corniaux, 2013). Financial support can also encourage the use of contemporary technologies such as irrigation systems or milk cooling units, which improve the quality and quantity of milk production. In order hand, farmers have in general limited opportunity and authority to participate in decision making processes for what is economically, socially and culturally good for them. Most obviously, government intervention is based on a top-down development approach which has lead to the imposition of ideas (Tesfaye, 1990).

5.4.Breeders' knowledge and skills

Improving the productivity of livestock systems in sub-Saharan Africa requires training and access to information on good livestock management practices, animal nutrition and veterinary health (Moll & Kaganzi, 2008). Modern breeding and pasture management techniques are integrated into livestock management. Balanced rations and appropriate nutritional supplements are essential for animal nutrition. The aim of veterinary health is to prevent and treat disease by providing training and access to veterinary services. Best practices can be rapidly disseminated through extension services, online platforms and mobile applications. Thanks to these initiatives, production increases, product quality is improved and rural communities are more economically resilient.

6. Constraints and challenges for dairy farmers

Dairy farmers in sub-Saharan Africa face numerous constraints, including economic challenges, natural resource management issues, limited access to veterinary services, feed resources, and a low level of farmer training. Addressing these constraints requires comprehensive support programs and targeted interventions

6.1.Economic constraints and access to markets

Dairy farmers in sub-Saharan Africa face major economic challenges, such as the high cost of agricultural inputs, low profitability due to the volatility of milk prices on local and regional markets, and difficulties in accessing formal markets. According to the study by Bebe et al (2003), these economic constraints can hamper the financial viability of family dairy farms.

6.2.Natural resource management

Farmers face problems in providing sufficient feed for their cows due to a number of factors, including a shortage of grass and quality forage. According to Thornton et al (2011), this can lead to reduced milk production and health problems in cows. In addition, concentrated feeds are often expensive, which often makes them difficult to access for many farmers, who have financial constraints (FAO, 2018). It is vital to implement agricultural development programmes that encourage growth in fodder production and offer farmers financial support to buy feed for their cows (Moll & Kaganzi, 2008).

6.3.Access to veterinary services and health management

According to Grace et al (2013), limited access to veterinary services and quality medicines is a major obstacle for dairy farmers in sub-Saharan Africa. Animal diseases such as foot and mouth disease (FMD) and mastitis have devastating effects on milk production. Foot-and-mouth disease, a highly contagious viral disease, causes painful lesions in animals, reducing their food and water intake, leading to weight loss and a significant drop in milk production. Mastitis, an inflammation of the mammary gland, reduces the quantity and quality of milk produced, sometimes making the milk unfit for consumption. The lack of accessible veterinary services means that many diseases are not diagnosed or treated in a timely manner, leading to the rapid spread of infections and high mortality rates. Lack of regulation of veterinary medicines compounds this problem, and farmers may not be informed about their correct use, leading to poor administration and the emergence of resistance.

6.4.Access to food resources

Access to feed resources is a major challenge for dairy cow farming in sub-Saharan Africa. Farmers face difficulties in obtaining adequate feed for their cows due to various factors, such as the limited availability of grass and quality fodder. This can lead to lower milk production and health problems for the cows. In addition, the high cost of concentrates often makes them difficult to access for many farmers with limited financial resources. To overcome these constraints, it is essential to put in place agricultural development programmes that encourage growth in fodder production and provide financial support to farmers for the purchase of feed for their cows.

6.5.Low level of training of farmers

Low levels of farmer training are a major challenge in dairy farming in sub-Saharan Africa. Many farmers lack the knowledge and skills to manage their dairy herds effectively, which limits their ability to maximise productivity and income. A lack of knowledge about nutrition, animal health, reproductive management and genetic selection can have a significant impact on dairy cow performance. To remedy this situation, it is important to set up training and education programmes for farmers, to build their capacity and equip them with the skills they need to improve the management of their dairy herds. In addition, the exchange of knowledge and experience between farmers can also help to improve the level of training and encourage the adoption of more efficient husbandry practices. According to Gebremedhin et al (2007), the adoption of modern husbandry practices and access to appropriate agricultural

technologies, such as livestock genetic improvement and irrigation systems for fodder crops, are major challenges for many dairy farmers in the region.

7. Good practice and innovation in dairy farming

Adopting good practices and innovations in dairy farming is essential to improve productivity and profitability. Key strategies include improving cow nutrition, utilizing advanced reproductive techniques, and implementing modern milking technologies.

7.1.Improving cow nutrition

Improving the nutrition of dairy cows in sub-Saharan Africa is essential to maximise their milk production. Farmers can use several strategies to achieve this objective. Firstly, they need to provide balanced rations made up of an appropriate combination of forage, concentrates and nutritional supplements. Access to quality feed resources is also crucial. Farmers can opt to graze on nutrient-rich land or grow forage crops suited to their climate. In addition, the use of feed conservation techniques, such as silage or hay, can ensure a regular supply of feed during periods of shortage. Finally, the provision of an adequate quantity of clean, fresh water is essential for maintaining the health and milk production of cows.

7.2.Advanced reproduction techniques

Advanced reproductive techniques are used in dairy farming in sub-Saharan Africa to improve animal fertility and reproduction. Artificial insemination (AI) is one such technique that has been widely adopted. It allows the use of semen from bulls of high genetic quality, thus improving the potential of dairy cows. AI also offers an effective alternative to natural reproduction, allowing farmers to control and optimise herd reproduction. In addition, the heat synchronisation technique is used to group cows in heat and facilitate the use of AI on a large scale. These advanced reproduction techniques are helping to increase the productivity and genetic improvement of dairy herds in sub-Saharan Africa.

7.3.Use of modern milking technology

The use of modern milking technologies offers many advantages in dairy farming in sub-Saharan Africa. Farmers can opt for mechanised milking systems, such as automated milking machines, which enable faster, more efficient and more hygienic milking. These systems reduce milking time and minimise the risk of milk contamination by pathogens (FAO, 2018). What's more, they improve cow comfort, reduce stress and promote higher milk production. Modern milking technologies are also accompanied by milk management systems, such as

refrigeration and adequate storage, to guarantee the quality and safety of the milk produced (Duteurtre & Corniaux, 2013). The adoption of these technologies enables farmers to optimise their milk production and access markets that are more demanding in terms of quality and standards.

8. Environmental impact of dairy farming

Dairy farming in sub-Saharan Africa has significant environmental impacts, including greenhouse gas emissions, land and water degradation, and waste management challenges. Strategies to mitigate these impacts include improving cow feeding practices, adopting sustainable land management techniques, and implementing effective waste management systems.

8.1.Greenhouse gas emissions (GHG)

Greenhouse gas emissions are a major environmental impact of dairy farming in sub-Saharan Africa. Cows produce methane, a more potent greenhouse gas than carbon dioxide, when digesting their feed. According to Gerber et al (2013), dairy farming contributes to greenhouse gas emissions, mainly through the production of enteric methane by ruminants. These emissions contribute to global warming. According to FAO and GDP (2018) cited by Hakuzimana et al (2021), GHG emissions from dairy sector have dramatically risen by 18% between 2005 and 2015 due to the increased consumption demand globally. During this period 4% of all global anthropogenic GHG emissions have been contributed by dairy sector. In 2015 the dairy sector in developing regions such as SSA, South Asia, West Asia and North Africa were found to have higher emission ranging between 4.1 to 6.7 kg CO□ eq. per kg fat-and-protein corrected milk (FPCM).Efforts must be made to reduce these emissions, in particular by improving cow feeding practices and promoting more sustainable farming systems.

8.2.Land and water degradation

Intensive dairy farming contributes to land and water degradation. Pastures are often overgrazed, leading to a reduction in soil fertility and erosion. Deforestation to create new pastures exacerbates this problem. In addition, the dairy industry requires large quantities of water for the needs of the cows and for milk production. This can lead to overexploitation of water resources and contamination of water sources by livestock waste (Steinfeld et al., 2006). According to Tadesse et al (2017), Environmental issues associated with the pastoral

and highland small-holder dairy production systems are overgrazing and land degradation that are the results of continuous utilization of crop lands and communal grazing lands without rehabilitation and conservation works. Hygienic and sanitary hazard and pollution of soil, water and air due to a large volume of waste and close human-animal interaction are environmental risks associated with the urban, peri-urban and the intensive commercial dairy production systems (FAO, 1999). Sustainable land and water management measures need to be put in place to limit these negative impacts.

8.3.Management of waste from dairy cows

Livestock waste management is a major challenge in dairy cow farming in sub-Saharan Africa. Cow excrement contains nutrients such as nitrogen and phosphorus, which can be beneficial if used as fertiliser. However, if this waste is not properly managed, it can pollute soils and water sources (Thornton and Herrero, 2010). Storage and treatment systems for livestock waste are often inadequate, leading to risks for the environment and human health. It is crucial to adopt appropriate livestock waste management practices, such as the creation of purification farms, to minimise the environmental impact of dairy farming.

9. Policies and programmes to support dairy farming in sub-Saharan Africa

Policies and programs play a crucial role in supporting dairy farming in sub-Saharan Africa. Subsidies, financial incentives, and farmer training programs have been implemented to encourage investment and improve productivity. Successful initiatives, such as Ethiopia's 'National Livestock Development Plan' and AfDB's financial support programs, have significantly benefited the dairy sector

9.1.Subsidies and financial incentives

Subsidies and financial incentives are essential tools for supporting dairy farming in sub-Saharan Africa. Governments and international organisations provide subsidies to farmers to help them acquire modern milking equipment and materials, improve livestock infrastructure and build their technical capacity. According to MOaALR (2015), in Ethiopia, the government has launched the ‘National Livestock Development Plan’ which includes specific measures to improve the productivity and sustainability of dairy farming. In addition, financial incentives are provided in the form of loans at preferential rates for the purchase of dairy cows of high genetic quality. In this sense, the African Development Bank (AfDB) has launched financial support programmes for smallholder dairy farmers in sub-Saharan Africa, facilitating access

to credit and investment in agricultural infrastructure (AfDB, 2018). These measures aim to encourage farmers to invest in dairy farming and improve the productivity and profitability of their farms.

9.2.Training and education of farmers

Farmer training and education are key to improving dairy farming in sub-Saharan Africa. Governments and organisations are developing training programmes to enhance farmers' skills and knowledge. For example, the Food and Agriculture Organization of the United Nations (FAO) has implemented training and capacity-building programmes for dairy farmers, particularly in the areas of sustainable animal husbandry practices and efficient resource management (FAO, 2018). These programmes cover topics such as feed management, animal health and welfare, reproductive management and genetics. They also provide advice on good husbandry practices and advanced techniques. By strengthening the training and education of farmers, we can expect to see an improvement in the productivity and profitability of dairy farming in sub-Saharan Africa.

10. Conclusion

In conclusion, this literature review highlights the crucial role of dairy farming in sub-Saharan Africa's economy, food security, and rural development. Despite significant challenges, opportunities for growth and investment exist. To achieve sustainable development in the dairy sector, coherent government policies, strategic investments, and active stakeholder engagement are essential.

11. Recommendations for improving dairy cow breeding

To improve dairy cow breeding in sub-Saharan Africa, it is crucial to:

- enhance access to feed resources, strengthen disease prevention and control measures,
- develop infrastructure and technologies, and
- improve farmer training and education.

- improve productivity of local animals

Implementing these recommendations will promote sustainable improvements in dairy farming across the region.

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