

An Overview of Livestock Role in Ensuring Food and Nutrition Security: The Case of Ethiopia

Getiso A* and Mijena D

Ethiopian Institute of Agricultural Research, Ethiopia

***Corresponding author:** Aman Getiso, Ethiopian Institute of Agricultural Research, Wondogenet Agricultural Research Center, P.O. Box: 198, Shashemene, Ethiopia, Email: aman.getiso@yahoo.com

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Abstract

This review aimed to deliver and document summarized information on the contribution of livestock to food and nutrition security, both generally and specifically in the case of Ethiopia. Livestock have made both positive and negative contributions to food and nutrition security. Positively, they provide high biological value, palatable, and nutrient-dense food sources such as milk, meat, and eggs for human consumption. They also offer quick income, employment, source of fuel, social functions, raw materials for industry (hide and skin.... etc.), input for soil fertility (manure) and draft power, indirectly contributing to stable food cultivation. However, livestock also pose negative impacts on food and nutrition supply by competing with humans for grains, utilizing fodder crop lands, emitting greenhouse gases, and transmitting zoonotic diseases to humans. In Ethiopia, trends in livestock populations and food production levels reveal disparities between actual consumption and productivity compared to available resources. Energy, protein, and fat supply from the livestock sector has increased from 2010 to 2021. Yet, the country's per capita consumption of dairy, meat, and eggs remains below global averages, exacerbating undernutrition, particularly in rural areas. Livestock products are rich in high-quality protein and essential micronutrients crucial for growth and development, especially in children and infants. Enhancing nutritional outcomes in Ethiopia necessitates addressing barriers to livestock output and promoting the consumption of livestock-derived foods. Tackling underlying issues impeding livestock productivity is equally vital as efforts to enhance productivity and ensure access to livestock-based foods.

Keywords: Consumption; Food; Livestock; Nutrition

Introduction

Livestock production plays a dynamic role in enabling smallholders to have resilient livelihoods and avoid both food shortage and poverty, as livestock can contribute up to 33% of the household income. Livestock products are vital for hundreds of millions of people worldwide as a means of food security, nutrition, livelihoods, and resilience Nabarro D, et al. [1], and 42% of global agricultural revenue comes

from livestock. The average global consumption of food items originating from livestock is approximately 13% in terms of calories and 28% in terms of protein, milk, meat, eggs, and offal Falvey L [2]. Another scholar, Henchion M, et al. [3] also noted that livestock sourced food accounts for 25% of the protein and 18% of the calories consumed globally, and demand will continue to grow. According to Randolph TF, et al. [4], Smith J, et al. [5], benefits from livestock to food and nutrition security arise both directly (by improving

the household diet by increasing access to livestock source food) and indirectly (by improving income and the ability to purchase more diverse foods).

The FAO [6] highlighted that livestock substantially contributes to the gross value of agricultural production, which varies for certain countries from 24% to 45 %, demonstrating the importance of the cattle industry in many countries. The majority of the poor living in rural areas keep livestock; Tunisia (70%), Egypt (60%), Lebanon (44%) and the majority of people living in Mauritania and Sudan. Thus, the cattle industry frequently multiplies economic growth and job creation more than other industries. Additionally, in numerous developing countries, particularly in sub-Saharan Africa, livestock contributes almost 40% of the agricultural gross domestic product Steinfeld H, et al. [7], and in some countries, the contribution exceeds 85% Nabarro D, et al. [1].

In Ethiopia, livestock is a vital element of agriculture, contributing approximately 45% of the overall agricultural output value and sustaining the livelihoods of a sizable portion of the population FAO [8]. In addition to being a crucial part of the agricultural sector, livestock is a source of industrial raw materials (milk, meat, hides, and skin) and high-value proteins for potential consumers in Ethiopia Eshetie T, et al. [9]. Livestock also serves as a source of fuel, social functions, employment, raw materials for industry, inputs for crop development, and soil fertility control Endalew B, et al. [10]. Livestock source foods contain quality nutrients, immunity, and behavioral outcomes and are important for growth and development Fite MB, et al. [11]. However, the average yearly per capita consumption of dairy, meat, and eggs of the country is 16.7 kg, 0.2 kg, and 4.6 kg, respectively; these amounts are less than tenth of what is consumed in the United States Tarefe K, et al. [12]. Livestock-derived food is regarded as a luxury item rather than a necessary component of the regular home diet and is usually consumed in rural areas during important family or social occasions Betru S, et al. [13], Berhane HY, et al. [14]. Thus, the aim of this review paper is to deliver and document summarized information on the contribution and importance of livestock to food and nutrition security in general and the case of Ethiopia particularly.

Definition of Food and Nutritional Security

Food security is a multidisciplinary and multi-sectoral approach, and despite its importance, it has many meanings and operationalizations. It is the result of several issues related to food supply, use, and accessibility Martin-Shields CP, et al. [15]. The World Food Summit (1996) provided a widely accepted concept of food security. Food security is achieved when everyone has economic and physical access to a safe, nutritious, and adequate amount of food to fulfill their dietary needs and choices for a healthy life FAO [16].

Food security consists of four dimensions: the physical availability of food, economic and physical access to food, food utilization, and stability of the other three dimensions over time. According to UN -HTLF [17] nutritional security defined as "...exists when everyone at all times consume food of sufficient amount and quality in terms of variety, diversity, nutrient content and safety to meet their dietary requirements and food preferences for an active and healthy life, coupled with a sanitary environment, adequate health, education and care." As a commonly used discourse in development, food security typically stresses the amount of food compared to quality, and the quality factor is captured by nutritional security Smith J, et al. [5].

Livestock Contribution in Food Supply

Direct Contribution

According to Hodgson RE [18], livestock products play a significant role in enhancing food supply, and livestock currently play a significant role in boosting local food availability in numerous food-deficient countries. Livestock significantly enhances their contribution to the production and utilization of food through an appropriate focus on their development. It is estimated that the production of food from farm animals could be augmented by 33–50% using existing animal populations, provided that appropriate technology tailored to specific local circumstances is implemented. According to Smith J, et al. [5], the contributions of livestock, such as cattle, sheep, goats, pigs, chickens, and several lesser-known yet locally significant species (such as guinea fowl, yaks, and camels) to the global diets of seven billion individuals are intricate and multifaceted, and also they alters low-biological value protein sources, which are less palatable and have lower nutrient concentrations, into high-biological value sources, which are both highly palatable and nutrient-dense. Globally, approximately 13% of the energy and 28% of the protein consumed are gained from milk, meat, and eggs; in developed countries, these amounts increase to 20% and 48% for energy and protein, respectively FAO [19].

Indirect Livestock Contribution

In addition to their direct contribution to livestock-sourced food, 50% of cereals are produced via mixed crop-livestock systems Herrero M, et al. [20]. By offering quick income to purchase fertilizer or planting materials or to pay labor for planting, weeding, harvesting, providing manure, and helping in land preparation, livestock contributes to the cultivation of stable food. Contributions from livestock can, therefore, increase the amount of cultivated land, yield, and productivity attained, feed processed from crop leftovers, and sustainability of farming systems through improved nutrient recycling Smith J, et al. [5]. Livestock fertilizes the soil with manure, enriches its fertility, and

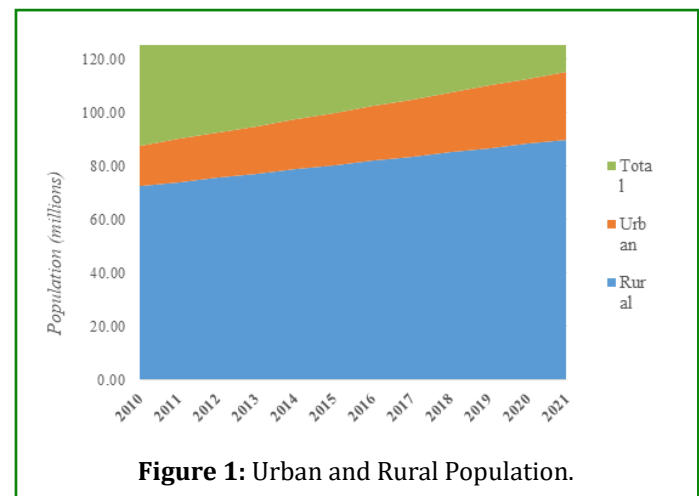
encourages healthy plant growth. Livestock contributions can thus increase the area of land cultivated, the yields and productivity achieved, the feed produced from crop residues, and the sustainability of farming systems through enhanced nutrient recycling. Livestock in poor countries contributes to food security by generating income from the sale of livestock, livestock products, or services, or through employment along livestock-sourced food value chains. This income can be used to buy basic food Smith J, et al. [5]. Staal S, et al. [21] and Pica-Ciamarra U, et al. [22], in a number of developing countries, the contribution of livestock to household income varies greatly, from 2% to more than 33%. In Ethiopia, in addition to producing food, livestock also serves as a source of fuel, social functions, employment, raw materials for industry, input for crop development, and control of soil fertility Endalew B, et al. [10], and 45% of the overall agricultural output value sustains the livelihood of a sizable portion of the population FAO [8].

Nutritional Advantage of Livestock Source Food

As livestock possesses the remarkable capacity to convert nutrient-dense, low-value protein meals that are less attractive and inedible into palatable and high-value feeds Smith MW, et al. [23], livestock-derived food may have a significant impact on lowering stunting and certain critical nutritional deficits Millward DJ [24]. Livestock-derived foods (milk, meat, and eggs) are nutrient-dense foods that contain high-quality proteins, several highly bioavailable vitamins (such as vitamin B12, which is found only in animal-sourced foods), preformed vitamins A and D, and minerals, such as iron, zinc, and calcium Grace D, et al. [25]. Other scholars Sigman M, et al. [26], Krebs NF, et al. [27] also indicated that, livestock-derived foods are the major source of high-quality protein and essential micronutrients that are particularly important for the health and development of infants and young children. A similar finding was noted by Garrow JS, et al. [28]; animal products are good sources of minerals (iron, calcium, and zinc) and other vitamins, especially vitamin A, thiamin, riboflavin, and niacin. The nutrient profile of animal source food is specifically tailored to meet the demands of the human body, especially in the first 1,000 days of life, which span from conception through pregnancy and up to two years of age Dror DK, et al. [29]. Diets without livestock food sources can be particularly low in vitamins A and B12, riboflavin, calcium, iron, and zinc Murphy SP, et al. [30]. Compared to non-animal proteins, animal proteins are of a higher caliber, are more readily absorbed, and have a higher biological value. This allows for higher net protein usage. Compared to human tissues, animal proteins have a better-balanced essential amino acid composition WHO [31].

Livestock Contribution to Food and Nutrition in Ethiopia

Ethiopian Human Population: Ethiopia is the second most populous country in Africa, with a population of approximately 102 million (after Nigeria). With an annual per capita income of USD 767, it is a low-income nation FAO [8]. Approximately 20% of the population live in cities. According to estimates from the Economist [32], only 2% of Ethiopians belong to the middle class. During the past ten years, GDP growth in Ethiopia has averaged more than ten percent, making it one of the fastest-growing economies in Africa. By 2025, it will be in the lower-middle income range FAO [8]. According to FAOSTAT [33] data, the 2021 human population of Ethiopia is 120.28 million, with an annual average growth rate of 2.75% from 2010 (Figure 1).



Ethiopian Livestock Population: Ethiopia has diverse agro-ecology, plant and animal diversity, and habitats for different species and breeds of animals Getinet M, et al. [34]. Livestock is an integral component of the agricultural sector of Ethiopia, with the largest livestock population in Africa, with around 67.96, 35.07, 49.32, 1.53, and 41.97 million cattle, sheep, goats, camels, and chickens, respectively, in 2021 FAOSTAT [33] (Figure 2). Overall, the livestock population in the country grew with some fluctuations in certain categories. This growth indicates the importance of livestock in Ethiopia's agricultural sector and economy. Hence, the country's continuous urbanization and economic growth will increase the demand for livestock products, making them a significant source of protein Hall DC, et al. [35], Seré Rabe C, et al. [36]. Furthermore, the population projection for Ethiopia indicates a worrying pattern of growth, which raises the demand for food, particularly that derived from cattle Didanna HL [37]. In addition to the shortage of feed (both in quantity and quality), the absence of better breeds, and sufficient support services (veterinary, extension, credit,

information, land, etc.), these are among the hindrances to the development of a commercially oriented livestock industry Negassa A, et al. [38].

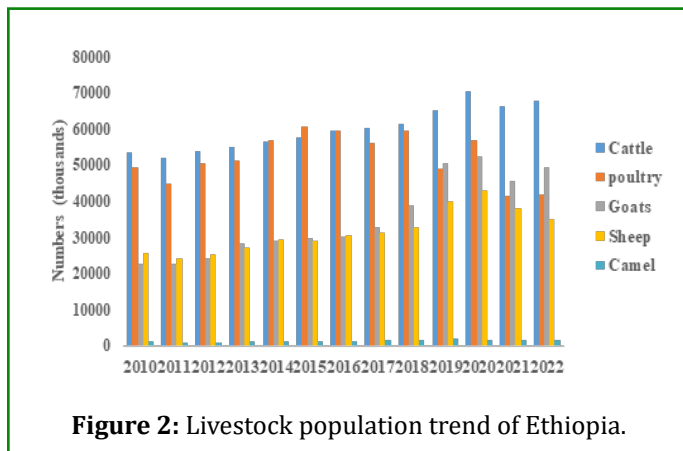


Figure 2: Livestock population trend of Ethiopia.

Livestock Source Food Production Potential in Ethiopia

According to FAO [8] statement, 5.6 million liters of milk, 1.1 million tons of meat, and 419 million eggs are produced per annum in the country, which equates to a per capita annual intake of 56.2 liters of milk, 9 kg of meat, and around 4 eggs. Approximately, 80% of all meat and milk consumption comes from cattle products, such as beef and cow milk. The low production and productivity of livestock, despite their large population, may be attributed to several factors, such as poor genetic performance, shortage of quality feed and seasonal availability, high disease incidence, parasite challenges, and limited access to services and inputs in Ethiopia Management Entity [39]. Overall, although there have been some fluctuations in the production of milk, meat, and eggs over the years, there has been a general increasing trend, especially in meat and egg production. Milk production has also increased over the years, but there were some fluctuations between 2019-2021 (Figure 3).

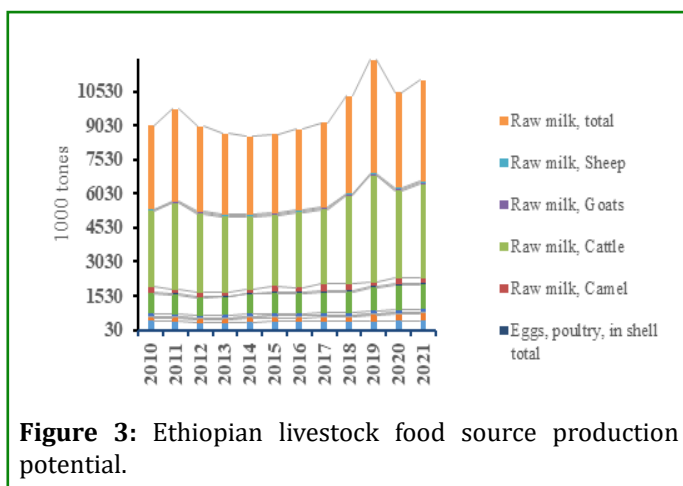


Figure 3: Ethiopian livestock food source production potential.

Livestock Source Food Consumption Trend in Ethiopia

Based on the food balance sheets of the FAOSTAT [33] data, an individual in Ethiopia will consume 105.5 liters of milk, 9.2 kg of meat, and approximately nine eggs per year in 2021 (Figure 4). According to a report by Tarefe K, et al. [12], this amount is less than one-tenth of the amount consumed in the United States of America. The consumption patterns of meat and milk were inconsistent throughout the year, fluctuating only slightly over time (Figure 4). The consumption per capita per year of eggs has remained relatively stable, with slight fluctuations from 2010 to 2021, hovering at around 0.42 to 0.53 units. This could indicate a consistent demand for eggs over the years, with perhaps minor changes influenced by factors, such as pricing, dietary trends, and consumer preferences. Regarding meat consumption, there seems to be a gradual decline from 9.87 units in 2010 to 9.21 units in 2021. This trend suggests a potential shift in dietary habits, possibly towards more plant-based diets or healthier alternatives, as people become more conscious of the health and environmental concerns associated with high meat consumption. In contrast, milk consumption exhibited a more erratic pattern. After peaking at 44.34 units in 2011, there was a noticeable decrease until 2019, followed by slight increases in 2020 and 2021. This fluctuation could be attributed to various factors, such as pricing, changes in dietary preferences, availability of alternative beverages, or shifts in consumer awareness regarding lactose intolerance or dairy-related health concerns. Overall, these trends reflect the dynamic nature of food consumption habits, which are influenced by various factors, including health consciousness, environmental concerns, economic conditions, and cultural preferences. Analyzing these trends can provide valuable insights for policymakers, businesses, and researchers to understand and address the evolving dynamics of food consumption. Although Ethiopia has a significant livestock population, its annual per capita consumption, productivity, and production are all quite low. As a result, children in the country typically eat blind diets that consist primarily of low-nutrient, low-energy staples such as grains and tubers Eshetie T, et al. [9]. According to Berhane HY, et al. [14], livestock source food is mostly eaten at special family or social events in rural communities, as it is regarded as a luxury item rather than a necessary component of the everyday household diet, resulting in undernutrition in children. Zinc and vitamin A deficiency in mothers and children in Ethiopia remains a serious public health issue CSA [40], Christiansen L, et al. [41]. Given the high rate of undernutrition in children, it is imperative that newborns and early children have improved access to diverse diets by consuming animal-derived food MoH [42].

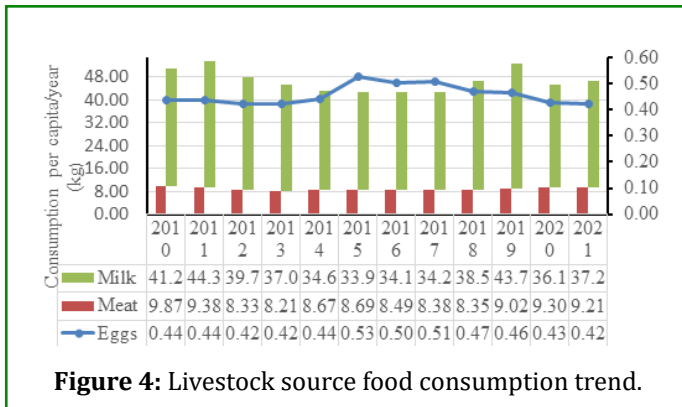


Figure 4: Livestock source food consumption trend.

Energy, Protein and Fat Supply Trend in Ethiopia

A ten-year (2010–2021) energy per capita supply trend in Ethiopia calculated from FASTAT [33] is displayed in Figure 5a. The per capita energy supply from crops was 1743 kcal/day in 2010 and reached a maximum of 1993.37 kcal/day by 2021, while the per capita energy supply from livestock was 204 kcal/d in 2010 and climbed to 326 kcal/day in 2021. The amount of energy gained from crops and livestock per person is increasing, and by 2021, the value obtained from crops will be approximately 14% more than that of 2010 at 244 kcal/day, whereas the value obtained from livestock will be 59% higher at 120 kcal/day. Crops provide more energy than livestock in Ethiopia's food supply (Figure 5a). Cereals have historically contributed the most energy of all crops, and they still do, even though their proportional contributions have changed over time Sheehy T, et al. [43]. Per capita daily calorie consumption from livestock products constitutes a very modest portion of the total calories consumed, and this may increase steadily with affluence Tarefe K, et al. [12]. The same scholar stated that the richest quintile of Ethiopians receives approximately 107 calories per day, which is 207 percent higher than the average of the first quintile. The poorest quintile received only 35 calories per day from livestock products. Other scholars Guo X, et al. [44] have revealed similar results, demonstrating that urbanization improves nutrition and promotes dietary diversity. Furthermore, a greater proportion of well-lived urbanites than rural ones obtain more than 30% of their calories from cattle Tarefe K, et al. [12]. There is a slight change in the composition of these goods (the percentage of calories from animal sources increases, despite the fact that the quantity of calories from all major livestock products increases with income) (Figure 5a).

Figure 5(b) and Figure 5(c) show the 10-year trends in Ethiopia's per capita supply of protein and fat, respectively. FAOSTAT [33] reports that between 2010 and 2021, the per capita protein supply from crops increased from 47.7 g/day to 49.4 g/day, whereas the per capita protein supply from livestock decreased from 8.7 g/day to 7.1 g/day. According

to the FAOSTAT [33] report, the overall average daily protein supply is 76 g/capita, which is higher than SSA (59 g/capita) but lower than the global average (79 g/capita) FAO [45]. Livestock provided less protein per person between 2010 and the beginning of 2012, although there was no sign of significant trend reversal. However, since 2013, the amount of protein per person derived from livestock has increased, rising from 6.9 g/day in 2013 to 7.1 g/day in 2021. Although high-value proteins are essential for the growth of children and newborns, Willett W, et al. [46]. According to Bruhn K [47], Ethiopia's average daily supply of livestock-derived protein is 7.1 g/capita/day, compared to Sub-Saharan Africa's 13 g/capita/day. However, livestock proteins often have an amino acid composition that indicates a higher quality level than proteins derived from plants. In addition to the nutrients found in animal-based foods, cereal and vegetable proteins are enhanced by their high biological value and amino acid composition. But since 2010, the per capita supply of fat from both livestock and crops has been raised; by 2021, they will have increased to 30.9 g/day from 15.4 g/day and 38 g/day from 18.9 g/d. Figure 5(b) and 5(c), respectively.

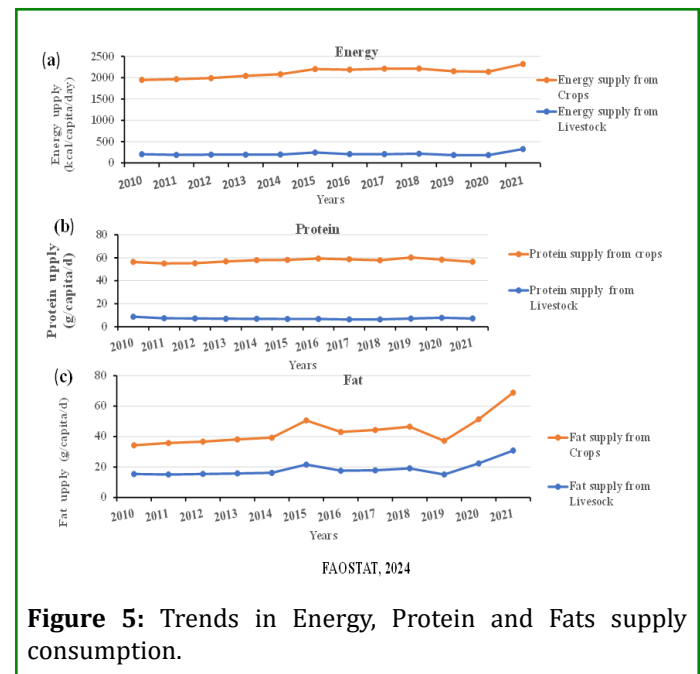


Figure 5: Trends in Energy, Protein and Fats supply consumption.

Impact of Livestock on Food Supply

Livestock can lower the overall volume of food accessible by consuming feedstuffs, such as grains and legumes, which are better fed directly to humans Smith J, et al. [5]. Currently, livestock, particularly monogastric livestock, are fed to almost half of the world's grain output McIntyre BD, et al. [48]. In addition, livestock is fed 77 million metric tons of plant protein to yield 58 million metric tons of animal protein Steinfeld H, et al. [7], contributing to 13% of the world's

energy intake. Half a billion hectares of land is devoted to forage crops, with grazing land and livestock encompassing four-fifths of all agricultural land Steinfeld H, et al. [49]. As a result, there is a decrease in the amount of land used for food crops, which lowers the food supply.

Livestock can have detrimental effects on food and nutrition security in the long term through greenhouse gas (GHG) emissions, which contribute to climate change. Climate change is predicted to significantly reduce yields in tropical regions, whereas it may have some positive effects in temperate regions Adger WN, et al. [50]. The collective emissions of these three greenhouse gases are expected to increase in the following decades. By 2030, methane emissions from livestock and nitrogen dioxide emissions from agriculture are predicted to increase by up to 60% Thornton P, et al. [51].

Smith J, et al. [5] demonstrated that livestock can affect food and nutrition security by transmitting diseases to humans through contaminated livestock-sourced food and biting vectors. As a result, these diseases lower people's capacity to produce their own food or work to earn money for food purchases, which lowers society's production performance. Other authors Grace D, et al. [52] also noted that livestock negatively impacts human nutrition and health, as 2.2 million low- and middle-income people are killed annually by 13 major zoonotic diseases. In addition, livestock-sourced food has other health issues resulting from saturated fatty acids. As reported by Larson S, et al. [53], excessive consumption of fatty red meat and hard cheeses, which contain high levels of saturated fats, can cause cardiovascular disease. On the other hand, overconsumption of processed meats such as pork and smoked meat has been linked to some types of cancer. Consuming more meat, dairy, and egg foods that are high in energy contributes to the global obesity crisis. This multifaceted issue is not limited to developed countries.

Conclusions

Livestock has made both advantageous and disadvantageous contributions to food and nutrition security. The positive aspect lies in the fact that livestock production is of paramount importance as it potentially contributes up to 33% of households' income, 42% of total revenue in the global agricultural sector, and provides essential goods to millions of people worldwide to ensure food security, nutrition, sustainable livelihoods, and resilience enhancement. Furthermore, apart from directly contributing to the production of livestock-derived food like milk, meat, and eggs, livestock also plays a crucial role in supporting staple crop cultivation through providing immediate income for input acquisition (such as fertilizers or seeds), covering labor costs (for activities like planting, weeding,

and harvesting), supplying organic manure, and supporting in land preparation by providing draft power. Conversely, livestock also poses some negative impacts on food and nutrition security by competing with humans for grains, utilizing fodder crop lands for forage production, emitting greenhouse gases into the environment, and transmitting zoonotic diseases to humans.

In Ethiopia, in addition to its significance in the agricultural sector, livestock plays a crucial role as a key source of industrial raw materials like milk, meat, hides, skin, and high-value proteins for potential consumers domestically. Moreover, livestock performs diverse functions including fuel provision, social purposes, employment generation, raw material supply for industries, contribution to crop development, and enhancement of soil fertility. The food products obtained from livestock offer a rich content of quality nutrients, immunity-boosting characteristics, and behavioral advantages, which are imperative for the process of growth and development. However, the average annual per capita consumption of dairy, meat, and eggs in Ethiopia is significantly lower than one-tenth of the consumption levels observed in the United States. Consequently, food items derived from livestock are often perceived as luxury commodities rather than fundamental elements of the daily household diet, predominantly consumed in rural settings during important family or social events.

Furthermore, the review underscores the importance of advocating for dietary diversity and enhancing the accessibility of animal-derived food products, particularly for vulnerable populations such as children and expectant mothers. Strategies aimed at improving livestock productivity, expanding market access, and sharing information on the nutritional benefits of animal-derived food items are pivotal in addressing malnutrition and bolstering food and nutrition security in Ethiopia. Ultimately, addressing the challenges faced by the livestock sector and promoting the consumption of animal-derived food sources are indispensable actions in advancing towards sustainable food security and improving nutritional outcomes both in general and specifically in Ethiopia.

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