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Livestock Health and Its Contribution to Nutrient-Rich Foods for Human Consumption

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ABSTRACT

The global population's rapid growth is coupled with food security challenges which underscores the livestock critical role by providing nutrient-rich foods. Livestock-derived products, including meat, milk, and eggs, serve as vital sources of high-quality protein and essential micronutrients to address nutritional deficiencies in vulnerable populations. Livestock systems including small mixed farms, urban production units, and livestock-dependent societies collectively support food security by billions of dollars by mitigating malnutrition and economic disparities. These systems contribute significantly to global meat, milk, and egg production while enhancing sustainability by resource recycling and waste utilization. However, disparities persist, with intensive production models in wealthier regions exacerbating food access challenges in poorer nations. In developing nations, livestock production systems must balance ethical considerations, environmental sustainability, and the growing demand for animal protein. Consequently, we can bridge the gap between food availability and accessibility, fostering resilience and equity in food systems worldwide by recognizing the pivotal contributions of livestock to global nutrition and implementing inclusive policies.

Keywords: Livestock health, Nutritional security, Food security, Sustainable animal production, Protein deficiency, Global malnutrition

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Introduction

In the 21st century, the global population growth rate averages 1.14% annually with projections for 2025 estimating a 9 billion people population. Approximately 784 million individuals (9.8%) face hunger despite this growth [1]. However, 2021 offered hope for recovery but following the COVID-19 pandemic challenges related to food security and global hunger continued to escalate. In 2020, around 3.1 billion people were unable to take a healthy diet due to rising food costs. This situation underscores disparities between nations and highlights regional inequalities within them that often stem from uneven economic recovery and income losses disproportionately affecting those most impacted by the pandemic [2].

Food security encompasses two key aspects:

1. Ensuring sufficient food availability and accessibility
2. Prioritizing the quality and safety of food consumed.

These include its harmlessness to health, nutritional value, and accessibility to nutritious food. Moreover, the role of livestock-derived products such as meat, milk, and eggs in achieving nutritional security remains underappreciated. The combined contribution of livestock-dependent societies, small mixed farms, and urban livestock systems supports food security for an estimated 1.5 billion people [3]. Without these systems, many would face malnutrition and health issues due to the lack of animal protein in their diets. However, this estimate is broad and overlaps with the approximately one billion chronically food-insecure individuals whose primary need may not necessarily be animal protein [4].

This foundational role of livestock in food security necessitates discussions about the future of animal production to sustain and expand these contributions. Livestock production has grown substantially in East and Southeast Asia, primarily through intensive systems, while sub-Saharan Africa lags [3]. For instance, China produces 70 million tons of eggs and 15 million tons of poultry meat annually, compared to India's 3 million and 0.6 million, respectively. However, poultry consumption has grown rapidly, reaching 50% of livestock protein. Dairy consumption rose from 178 grams per day 258 grams in 2009. In contrast, poorer Asian nations like Bangladesh exhibit slower growth. Some nations, such as Thailand, are major exporters of livestock products, but this primarily serves affluent markets. Policies for animal production in food-insecure nations often mimic those of exporting countries, increasing risks of shortages and malnutrition. For instance, intensive systems rely on human-edible grain, diverting resources from food-insecure populations. While extensive ruminant systems using non-arable lands align with ethical practices, dietary preferences and market-driven production undermine such efforts [5].

Animal Production Systems

Animal production systems can be categorized conventionally but they may be more effectively represented by examining societal segments that rely on specific production systems [6]. These segments include:

- Livestock-dependent societies
- Small mixed farmers
- Urban populations

Livestock-Dependent Societies

Livestock-dependent societies consist of approximately 120 million individuals who predominantly rear ruminants on uncultivated, non-arable lands. These societies derive up to 90% of their farm output from livestock. Such systems account for approximately 19% of global meat production and 12% of global milk production [7]. For instance:

- In Australia, this system enables the country to be the world's largest exporter, with 45% of its production exported.
- In Mongolia, extensive livestock farming contributes around 30% of GDP and 20% of export revenue.

These societies represent a sophisticated adaptation to otherwise uninhabitable landscapes. Despite a perceived decline in their numbers, encouraging these societies to maintain their rural lifestyle instead of migrating to cities could reduce food demand by 30%, ensuring food security for approximately 160 million people [6].

Small Mixed Farmers

A mixed farm is characterized by at least 10% of animal feed derived from agricultural by-products or over 10% of farm production value contributed by other agricultural enterprises. These rain-fed mixed systems produce substantial proportions of global meat and milk [7]:

- 48% of beef
- 53% of milk
- 33% of mutton

These farms often face narrow efficiency assessments focused on single products, which neglect the multifaceted contributions of animals, such as draught power and waste utilization. In Asia, integrated farming systems exemplify small-scale mixed farms. Animals in such farms provide diverse benefits beyond food production, including waste recycling, fertilization, and pest control. Small breeds are particularly suitable for these systems, offering flexibility and regular protein sources across seasons [8]. This approach, refined over millennia, has supported China's shift to food exports, despite earlier predictions of mass starvation. Approximately two billion people rely on small integrated farms for food security, helping rural populations sustain themselves and alleviating urban food challenges. Their contribution to global food security is equivalent to feeding about one

billion people when considering increased yields and reduced urban food demand [7].

Urban Populations

As over half the global population resides in urban areas, addressing food security in cities has become increasingly critical. An estimated 300 million urban dwellers, mostly in Asia, face extreme poverty and inadequate access to food. They remain unaffordable for many poor households while animal products are accessible to middle-class populations. Additionally, unsafe handling, poor refrigeration, and contamination risks exacerbate health vulnerabilities among urban poor. Urban livestock production has been deprioritized to mitigate zoonotic disease risks [9]. For example:

- Jakarta banned poultry production in urban areas as part of its Avian Influenza control measures.
- Tax incentives in Thailand encouraged urban livestock producers to relocate from Bangkok.
- In China, urban governance integrates livestock production, meeting substantial proportions of food demand within city limits. For instance, Beijing supplies 70% of its vegetables and milk locally, while Shanghai produces enough milk and eggs to meet internal demand.

Such policies improve food security for approximately 400 million urban dwellers globally, with China alone contributing to the food security of 200 million [6].

Food Safety

The United Nations advises stakeholders across the production chain to ensure sufficient and high-quality food supplies. This entails encouraging governments, agencies, institutions, private entities, and society to implement measures that sustain citizens' living standards. Food safety remains a shared responsibility among governments, producers, and consumers [2]. Ensuring the quality and safety of animal-derived food products throughout their supply chain—from farm to table—is critical to protecting public health. Any disruption in food safety protocols can adversely affect public health, trade, and the economy. The Pan American Health Organization highlights that food safety promotes trade, job creation, and poverty reduction. Additionally, the COVID-19 pandemic underscored the importance of modern production systems emphasizing animal welfare, food safety, and environmental sustainability [5].

Food security remains one of the most pressing global challenges. In regions where food is scarce, governance is fragile, and overall security is jeopardized, this issue has persisted since the establishment of early empires and states, and even earlier as a fundamental element of tribal or national stability [10]. While modern society considers itself more advanced because the reality is that food security is still the cornerstone of both national and international security, especially with a growing global population, instantaneous communication, and the capacity for mass migration during crises. These migrations can destabilize fragile states and strain the economies of developed nations. Hence, governments and international organizations bear a crucial responsibility to ensure that conflicts and disasters do not disrupt access to essential food supplies for survival. This paper explores the role of livestock in ensuring both food and national security [2].

Recent global trends have exacerbated the risk of food insecurity by prioritizing free trade over survival-focused food policies in poorer nations. FAO highlights that one of the toughest challenges is ensuring that those in need have the means to afford food. This is only one aspect, and another critical element is the existence of two billion small-scale farmers who sustain themselves and are outside the buying economy. Additionally, food security encompasses psychological reassurance alongside physical sustenance, emphasizing empathy for those in need rather than relying on generalized statistics or benchmarks [11].

Livestock significantly contributes to this broader concept of food security by meeting various development objectives. They offer diverse benefits, including high-quality protein, income, agricultural power, nutrient recycling, edible and non-edible by-products, and self-replication capabilities. Despite their contributions, livestock's role in food security is often overshadowed by the dominance of cereals as staple food sources. This underrepresentation stems from their products being perceived as luxury items. The topic remains insufficiently addressed, with their report attempting to bridge this gap despite considerable discussion on livestock's role in food security [12]. The International Livestock Research Institute (ILRI), a leading livestock research organization, also addresses this gap by integrating food security with objectives like poverty alleviation, environmental sustainability, and health improvement in areas with high development potential. Their efforts focus on inclusive growth, addressing environmental and health challenges, and mitigating the adverse impacts of livestock on ecosystems and human well-being. These initiatives mark a significant shift in understanding livestock's role and the animal sciences supporting it [13].

Addressing Diverse Livestock Systems

Global undernourishment declined from 28% to 13% (16% in developing countries) representing a 5% reduction in absolute numbers despite population growth. These estimates are based on caloric intake and fail to consider nutritional quality leaving approximately two billion people affected. Consequently, about 146 million children are underweight, with 31% experiencing stunted growth. In such scenarios, animal-derived products play a pivotal role in addressing nutritional deficiencies. Animal products supply approximately 13% of global caloric intake and 28% of protein through meat, milk, eggs, and offal [14]. Increased availability at the global level does not necessarily translate to improved diets for marginalized populations. However, these products alleviate deficiencies, particularly protein and micronutrients like iron, zinc, vitamin A, vitamin B12, and calcium where accessible. Additionally, gross protein intake exceeds minimum requirements except in sub-Saharan Africa despite the absence of universal nutritional guidelines for livestock product consumption [15].

In poorer nations, small quantities of animal products provide essential nutrients, such as zinc and iron from meat, along with vitamin B12, riboflavin, vitamin A, and calcium from milk. With iron deficiency affecting 1.6 billion people by impairing mental development in 40-60% of children, and causing 20% of maternal deaths annually, ensuring consistent access to animal products remains crucial for food security [16]. Rising meat consumption in developing countries underscores the growing importance of livestock-derived foods. Increased livestock production correlates with rising income levels, but national statistics often mask regional disparities and cultural factors, such as religious dietary restrictions or social trends like increased milk consumption in Thailand due to school programs. Livestock products contribute significantly to global nutrition, with misconceptions about vegetarian diets and often overlooking their status as the world's leading dairy producer and consumer [17].

Conclusion

Livestock enhances global food security and nutritional quality particularly to address malnutrition and protein deficiencies in vulnerable populations. Livestock systems offer multifaceted benefits, including high-quality protein, essential micronutrients, economic support, and agricultural sustainability from small mixed farms to urban and rural livestock-dependent societies. However, the inequitable distribution of resources and reliance on intensive systems in wealthier regions often widen disparities that leave millions without adequate access to nutrient-rich animal products. Moreover, it is crucial to adopt inclusive and context-specific strategies that prioritize sustainable livestock practices, enhance productivity, and ensure equitable access to animal-derived foods to overcome these challenges. Collaborative efforts among governments, organizations, and stakeholders are essential to harness the full potential of livestock to meet the growing demand for safe, affordable, and nutrient-rich foods.

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