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Livestock and poultry production in Sri Lanka: challenges and strategies for climate-resilient food security

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Livestock and poultry production is critical to Sri Lanka's food security, providing essential animal-sourced proteins, contributing to economic growth, and supporting rural livelihoods. This review examines the current status, challenges, and opportunities within the livestock and poultry sectors in Sri Lanka. Key performance indicators such as production growth, accessibility, affordability, and disease management are analyzed to assess the industry's resilience. The study highlights the impact of economic fluctuations, feed price volatility, policy constraints, and climate change on the industry. Integrating climate-resilient strategies into Sri Lanka's livestock and poultry sectors is essential to enhance sustainability. Key approaches include breeding heat-tolerant animals, introducing climate-smart feeds and nutritional strategies, improving water conservation, adopting climate-resilient housing systems, implementing sustainable waste management, utilizing renewable energy sources, enhancing farmer capacity through training and policy support, and strengthening disease surveillance and biosecurity measures. Implementing these strategies will improve productivity, reduce environmental impact, and enhance resilience against climate extremes. The review also explores the role of integrated livestock systems, digital technologies, and export potential in further strengthening the sector by guiding policymakers, researchers, and stakeholders in developing sustainable and climate-resilient solutions. Addressing these challenges through data-driven policies, farmer empowerment, and investment in innovation is essential to achieving a resilient and self-sufficient livestock industry in Sri Lanka.

KEYWORDS

climate resilience, economic stability, disease management, feed resources, sustainability

1 Introduction

As global food security faces growing challenges from climate change, economic instability, and resource constraints, the experience of small island nations like Sri Lanka provides valuable insights into sustainable livestock production. In Sri Lanka, livestock and poultry systems are integral to agricultural development, food security, and the achievement of sustainable development goals. With a growing population and rapid urbanization, the country is experiencing rising demand for animal protein. However, this demand is often limited by affordability, uneven access, and concerns over food safety. Addressing these

issues requires aligning production with nutritional needs while ensuring robust veterinary and processing standards. Livestock production, particularly from cattle, buffalo, goats, swine, chickens, and alternative poultry species, plays a critical role in meeting protein requirements, supporting rural livelihoods, and strengthening the economy. Enhancing these sectors contributes to food security by increasing the availability of nutritious food and generating income for farming communities, particularly in the face of climate-related disruptions. However, due to strong dependence on climatic conditions, agricultural activities such as poultry production are highly vulnerable to environmental changes (Malhi et al., 2021). South Asia's vulnerability to erratic rainfall and rising temperatures intensifies feed shortages and disease risks. Recent studies in India and Bangladesh highlight the severe impact of climate change on agricultural and livestock productivity, emphasizing the urgency of adaptive strategies. In Bangladesh, a study assessing drought vulnerability through a multi-criteria approach identify highly vulnerable regions, which significantly affects agricultural systems, including livestock production (Sarkar et al., 2024). Similarly, in the Ganges Delta, climate hazards, exposure, and vulnerability assessments reveal that agricultural areas along the Indian coast face high levels of climate risk, further threatening livestock productivity (Mandal et al., 2025). These emphasize the significant risk of livestock productivity losses, which can reach up to 20% during severe droughts (Mandal et al., 2025). To address these challenges, comprehensive adaptation measures, including improved institutional frameworks and targeted policy

interventions, are necessary to enhance climate resilience in the agricultural sector in South Asia (Aryal et al., 2020).

Sri Lanka's livestock and poultry sectors have evolved significantly, playing a crucial role in food security, income generation, poverty reduction, and climate resilience. As emphasized in our previous analysis (Priyashantha and Vidanarachchi, 2024b), resilient animal-sourced food systems are vital for stability during crises, particularly in the face of climate change-induced disruptions. Understanding the current contributions and challenges of these sectors is key to assessing Sri Lanka's food security and its ability to adapt to environmental stresses. Although these sectors provide critical socio-economic benefits, they also contribute 24% from livestock sector and creating a significant environmental pressure, in Sri Lanka's agricultural greenhouse gas profile (Lokupitiya, 2016). This article builds on prior findings, highlighting the need to enhance production robustness, reduce fluctuations, and promote sustainable rural development while integrating climate adaptation strategies. It examines the present status, sector-specific challenges, and potential strategies for strengthening food security and climate resilience. Additionally, it explores how the livestock and poultry sectors can drive economic growth, improve livelihoods, and develop adaptive measures to mitigate climate-related risks. The analysis evaluates three key performance indicators (KPIs) essential for measuring sector effectiveness in achieving food security and climate resilience: (i) population and production growth, (ii) accessibility and affordability, and (iii) advancements in health and disease control amidst climate adaptation measures (Figure 1). These insights aim to guide policymakers, researchers, and stakeholders in

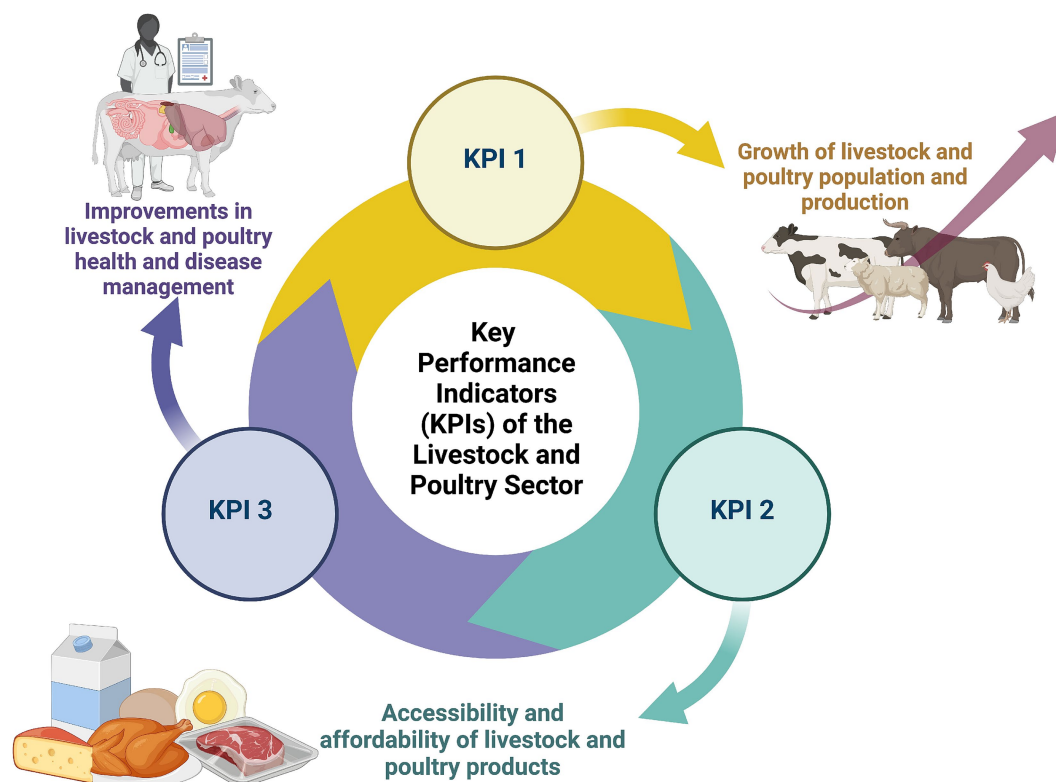


FIGURE 1

Key performance indicators (KPIs) of the livestock and poultry sectors are discussed in this article. Created in BioRender. Priyashantha, H. (2025) <https://BioRender.com/w26i906>.

developing sustainable and climate-resilient solutions for Sri Lanka's livestock and poultry industries.

This review builds upon existing literature by presenting a uniquely structured, KPI-based analysis of the Sri Lankan livestock and poultry sectors, focusing on the intersection of climate resilience, economic viability, and national food security. While previous studies have explored individual challenges in these sectors, few have offered a strategic, indicator-driven synthesis that aligns production trends, policy interventions, and climate adaptation pathways in an integrated manner. To the best of our knowledge, this is the first comprehensive policy & practice review that adopts a KPI framework to evaluate Sri Lanka's livestock and poultry sector. By using KPIs, this review delivers a holistic understanding of sectoral performance and outlines actionable strategies tailored to Sri Lanka's evolving agro-ecological and socio-economic contexts.

2 Methodology

This study employed a narrative review methodology designed to inform policy and practice, in line with the scope of policy & practice reviews. Data sources included national livestock and poultry statistics (2018–2023), peer-reviewed journal articles, government policy documents, development project reports, and guidelines from relevant regulatory and professional bodies.

3 Key performance indicators (KPIs)

3.1 Growth of livestock and poultry population and production

Livestock and poultry production is a key in sustainable food systems as they play a critical in contributing to food security, climate resilience, and rural livelihoods. They provide essential nutrients, income, manure, and draft power while supporting biodiversity conservation, soil carbon sequestration, and efficient resource use. As global demand for livestock and poultry products increases, sustainability challenges emerge, necessitating innovative strategies such as genetic improvements, alternative feed sources, precision technologies, and biotechnological advancements (Bist et al., 2024). The poultry sector, in particular, is advancing through eco-conscious organic farming, insect-based protein feed, solar energy integration, and improved waste management, reducing environmental footprints and enhancing industry resilience. Similarly, sustainable livestock production must navigate competing demands for land and water, the food-feed competition, and the need to operate within a carbon-constrained economy (Jaisli and Brunori, 2024). Achieving sustainability in these sectors requires a balance of efficiency (sustainable intensification), consistency (circular and grassland-based systems), and sufficiency (protein transition), recognizing trade-offs and regional variations. A holistic approach integrating climate-smart agriculture, circular economy principles, and stakeholder collaboration is essential for ensuring a resilient and ethical livestock and poultry industry that aligns with future food system sustainability goals in worldwide, as well as in Sri Lanka.

Livestock and poultry production systems are widespread across the country, varying based on regional needs, resource availability, and specific livestock operations. Figure 2 illustrates the number of registered livestock and poultry operations in Sri Lanka in 2023, emphasizing the sector's presence and significance. Consequently, population growth and production are key performance indicators (KPIs) essential for assessing the sector's impact, as discussed below.

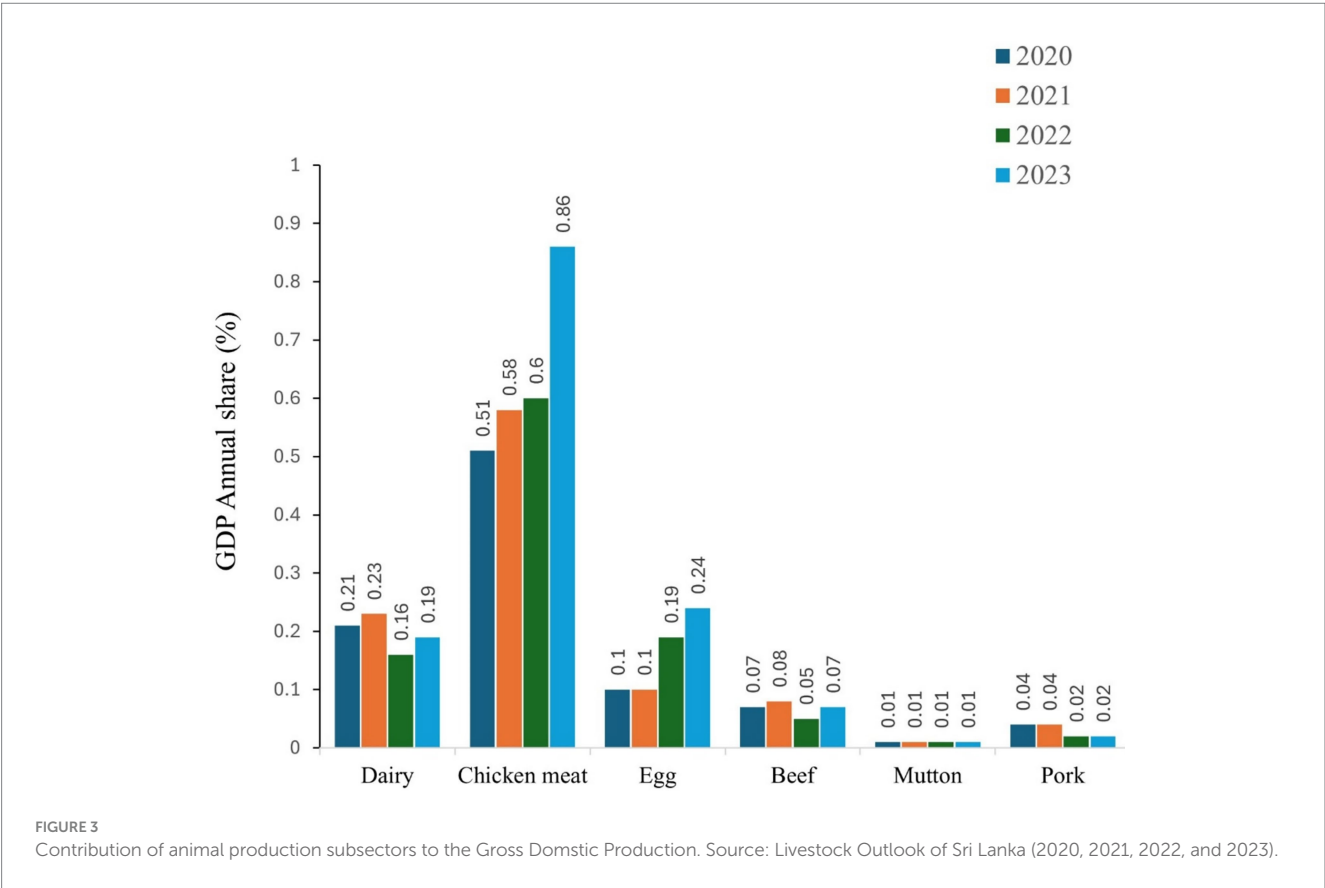
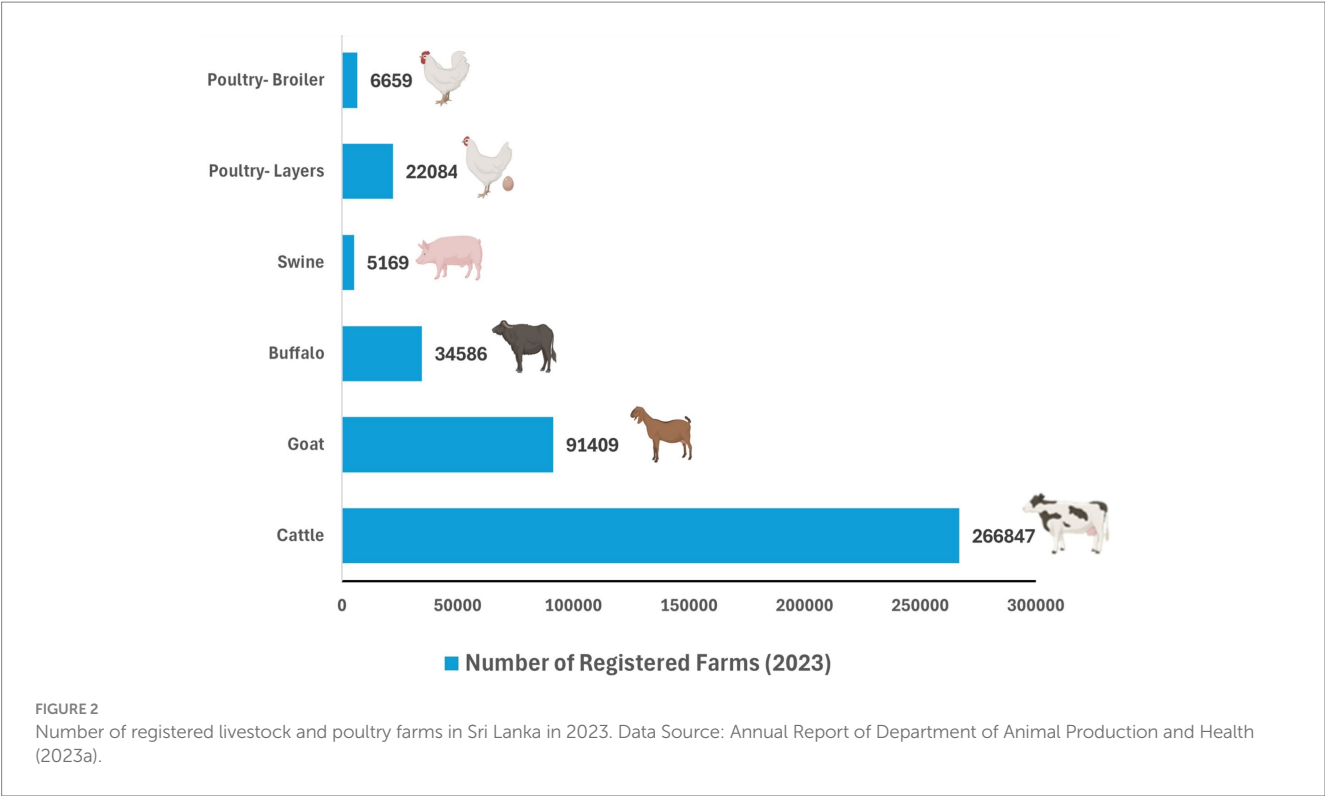
Over the years, Sri Lanka's livestock and poultry sector has shown a dynamic contribution to the national GDP, influenced by economic fluctuations and recovery trends. As reported by the Department of Animal Production and Health (DAPH) and the Central Bank of Sri Lanka (2022), the sector contributed 0.94% to GDP in 2020, rising to 1.04% in 2021 with post-COVID-19 recovery. A slight decline to 1.03% occurred in 2022 due to economic instability, rising feed costs, and supply chain disruptions. However, in 2023, the sector rebounded strongly, reaching 1.39% of GDP, driven by increased poultry, egg, and dairy production. Notably, chicken meat alone contributed 0.86%, while egg production rose from 0.19% in 2022 to 0.24% in 2023. This trend underscores the sector's resilience and its vital role in economic recovery, food security, and rural development. Variations in animal production subsector contributions to GDP are illustrated in Figure 3.

The rising global demand for affordable protein necessitates strategic investment in sustainable livestock and poultry production. Advances in genetics, precision feeding, and automation enhance productivity while reducing environmental impact and improving animal welfare (Castro et al., 2023). Additionally, sustainable livestock management practices such as rotational grazing, agroforestry, and precision feeding optimize resource use while minimizing ecological footprints (Khairi et al., 2025). However, global food system projections warn that agricultural expansion may come at the expense of forests, highlighting the urgent need for alternative, sustainable strategies. Policies promoting carbon conservation, reforestation, sustainable cropping, and dietary shifts can ensure food security without further deforestation (Bahar et al., 2020).

3.1.1 Cattle and Buffalo

Milk production in Sri Lanka has fluctuated in recent years, with differing estimates from the Department of Census and Statistics (DCS) and the DAPH. According to DCS (2023b), cow milk output rose from 311.34 million litres in 2015 to 425.37 million litres in 2021, before declining to 411.10 million litres in 2023. Buffalo milk increased from 71.12 million litres in 2015 to 93.05 million litres in 2023. Combined milk production peaked at 513.31 million litres in 2021, with the highest annual growth (4.4%) that year, before falling to 504.15 million litres in 2023. In contrast, DAPH data shows a decline from 424.13 million litres in 2019 to 370.32 million litres in 2023 (DAPH, 2019a, 2019b, 2020a, 2020b, 2021a, 2021b, 2022a, 2022b, 2023a, 2023b).

These discrepancies stem from methodological differences. The Department of Census and Statistics (DCS) includes informal and household production, while the Department of Animal Production and Health (DAPH) primarily reports data from registered processors and commercial farms. Consequently,



DCS estimates are consistently higher, reflecting the significant role of unregulated dairy production. These inconsistencies hinder policy formulation, resource allocation, and market planning, potentially leading to mismatches between supply and demand, inflated import requirements, and under-support for local farmers.

These inconsistencies underscore the urgent need for harmonized reporting protocols and investment in real-time monitoring technologies to inform national livestock strategies with reliable data. To improve accuracy, digital livestock registries, real-time data collection systems, satellite and AI-based analytics, and regular surveys are essential. Strengthened monitoring systems would support evidence-based decisions on self-sufficiency of animal-sourced foods and dairy sector resilience, particularly during external shocks like COVID-19 or geopolitical conflicts (Ching-Pong Poo et al., 2024). Countries such as the UK have integrated logistics and transportation connectivity into food security assessments, highlighting the need for adaptive strategies. Sri Lanka could adopt similar resilience frameworks, incorporating reliable, data-driven policies to safeguard its dairy sector from external shocks and ensure long-term sustainability.

DCS livestock data (2018–2023) shows the cattle population is around 1.11–1.13 million, with indigenous breeds dominating. Improved breeds rose from 274,160 in 2018 to 283,170 in 2023, suggesting a gradual shift toward higher-yielding animals. The number of milking cows increased modestly: indigenous cows from 229,700 in 2018 to 242,890 in 2023, and improved breeds from 99,680 to 100,460. However, growth in the lactating herd has not matched overall herd expansion, indicating inefficiencies in genetic selection, management, and resource use (DCS, 2023a). Emphasizing per-cow productivity is thus critical to achieving milk self-sufficiency. Conservation of indigenous breeds such as Lankan cattle and buffaloes is vital for maintaining genetic diversity and climate resilience. Community-based breeding programs, conservation herds, and national registries should be expanded to preserve these assets. Such breeds exhibit heat tolerance and feed adaptability critical for future climate scenarios.

The buffalo population has also fluctuated, peaking at 333,210 in 2021, dropping to 282,860 in 2022, and rebounding to 327,010 in 2023 (DCS, 2023a). These changes directly influence buffalo milk output, underlining the need for herd stability. Average milk yields have improved but remain below targets. Cow milk yield rose from 2.83 L/day in 2015 to 3.30 L/day in 2022, dropping slightly to 3.27 L/day in 2023. Buffalo yields remained steady at 2.34 L/day (DCS, 2023b). To meet national demand and reduce imports, yields must rise to 9.72 L/day for cows or 7.47 L/day when combining cows and buffaloes (DAPH, 2023a).

Production costs in intensive systems surged from 49.28 LKR/L in 2020 to 81.22 LKR/L in 2022, then slightly fell to 80.92 LKR in 2023, driven by inflation and feed import dependence. Meanwhile, cow milk farmgate prices rose from 70.83 LKR/L in 2019 to 153.03 LKR/L in 2023, with the steepest hikes in 2022 (35.50%) and 2023 (32.80%). Buffalo milk prices reached 175.65 LKR/L in 2023 (DAPH, 2019a, 2019b, 2020a, 2020b, 2021a, 2021b, 2022a, 2022b, 2023a, 2023b), highlighting cost pressures on both producers and consumers.

Milk imports, influenced by economic shifts, peaked at 102.35 million kg in 2020 before dropping 39.21% in 2022 due to forex shortages. Imports rebounded by 32.31% in 2023. Exports fell 22.67% in 2020, recovered in 2021 (+52.33%), then declined again (DAPH, 2019a, 2019b, 2020a, 2020b, 2021a, 2021b, 2022a, 2022b, 2023a, 2023b). In 2023, dairy imports cost 88.62 billion LKR, contributing to a total supply of 937.65 million liquid milk equivalent (LME) litres, while per capita availability dropped to 109.47 mL/day (39.98 L/year) (DAPH, 2023b).

Milk collection infrastructure also declined from 3,918 centers in 2020 to 3,656 in 2023, with Kurunegala still leading despite a drop

from 1,206 to 734 centers (DCS, 2023d). These patterns suggest regional shifts and the need to stabilize supply chains. Urgent policy reforms are required to address feed shortages, low artificial insemination success, and inadequate cooling facilities. The Market-Oriented Dairy (MOD) project in Sri Lanka (Vyas et al., 2020) emphasizes improving extension services, milk quality, and dairy management, primarily for medium- and large-scale operations, with little focus on buffalo milk. Dedicated initiatives for buffalo production are urgently needed. The MOD project addresses dairy farming challenges by improving market access, milk quality, and farm management. It connects informal producers to the formal market and offers training for farmers, extension agents, and AI service providers. Over 4,900 farmers and 1,160 extension agents have been trained, and mobile apps for ration formulation and services have been developed. The project has enhanced milk production, supported fodder enterprises, and attracted \$4 million in investments, resulting in improved productivity and income for farmers. Finally, enhancing dairy sector sustainability requires the introduction of (automatic) milking machines, AI-supported breeding services, genetic improvement, climate-resilient practices, and investment in renewable energy and waste management. Strategic public-private collaboration, improved standards, and better incentives will be vital to boosting domestic production and reducing import dependence.

3.1.2 Poultry sector

The poultry industry is a key contributor to Sri Lanka's economy, significantly impacting GDP, employment, and food security. It includes broiler farming for meat production, the layer industry for egg production, and non-industrialized backyard poultry farming. In 2023, the sector accounted for 1.1% of the national GDP and 79% of the total livestock GDP (DAPH, 2023a). Broiler day-old chick (DOC) production has fluctuated due to economic conditions, supply chain disruptions, and regulatory policies (Figure 4). In 2021, production peaked at 176.94 million but declined to 166.78 million in 2023. Broiler chicken meat production followed a similar trend, recovering to 236.11 MMT in 2023 after a slight drop in 2022 (DAPH, 2023a; DAPH, 2023d).

Broiler DOC prices have surged due to rising feed costs and market volatility, increasing from 69.29 LKR in 2019 to 216.00 LKR in 2023, peaking at 274.00 LKR in July (Figure 4). Farm gate chicken meat prices also rose significantly, reaching 1,140.00 LKR/kg in 2023, a 355% increase since 2019 (DAPH, 2023a). The layer industry faced disruptions from reduced DOC imports and premature flock culling. Layer DOC production rose to 10.55 million in 2020 but dropped to 5.08 million in 2022 before recovering to 7.29 million in 2023 (DAPH, 2023a). Globally, consumer demand for animal welfare and sustainability is driving a shift to free-range and organic egg production (Gautron et al., 2021). Sri Lanka's egg industry must adapt by embracing welfare-friendly practices and technological advancements. Welfare-friendly practices include providing hens with enriched environments that allow natural behaviors such as perching, dust bathing, and foraging, reducing cage confinement, ensuring proper ventilation and lighting, and adopting humane handling methods. These changes not only improve animal wellbeing but also align with global certification standards for ethical production. Technological advancements such as automated climate control

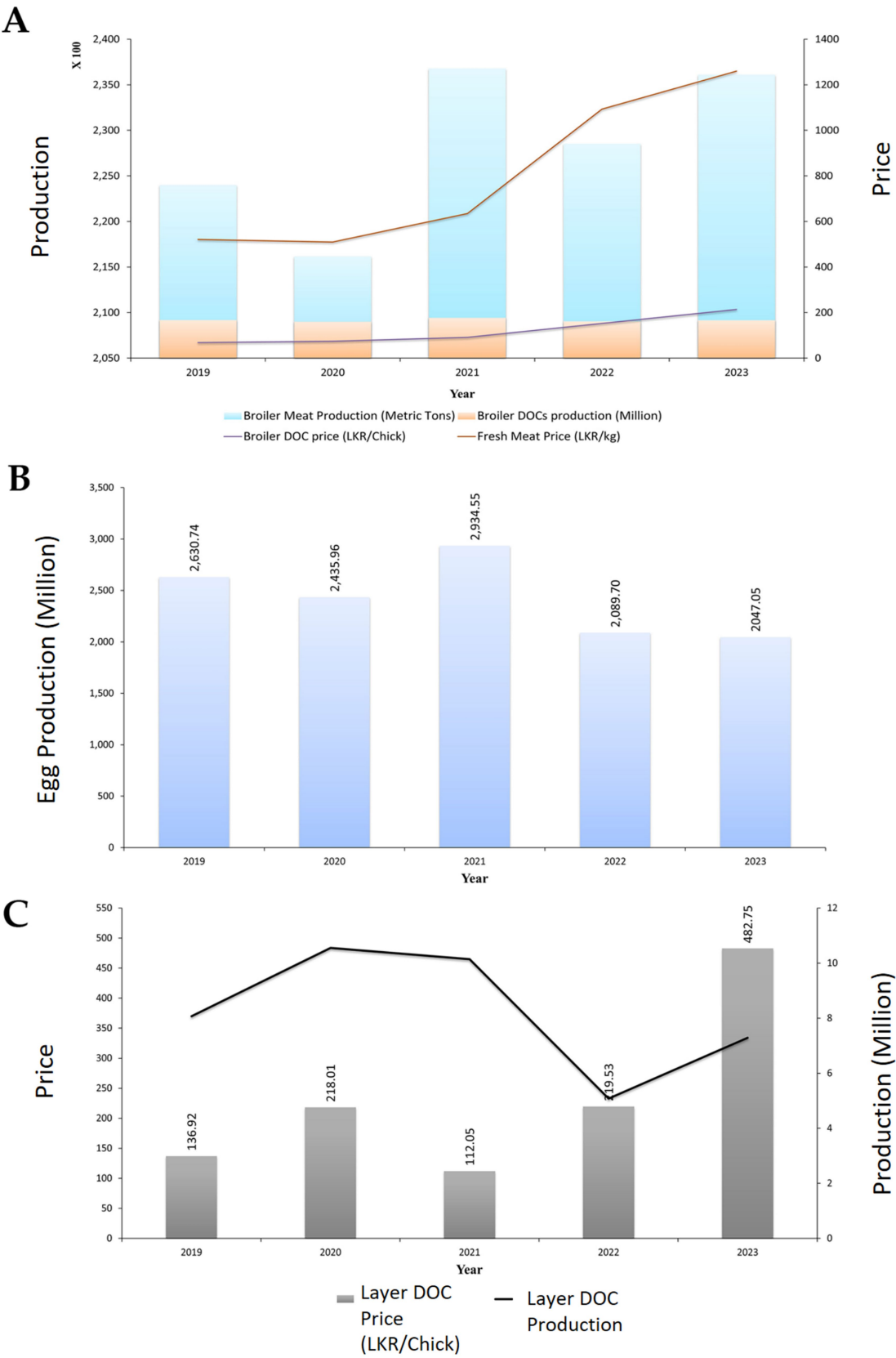


FIGURE 4
(A) Trends in broiler meat and broiler day old chick (DOC) production and prices in Sri Lanka (2019–2023); (B) Egg production and (C) layer DOC production and prices. Source: DAPH Annual Reports (2019–2023).

systems, real-time monitoring of feed and water intake, precision lighting, and smart sensors for health tracking can enhance flock management, reduce stress, and improve productivity. The integration of data-driven tools supports proactive disease prevention, optimal resource use, and compliance with international welfare standards, positioning Sri Lanka's egg sector for improved resilience and export potential.

Egg production in Sri Lanka fluctuated, peaking at 2,934.55 million in 2021 before dropping to 2,089.70 million in 2022 and slightly recovering to 2,047.05 million in 2023 (Figure 4). Egg prices were volatile, peaking at 70.00 LKR for brown eggs in 2022 and averaging 46.00 LKR (white) and 49.00 LKR (brown) in 2023 (DAFH, 2023a). Annual per capita poultry product availability fluctuated with production changes. Chicken meat availability rose to 10.64 kg in 2023, while egg availability rebounded to 99.74 kg in 2023 (DAFH, 2021a, 2022a, 2023a). Poultry feed production grew by 6% in 2023, driven by a rise in commercial feed and a drop in self-mixed feed, reflecting reliance on commercial formulations due to raw material shortages (DAFH, 2024). The sector remains vulnerable to economic and supply chain disruptions, impacting DOC, egg, and meat prices (Priyashantha and Vidanaratchchi, 2024b).

The significant rise in chicken meat and egg prices from 2019 to 2023 highlights the need for strategic interventions. Key measures include cost-effective feed production, stable input sourcing, and improved efficiency. Strengthening policies, stabilizing supply chains, and promoting local production are vital for long-term sustainability and food security. Enhancing climate resilience through adaptive farming and climate-smart poultry production is crucial to mitigating future disruptions. Future poultry production must shift from cost-minimization to profit-maximization models, integrating bird genetics, feed quality, housing, and environmental factors to optimize productivity (Pesti and Choct, 2023). Advancing poultry feed formulation with alternative protein sources, precision nutrition, and sustainable feed strategies can reduce reliance on expensive soybean imports and improve cost-effectiveness for small and medium-scale producers. By repurposing by-products from egg and meat processing, such as eggshells, feathers, and offal, producers can minimize waste and generate additional revenue, ultimately lowering overall production costs. Continuous recalibration of production models based on real-world conditions will support economic viability and sustainability in the sector.

3.1.3 Swine sector

The swine farming sector ranks among Sri Lanka's key livestock subsectors, following poultry and dairy, due to its contribution to the national economy. Approximately 5,000 farmers rely on swine farming as their primary income source, with production concentrated in the Western and Northwestern coastal regions, where extensive, semi-intensive, and intensive management systems are practiced (DAFH, 2023a).

Sri Lanka's pig population increased from 163,684 in 2020 to a peak of 178,522 in 2021, before slightly declining to 170,409 in 2023. National pork production reached 10.23 MMT in 2023, a 13.7% increase since 2020 (DAFH, 2020a, 2020b, 2021a, 2021b, 2022a, 2022b, 2023a). However, production costs surged, with live weight prices rising from 245.29 LKR/kg (2020) to 380.27 LKR/kg

(2023), while dressed-weight pork increased from 353.94 LKR/kg to 565.27 LKR/kg. Consequently, retail pork prices doubled, reaching 1,626.99 LKR/kg in 2023, making affordability a growing concern (DAFH, 2020a, 2020b, 2021a, 2021b, 2022a, 2022b, 2023a).

Pork imports peaked at 244.32 MT in 2022 before dropping to 56.78 MT in 2023, while exports increased steadily until 2022, followed by a slight decline in 2023 (DAFH, 2022a, 2023a). The industry faced multiple challenges, including COVID-19-related supply chain disruptions (2021), economic instability (2022), and rising input costs. Additionally, Porcine Respiratory and Reproductive Syndrome (PRRS) outbreaks in 2020–2021 threatened production, though improved biosecurity measures prevented major disease outbreaks in 2022–2023 (DAFH, 2021a, 2021b, 2022a, 2022b, 2023a). African Swine Fever (ASF) was first detected in Sri Lanka in October 2020, severely impacting the swine industry with high mortality rates and economic losses. Subsequent outbreaks, including those reported in 2024, led to the culling of infected herds to contain the disease. Ongoing control measures, such as improved biosecurity, movement restrictions, and surveillance, remain crucial to preventing further outbreaks and protecting the country's swine farming sector. Despite these challenges, per capita pork availability has remained stable at ~0.42 kg/year, supported by local production and imports. The sector's sustainability depends on stabilizing production costs, ensuring a steady feed supply, and improving market access. Strengthening disease management, optimizing resource use, and enhancing climate resilience through sustainable feed solutions and adaptive management practices will be critical for the industry's long-term viability.

3.1.4 Goat sector

Goat farming in Sri Lanka, particularly in the dry zone's Eastern and Northern provinces, has high income-generating potential. The goat population peaked at 773,080 in 2021 before slightly declining to 750,987 in 2023, while farm numbers increased to 91,409, reflecting higher smallholder participation (DAFH, 2021a, 2021b, 2022a, 2022b, 2023a). Production costs nearly doubled from 950.11 LKR/kg in 2020 to 1,826.11 LKR/kg in 2023, causing retail chevon prices to surge from 1,943.57 LKR/kg to 3,014.45 LKR/kg. Despite these cost increases, chevon imports declined sharply from 1,067.2 MT in 2020 to 279.07 MT in 2023, highlighting a growing reliance on domestic production (DAFH, 2021a, 2021b, 2022a, 2022b, 2023a).

Sri Lanka's livestock and poultry sectors exhibit distinct trends (Table 1). While cattle and buffalo populations fluctuate, the poultry sector expanded significantly when the volumes of chicken meat and egg productions were considered. Goat farming remained relatively stable as a traditional livestock subsector, whereas swine production experienced moderate shifts. These sectoral differences underscore the need for continuous monitoring and data-driven planning. Importantly, the impact of external factors such as economic instability, climate change, and input price fluctuations varies across subsectors. As most cattle, buffalo and goat farmers are small-scale producers, they remain highly vulnerable to external shocks, requiring targeted policy interventions to ensure sustainability and resilience.

TABLE 1 Livestock and poultry populations of Sri Lanka.

Species	Animal population (Number)			
	2020	2021	2022	2023
Cattle				
Cows				
Milking cows	496,343	506,263	598,454	523,388
Non-milking cows	265,195	280,191	184,016	221,662
Other cows	116,987	110,667	98,445	97,003
Young female animals				
Heifers	262,595	255,014	244,341	278,013
Calves	189,223	185,711	176,291	172,331
Male animals				
Adults	140,981	144,120	143,603	137,819
Calves	157,447	168,330	167,564	160,582
Buffaloes				
Cows				
Milking cows	145,533	142,829	171,717	146,873
Non-milking cows	81,818	82,017	52,595	61,625
Other Cows	35,370	32,822	26,933	29,569
Young female animals				
Heifers	82,059	81,335	73,889	83,136
Calves	60,115	60,533	60,950	57,254
Male animals				
Adults	41,825	44,573	41,169	43,294
Calves	50,596	46,933	48,797	51,738
Goats	702,892	757,983	773,080	750,987
Swine	163,684	178,522	169,267	170,409
Poultry (Number-Million)				
Grandparents and parents	3.53	1.89	1.77	1.75
Commercial	37.34	30.76	26.38	26.48
Backyard	1.1	2.2	3.20	3.23

Source: Livestock Outlook of Sri Lanka (2020, 2021, 2022, and 2023).

3.2 Accessibility and affordability of livestock and poultry products

3.2.1 Livestock and poultry consumption and production dynamics

3.2.1.1 Consumption, economic value, and import dependency of animal-sourced products

Dairy consumption is central to daily life in Sri Lanka, making the sector particularly sensitive to market fluctuations that affect accessibility and affordability. This was evident during the nationwide milk powder shortages in 2021–2022, which triggered public concern. In contrast, other animal-sourced foods such as eggs, chicken meat, and fresh fish are largely self-sufficient, reducing dependence on imports in most situations.

Despite the Sri Lankan dairy industry's estimated annual value of 55–60 billion LKR (~300 million USD), a substantial share of domestic

demand is met through imports. In 2020, per capita LME consumption was 63.3 L/person, combining local and imported sources (Priyashantha and Vidanarachchi, 2021). The sector's fragmented supply chain and import dependency underscore the need for resilience-building through strategic investments, policy reforms, and quality management.

Globally, food security in developing nations is shaped by production infrastructure, economic stability, and environmental pressures (Pawlak and Kołodziejczak, 2020). Enhancing long-term sustainability requires technological innovation, adaptive policy frameworks, and awareness initiatives that support rural economies and respond to evolving dietary and climatic challenges (Stringer et al., 2020). Looking ahead, advancements in bioinformatics, genetics, and feed efficiency will influence livestock production systems. Yet, external shocks such as geopolitical instability and resource scarcity demand proactive strategies to ensure stable, affordable, and sustainable access to animal-sourced foods. Balancing economic goals and environmental responsibility is crucial. While feed intensification

increases milk yields, it raises green house gases and input costs. Smallholders face constraints in adopting precision technologies without incentives. Thus, policies must subsidize eco-efficient practices and target equity for vulnerable producers.

3.2.1.2 Traditional dairy processing

Sri Lanka has a rich heritage of traditional dairy processing, with “Pasgorasa” (five tastes of milk) being a historical example of utilizing excess fresh milk. This unique dairy combination includes milk (*Ksheer*), fermented cow milk (*Deekiri*), ghee (*Githel/Dunthel*), cream (*Wendaru/Yodaya*), and whey (*Moru/Mohuru*) (Priyashantha et al., 2021). Among modern dairy products, yoghurt (set- and drinking-), and *Meekiri* (fermented buffalo curd) have gained popularity, surpassing liquid milk consumption in recent decades. *Meekiri*, a staple across Sri Lankan ethnic communities, is primarily produced in buffalo farming regions. A study by Adikari et al. (2021) identified key lactic acid bacteria (LAB) species in traditionally fermented *Meekiri*, including *Limosilactobacillus fermentum*, *Latilactobacillus curvatus*, *Lactobacillus acidophilus*, and *Lactiplantibacillus plantarum*, with minimal geographical variation.

3.2.1.3 Inclusive livestock development

To enhance domestic milk production and empower women, the State Ministry of Livestock, Farm Promotion, and Dairy and Egg Related Industries (2020) launched a project providing female farmers with dairy cows and processing equipment. Women’s empowerment in livestock is crucial for gender equality, increased household productivity, and

improved nutrition. The Women’s Empowerment in Livestock Index developed by Galie et al. (2019) provides a structured framework to assess empowerment through decision-making in agricultural production, nutrition-related choices, access to and control over resources, financial independence, and workload management. These aspects are essential in measuring and enhancing women’s roles in livestock farming, ensuring their participation leads to sustainable benefits for both families and communities. Complementary models such as youth entrepreneurship in poultry, indigenous breed conservation programs, and female-led dairy cooperatives offer inclusive pathways to participation across age and gender divides. Furthermore, integrating indigenous veterinary knowledge can enhance locally adapted livestock management practices and bolster disease resistance, especially in resource-limited settings. These inclusive and culturally embedded approaches can strengthen the social foundations of livestock development, ensuring that empowerment translates into long-term resilience and productivity.

3.2.1.4 Availability of livestock and poultry products

The availability of livestock and poultry products in Sri Lanka has fluctuated significantly over the past 5 years, reflecting economic shifts, production challenges, and changing consumption patterns (Table 2). Milk and dairy product availability (LME) declined from 52.81 L in 2020 to 34.60 L in 2022 due to supply chain disruptions, rising production costs, and reduced dairy sector performance. However, in 2023, per capita milk availability increased to 39.98 L, indicating gradual stabilization (Table 3). Food safety compliance

TABLE 2 Livestock and poultry product availability in Sri Lanka.

Commodity	Availability per year			
	2020	2021	2022	2023
Annual milk production				
Cow milk (Mn Lt)	363.21	356.11	326.12	317.06
Buffalo milk (Mn Lt)	51.63	55.95	53.88	53.26
Total milk (Mn Lt)	414.84	412.06	380	370.32
Meat and egg production				
Chicken meat ('000 MT)	216.16	236.79	228.13	236.11
Egg (Mn)	2,435.96	2,934.55	2,089.7	2,043.5
Pork ('000 MT)	9.01	9.82	9.3	9.37
Beef ('000 MT)	29.54	27.86	27.62	27.28
Chevon ('000 MT)	1.96	2.5	2.68	2.75

Source: Livestock Outlook of Sri Lanka (2020, 2021, 2022, and 2023).

TABLE 3 Annual per capita availability of livestock and poultry products in Sri Lanka.

Commodity	Annual per capita availability of livestock and poultry products			
	2020	2021	2022	2023
Milk and milk products (LME)-L	52.81	48.69	34.6	39.98
Chicken (kg)	9.79	10.68	10.27	10.64
Beef (kg)	1.35	1.26	1.25	1.23
Chevon (kg)	0.14	0.15	0.14	0.12
Pork (kg)	0.41	0.44	0.43	0.43
Egg (Number)	110.71	132.3	93.4	99.74

Source: Livestock Outlook of Sri Lanka (2020, 2021, 2022, and 2023).

among Sri Lankan dairy farmers remains moderate, with an average Food Safety Index (FSI) score of 0.54 (Korale-Gedara et al., 2023). Adoption varies by production system, with intensive farms showing higher compliance. Training and subsidies for farm infrastructure enhance safety measures, but market-driven incentives are insufficient for widespread improvements.

3.2.1.5 Meat production and consumption trends

Chicken remains the primary meat source in Sri Lanka, with per capita availability stabilizing around 10.5 kg despite economic fluctuations (Table 3). Beef consumption declined from 1.37 kg in 2019 to 1.23 kg in 2023 due to rising prices and changing consumer preferences. Chevron and pork consumption remained consistently low. Egg availability dropped from 132.30 per capita in 2021 to 93.40 in 2022 due to increased feed costs and reduced production, but partially recovered to 99.74 eggs in 2023 (Table 3), with a projected increase to 130 eggs in 2024. These shifts highlight the critical role of livestock products in national food security and the need for strategic policy interventions to enhance production efficiency, stabilize supply chains, and ensure affordability (Pawlak and Kołodziejczak, 2020).

3.2.1.6 Processed meats and value-added products

Sri Lanka produces various meats, including chicken, pork, chevon, and beef, with a growing demand for value-added products such as sausages, ham, nuggets, and cured meats. Convenience, urbanization, and socio-economic factors drive this shift toward processed meats. Poultry production remains a key sector for rural livelihoods and national food security, providing income through egg and meat sales, live animal trade, and by-products. The State Ministry of Livestock (2020) introduced a poultry development program to achieve per capita consumption targets of three eggs per week and 10 kg of chicken meat per year. According to the DAPH Annual Report (2023a), broiler chicken is now the dominant meat in Sri Lanka, with rising consumer demand due to its affordability and adaptability in various diets. However, Sanitary and Phytosanitary (SPS) compliance remains a major challenge limiting Sri Lanka's ability to access high-value international markets for animal-sourced products (Sirisena, 2016). While domestic demand for value-added meat products such as sausages, hams, and nuggets is increasing, export competitiveness is constrained by several factors. These include substandard slaughterhouse infrastructure, inadequate cold chain logistics, poor enforcement of hygiene regulations, and limited adoption of international food safety management systems such as HACCP and ISO 22000.

Traceability is another significant barrier, as most livestock value chains in Sri Lanka lack robust animal identification, movement tracking, and product traceability systems, which are increasingly demanded by importing countries, especially in the European Union, Gulf Cooperation Council (GCC) countries, and East Asian markets. Furthermore, concerns over antimicrobial residues and the absence of systematic residue monitoring programs have hindered progress in meeting Codex Alimentarius and World Organisation for Animal Health (WOAH) standards.

Addressing these compliance issues requires an integrated approach involving modernization of slaughter and processing facilities with the increasing demand for animal-derived food, capacity building among producers and processors, public investment in residue testing labs, and the development of

national traceability systems. Encouraging private sector engagement and public-private partnerships will be essential to elevate Sri Lanka's export readiness in animal-sourced food commodities.

3.2.1.7 Challenges in beef and pork production

Beef production, however, has stagnated due to religious and cultural constraints on cattle slaughter, with buffalo slaughter entirely banned. Similarly, in the Indian context, religious reverence for cattle, deeply embedded in the culture and influenced by Hindu traditions, has significantly shaped policies restricting cattle slaughter. This cultural phenomenon, which can be traced back to the Indus Valley Civilisation, has evolved into a deeply entrenched religious and socio-political ideology (Kennedy et al., 2018). This reverence has led to sustained efforts over the past decade to ban cattle slaughter, largely driven by religious organizations and cultural advocacy groups.

Pork imports have increased to meet domestic demand, reflecting shifting consumer preferences. However, the pork industry faces challenges such as limited land availability, environmental concerns, and disease management. Similar challenges are observed Wang and Li (2024) across Asia, the world's largest producer and consumer of pork, where small-scale farms dominate the sector. The industry requires strategic investments in large-scale production, alternative feed resources, precision feeding, and disease control through preventive medicine and vaccines to ensure sustainable growth. Additionally, implementing manure recycling techniques and efficient waste management practices can contribute to environmental sustainability.

3.2.1.8 Goat farming and sector challenges

Goat farming, a traditional practice in Sri Lanka's dry and intermediate zones, remains underdeveloped despite high demand for chevon, especially during religious and cultural festivals. The sector faces major challenges, including inconsistent supply, a lack of breeding programs, weak market infrastructure, and inadequate processing facilities. These limitations mirror the challenges faced by the goat industry in Vietnam, as explained by Nguyen et al. (2023), where small-scale farms dominate production, and marketing remains largely informal. Vietnam's experience highlights the need for structured supply chains, research-driven breeding improvements, and market development initiatives to meet growing demand. Strengthening Sri Lanka's Chevron sector through similar approaches could reduce imports, improve self-sufficiency, and create export opportunities.

3.2.2 Value chain development and processing

Sri Lanka's animal-source food value chains, including dairy, meat, and eggs, are critical to national food and nutrition security but remain constrained by structural inefficiencies and underdeveloped processing systems. As reviewed by Priyashantha and Vidanarachchi (2024b), the dairy sector meets less than half of domestic demand, limited by fragmented supply chains, inadequate chilling infrastructure, and inconsistent product quality. While dairy value chains involve chilling centers, cooperative societies, and branded processors, quality assurance remains weak. The meat sector focuses mainly on broiler and pork products but suffers from limited cold chain infrastructure and minimal processing. Egg value

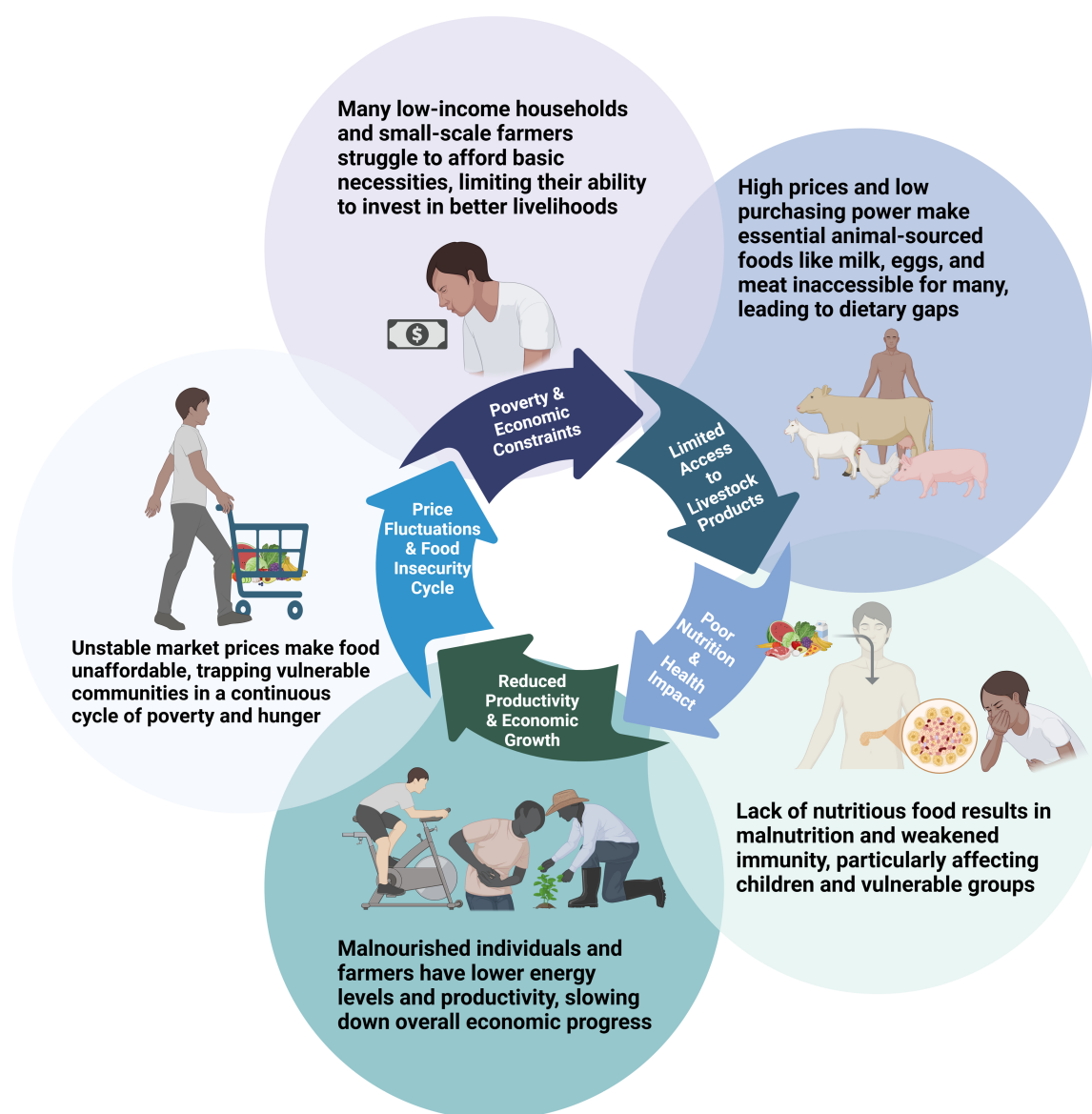


FIGURE 5

The vicious cycle of poverty and livestock product consumption in Sri Lanka illustrates the interplay between economic constraints, limited access to animal-sourced foods, nutritional deficiencies, and reduced economic productivity. The diagram highlights key factors affecting food security, price fluctuations, and resilience strategies for the dairy and poultry sectors. Created in BioRender. Priyashantha, H. (2025) <https://BioRender.com/n78g808>.

chains also lack value-added diversification. These limitations, coupled with weak traceability and compliance systems, hamper market growth and reduce profitability across animal-source food value subsectors.

To address these challenges, Priyashantha and Vidanarachchi (2024b) recommend targeted interventions including investments in decentralized processing facilities, public-private partnerships, and adoption of HACCP/ISO standards to improve food safety and traceability. Strengthening technical capacity through producer training, promoting cooperative models, and expanding digital tools for market integration are also essential. Moreover, supporting value-added production, such as cheese, yogurt, and processed meats can enhance domestic value addition and export competitiveness. These measures are vital to improving resilience, market efficiency, and inclusive growth within Sri Lanka's food system.

3.2.3 The impact of poverty on food security

The vicious cycle of poverty, as illustrated in Figure 5, significantly influences the accessibility, availability, and affordability of livestock and poultry products, which are often considered high-cost food items in the market. Limited financial resources restrict households' ability to afford nutrient-rich animal-sourced foods, leading to poor dietary intake and weakened health status. This deterioration in health further reduces economic productivity and earning potential, perpetuating the cycle of poverty and food insecurity.

On a global scale, similar patterns emerge in regions where food affordability is impacted by structural challenges such as climate variability, infrastructure limitations, and conflict. Analysis of food price data in West African countries, including Burkina Faso, Mali, and Mauritania, demonstrates how diverse, well-connected agricultural markets offer more affordable nutrient-adequate diets,

while regions affected by conflict and harsh climatic conditions experience significantly higher food prices and reduced diet affordability. Even in areas with favorable agricultural conditions, economic barriers often prevent households from accessing nutrient-rich foods, reinforcing cycles of malnutrition and poverty (Shepperdley et al., 2024). These findings highlight the urgent need for targeted interventions such as improving market access, investing in resilient food supply chains, and strengthening rural economies to break the poverty trap and ensure sustainable food security worldwide.

Rising food prices significantly impact household food security, particularly in low-income communities, by limiting access to nutrient-rich livestock and poultry products. While increased prices can benefit producers through higher incomes, they also strain consumers, exacerbating socio-economic disparities. A redefined understanding of these dynamics is essential for developing policies that balance affordability and economic growth related to Sri Lanka's livestock and poultry sector (Gustafson, 2013).

Global trends indicate that livelihood shifts influence food choices, with urbanization, changing occupations, and income variations altering dietary patterns in low- and middle-income countries (LMICs). These shifts affect food accessibility, as urban populations tend to consume more processed foods due to time constraints and evolving social norms, while rural areas may struggle with availability (Kenney et al., 2024). Simultaneously, food systems are at the center of multiple global crises, including climate change, malnutrition, and social inequities. Transformative actions at the global level, such as those discussed at the UN Food Systems Summit, highlight the importance of integrating sustainable nutrition policies with economic and environmental considerations (Fanzo et al., 2021).

The lessons from past food price crises emphasize the dual impact of rising costs, improving rural economies when managed well but pushing vulnerable households further into poverty when policies fail. High food prices have shown both short- and long-term consequences outside the Sri Lanka as well, demonstrating the necessity of targeted interventions to support food affordability, enhance market infrastructure, and strengthen social safety nets (Gustafson, 2013). Investing in sustainable agricultural practices and equitable food policies is crucial for ensuring long-term food security in Sri Lanka and globally.

3.2.4 Livestock and poultry as a renewable energy source

Livestock and poultry play a crucial role as renewable energy sources, particularly in developing countries with low levels of farm mechanization. In Sri Lanka, buffalo and cattle have historically been used for agricultural purposes, providing draft power for ploughing, threshing, and transporting harvested crops. While not universally adopted across all farming systems, the use of livestock for traction reduces dependency on fossil fuel-based machinery, thereby enhancing food security and promoting sustainable agricultural practices (Herrero et al., 2013).

Beyond their traditional role in agriculture, livestock and poultry also contribute significantly to renewable energy production. Biogas digesters, for instance, enable the conversion of livestock and poultry waste such as slurry and liquid manure into biogas. This process not only manages animal waste effectively but also mitigates methane emissions, reducing greenhouse gas impacts and preventing eutrophication (Brahmi et al., 2024; Jameel et al., 2024). Biogas

production through anaerobic digestion is an environmentally friendly alternative to conventional energy sources, offering a sustainable means of waste disposal while generating valuable energy (Jameel et al., 2024).

The benefits of biogas extend beyond energy generation. The effluent from digesters serves as a nutrient-rich organic fertilizer, often proving more effective than untreated manure in enhancing soil fertility and crop yields (Brahmi et al., 2024). Additionally, dried animal dung can be utilized as a fuel source, providing a renewable alternative to firewood and fossil fuels. By harnessing the energy potential of livestock, rural communities can improve energy access, enhance agricultural productivity, and reduce environmental degradation (Jameel et al., 2024; Majeed et al., 2023).

The expansion of biogas technology and livestock-based energy solutions requires strategic policy interventions. Increased public subsidies, targeted investments, and the development of small and medium-sized biogas plants could further promote sustainable energy production while minimizing transportation-related emissions (Brahmi et al., 2024). Moreover, integrating renewable energy sources such as solar and wind with livestock-based energy systems could improve overall energy efficiency in agriculture (Majeed et al., 2023). Hence, livestock and poultry contribute significantly to sustainable energy solutions, supporting both agricultural productivity and environmental conservation. By adopting biogas technology and other livestock-based renewable energy initiatives, Sri Lanka and other developing nations can enhance rural energy access, reduce reliance on fossil fuels, and promote climate-resilient farming practices.

3.2.5 Livestock and poultry in integrated agriculture

Integrated livestock and poultry systems play a crucial role in enhancing agricultural productivity, ensuring food security, and promoting environmental sustainability. By integrating livestock and poultry with different agricultural operations, farmers can improve efficiency, resilience, and overall system stability (Sekaran et al., 2021). One of the key benefits of integrating livestock is the contribution to crop production through natural weed and pest control. Livestock and poultry species such as cattle, sheep, buffalo, ducks, and geese help manage weeds and pests, reducing reliance on synthetic weedicides and pesticides. This practice can lower weed control costs by up to 40%, allowing farmers to allocate resources more efficiently while improving yields (Datta et al., 2024). Additionally, integrated systems enhance nutrient recycling, as livestock manure rich in nitrogen (N), phosphorus (P), and potassium (K) serves as an effective organic fertilizer (Figure 6), improving soil fertility and reducing dependency on expensive chemical alternatives (Rayne and Aula, 2020).

The integration of crops and livestock also optimizes resource utilization, particularly in feed management. Utilizing crop residues and agricultural by-products as livestock and poultry feed reduces feed costs while ensuring the availability of nutritious feed sources. This practice not only maximizes the use of available resources but also strengthens the circular economy within food systems by minimizing waste and enhancing productivity (Sekaran et al., 2021). Moreover, livestock manure can support alternative food production methods, such as algae cultivation, which serves as a sustainable protein source for aquaculture, further diversifying food production and enhancing nutritional security (Datta et al., 2024).

Integrated livestock systems contribute to long-term agricultural sustainability by reducing reliance on external inputs and maintaining

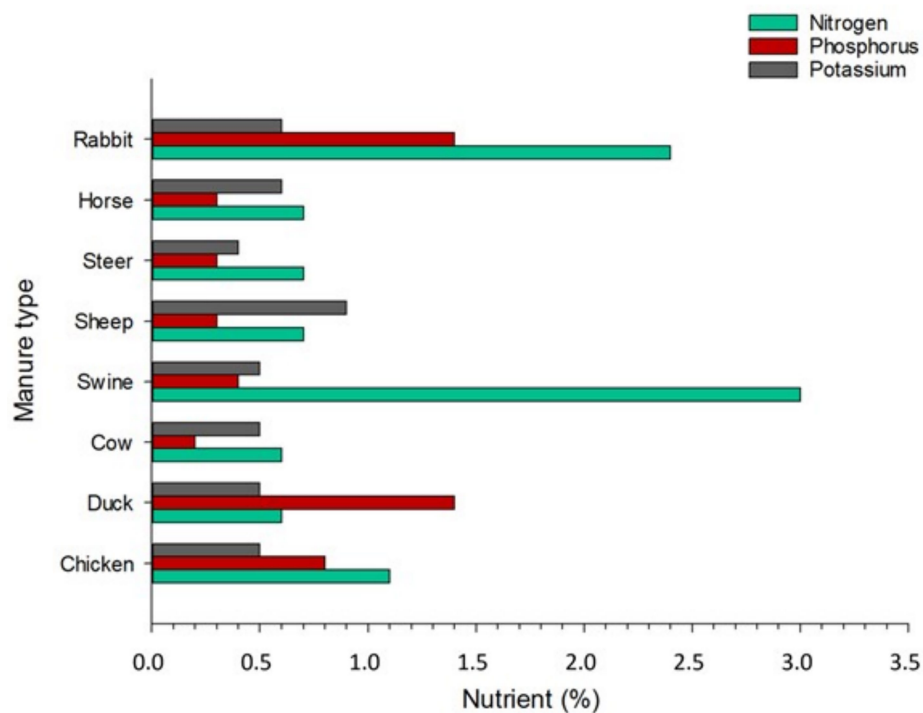


FIGURE 6
Animal manure type and approximate NPK percentages. Source: Fertilizer Association in India (2020–2021).

soil health. These systems enhance soil structure, improve water retention, and support microbial activity, all of which are essential for sustained agricultural productivity (Rayne and Aula, 2020). By fostering a balance between crop and livestock production, integrated systems help mitigate environmental degradation associated with intensive monoculture farming. Thus, integrated livestock and poultry systems provide a holistic approach to sustainable agriculture by improving crop yields, promoting nutrient recycling, reducing external input dependency, and diversifying food production. Implementing these systems aligns with circular economic principles by minimizing waste, keeping resources in use, and regenerating natural ecosystems, ultimately supporting global food security and environmental resilience (Sekaran et al., 2021).

3.3 Improvements in livestock and poultry health and disease management in Sri Lanka

Effective disease management in the livestock and poultry sector is critical for ensuring food security in Sri Lanka. Livestock and poultry diseases significantly impact animal health and productivity, leading to economic losses and potential disruptions in the food supply chain (Xu et al., 2022). Preventive measures such as vaccination, biosecurity protocols, and disease surveillance are essential for maintaining healthy livestock populations and ensuring the safety and quality of animal-sourced food (Nimmanapalli and Gupta, 2020). By controlling and preventing diseases, the risk of food contamination is minimized, and the sustainability of the agricultural industry is enhanced. Extension reforms should integrate participatory approaches, combining ICT tools

with field-based demonstration activities. Localized farmer field schools and vocational training, with a focus on gender and youth inclusion, can bridge knowledge gaps and improve effective disease management strategies as well as preparedness.

Disease outbreaks can result in the loss of valuable animal genetic resources, negatively affecting breeding programs and reducing productivity. Implementing effective disease management strategies helps safeguard genetic diversity and sustain the livestock and poultry sectors, ensuring long-term food security (Nimmanapalli and Gupta, 2020). Since June 2018, Sri Lanka has banned in-feed antibiotics due to concerns about antibiotic resistance. The overuse of antibiotics in livestock has led to an imbalance in beneficial intestinal microflora and the emergence of resistant bacteria, posing risks to both animal and human health (Gupta and Sharma, 2022; Roe and Pillai, 2003). Many antibiotics used in animals have human analogs, reducing their effectiveness in treating infections across species (Koutsoumanis et al., 2019). Monitoring resistance mechanisms and their dissemination into the food chain is crucial for the sustainability of livestock and poultry sectors (Roe and Pillai, 2003). Given consumer preferences for antibiotic-free animal products, various alternatives have been explored as performance enhancers and health promoters (Koutsoumanis et al., 2019). However, even a long-term withdrawal of antibiotics from feed may not significantly reduce antibiotic-resistant bacteria. Therefore, alternative strategies must consider effectiveness, safety, regulatory acceptance, ease of use, and economic viability (Koutsoumanis et al., 2019).

In 2023, Sri Lanka made significant progress in promoting livestock and poultry health, strengthening food security and agricultural productivity. The DAPH is responsible for disease surveillance, prevention, and control, implementing vaccination

programs, disease monitoring, and diagnostic services (DAFH, 2023a). Key vaccination initiatives target diseases such as Foot and Mouth Disease, Haemorrhagic Septicaemia, Black Quarter, and Bovine Brucellosis, with vaccines like those for Foot and Mouth Disease and Newcastle Disease provided free of charge to farmers, reducing disease spread and economic losses (DAFH, 2023a).

DAFH has launched several health management programs to protect animal health, enhance productivity, promote animal welfare, and support sustainable livestock and poultry sectors. Successful initiatives include the Livestock Health Improvement Project, Avian Influenza Surveillance Programme, Salmonella Control Programme, and the upgrading of Regional Veterinary Laboratories in Kurunegala, Puttalam, and Gampaha (DAFH, 2023a). The Livestock Health Improvement Project, initiated in 2007, utilizes the California Mastitis Test to detect and control subclinical mastitis while providing essential supplies such as teat dip solutions and California Mastitis Test reagents, improving dairy hygiene and overall health (DAFH, 2023a).

The Avian Influenza Surveillance Programme plays a crucial role in preventing Notifiable Avian Influenza (H5 and H7) from entering the country. It includes clinical disease surveillance, sero-surveillance of commercial layers (with 2,826 samples tested in 2021), and targeted epidemiological surveillance in 69 high-risk coastal areas. No cases of the virus have been detected, demonstrating the program's effectiveness (DAFH, 2021a). Similarly, the Salmonella Control Programme helps manage Salmonellosis in poultry, which can impact both production and health. In 2021, surveillance of 45 registered poultry farms indicated minimal positive results, maintaining breeder farms and hatcheries in salmonella-free status (DAFH, 2021a).

Efforts are also underway to mitigate disease threats to wildlife through dedicated monitoring programs. Veterinary Investigation Centers aid in detecting and managing zoonotic diseases, protecting both animal and human health. These strategic initiatives encompass ongoing monitoring for diseases such as Avian Influenza and continuous sero-surveillance to uphold disease-free status among poultry and livestock populations (Horefti, 2023). By adopting a One Health approach, which integrates human, animal, and environmental health, Sri Lanka could aim to enhance disease prevention, surveillance, and control. This holistic strategy fosters collaboration among veterinary, medical, and environmental sectors, enabling early detection and rapid response to emerging threats. Strengthening biosecurity measures, improving diagnostic capabilities, and promoting responsible antimicrobial use are critical components of this approach. Ultimately, these efforts could contribute to a stable and sustainable food system in Sri Lanka and globally, while mitigating public health risks associated with zoonotic diseases and antimicrobial resistance.

4 Comprehensive policies and recommendations for enhancing livestock and poultry in Sri Lanka

Recommendations have been summarized in Figure 7 and also described in detail in this section. Those recommendations can be adopted to safeguard the food security in Sri Lanka through the livestock and poultry sectors based on three strategic approaches spanning short-, mid-, and long-term frameworks. Proposed strategies align with FAO's Climate Smart Agriculture Framework and IPCC

adaptation pathways, emphasizing productivity, resilience, and mitigation co-benefits.

4.1 Nutrition and feeding

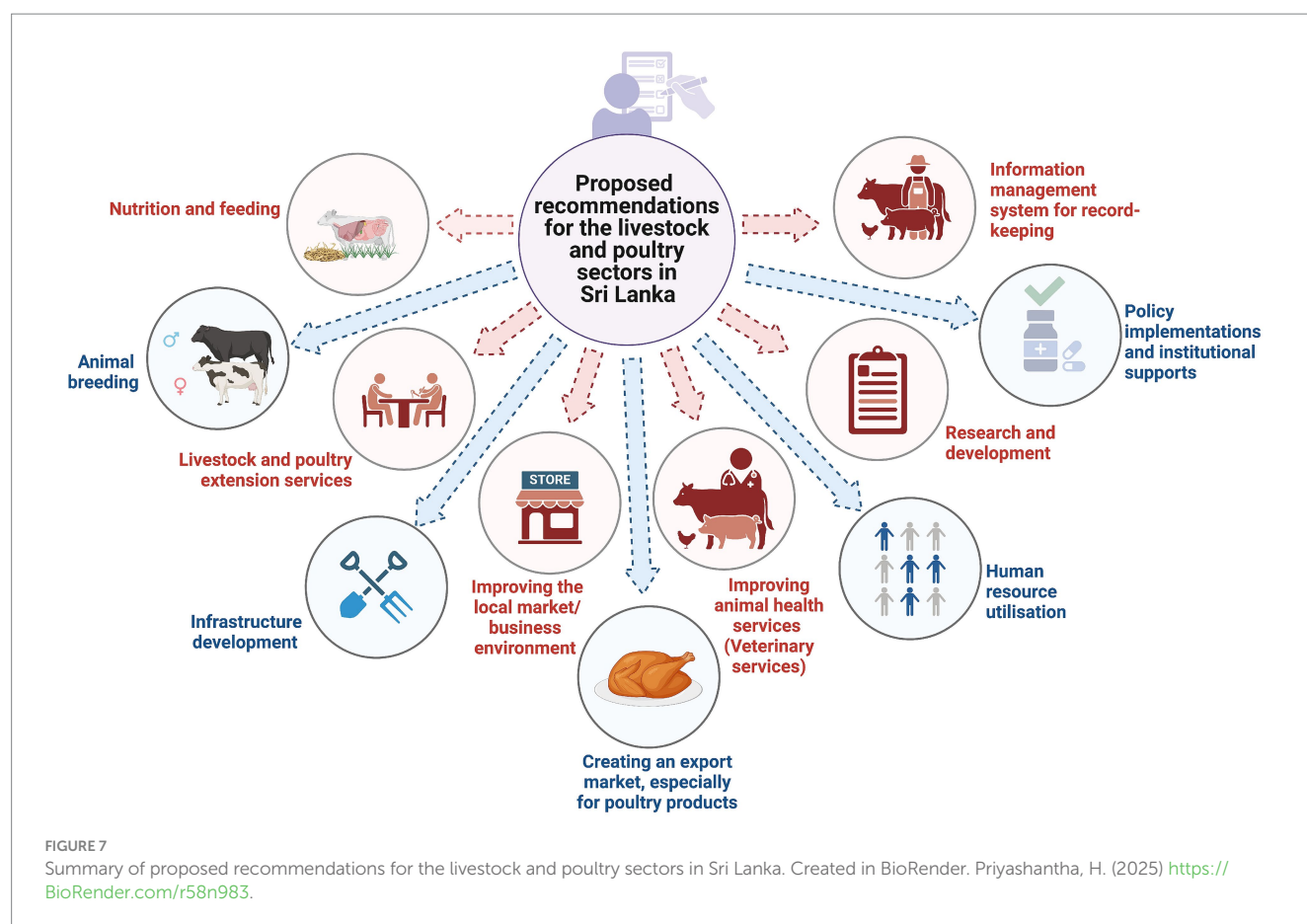
- Promote the concept of forage as a crop and provide incentives and training on growing forages.
- Increase access to quality pasture, fodder, and animal feed, and develop comprehensive animal nutrition plans to avoid sudden changes in feed quality (Figure 8A).
- Encourage private sector investment in the forage industry and forage conservation to produce high-quality silage.
- Improve strategies to enhance the nutrient digestibility and availability of existing feed materials.
- Adopt precision feeding techniques according to the growth and development stages of livestock.
- Promote methodologies to increase the feed intake of dairy cows by offering quality feed, using management-intensive grazing systems, and increasing feeding frequency.
- Enhance the availability of roughage to combat the lack of properly maintained pasture lands and dry climatic conditions with less water availability.

4.2 Animal breeding

- Implement the animal breeding policy guidelines and establish a mechanism to supply recommended breeding materials in appropriate quantities.
- Integrate crossbreeding, genetic selection, and advanced reproductive technologies to develop a resilient, high-producing herd suited for climate-smart dairy farming.
- Establish a national-level performance recording scheme for herd assessment and a breeding value calculation program for breeding herds.
- Facilitate monitoring and evaluation of the breeding programs that have been implemented.
- Establish stud bull services appropriately for areas/species whenever necessary.
- Improve the efficiency of artificial insemination service through capacity building.
- Introduce appropriate animal reproductive and breeding technologies to established breeder farms.
- Systematically introduce improved genotypes based on a thorough investigation of the industry's needs.

4.3 Livestock and poultry extension services

- Establish a dedicated extension service for the livestock sector to provide targeted support and resources.
- Introduce effective extension strategies and up-to-date knowledge to enhance knowledge sharing.
- Facilitate opportunities for small-holder farmers to participate in extension programs, ensuring they have access to the latest information and techniques.



4.4 Infrastructure development

- Establish facilities for milk storage and cooling for small farmer cooperatives in areas without nearby regional milk chilling centers.
- Enhance feed storage facilities to minimize contamination from fungal toxins.
- Develop infrastructure to provide adequate and high-quality drinking water, including water conservation strategies for the dry season.
- Offer new farming machinery for the livestock and poultry sectors at concessionary rates (Figure 8B and D).
- Implement manure disposal and treatment facilities, and provide skill and knowledge enhancement programs for farmers.

4.5 Improving the local market/business environment

- Develop price stabilization mechanisms to mitigate market uncertainties and fluctuations.
- Implement market intelligence systems for real-time data on demand, supply, and pricing trends.
- Improve farm-to-market linkages by addressing logistical and distribution inefficiencies.
- Establish producer cooperatives and contract farming models to enhance bargaining power and supply consistency.

- Invest in new product development and extend the shelf life of dairy products such as yoghurt and *Meekiri*.
- Support innovation in processing, packaging, and branding to enhance market appeal.
- Strengthen quality control systems for raw milk and eggs through regulatory enforcement and training programs.
- Promote Good Agricultural Practices (GAP) and Good Manufacturing Practices (GMP) at all stages of production.
- Implement strict monitoring systems to prevent the adulteration of milk (Figure 8B).
- Educate farmers on the judicious use of antibiotics and enforce regulations to combat antimicrobial resistance (AMR).
- Expand digital platforms for marketing, traceability, and direct farm-to-consumer sales.
- Promote mobile-based financial services and digital payment solutions for rural farmers.

4.6 Creating an export market, especially for poultry products

- Establish a system for value addition and adherence to international quality standards.
- Form international trade partnerships to expand export opportunities for high-quality dairy and poultry products.
- Encourage foreign direct investment (FDI) and technology transfer to enhance industry competitiveness.



FIGURE 8

(A) Intensively managed dairy farm in Sri Lanka, where the quantity and quality of feed play a crucial role in animal health and productivity; (B) Milk quality testing at a milk chilling center in Sri Lanka to ensure safety and standards; (C) Commercial-scale broiler chicken farm in Sri Lanka, highlighting intensive poultry production practices; (D) Commercial hatchery in Sri Lanka specializing in the production of day-old chicks for the poultry industry.

- d Train farmers with a focus on value orientation, both socially and professionally.
- e Foster entrepreneurship by encouraging youth and young farmers to add value to their products and services.
- f Reconnect fragmented value chains and improve market linkages to promote value chain integration.
- g Increase domestic value addition and strengthen export competitiveness.
- h Focus on differentiation, value addition, branding, and improving the quality and safety of animal-derived products.

4.7 Improving animal health services (veterinary services)

- a Equip the Animal Quarantine Division with advanced diagnostic technologies and enforce strict quarantine measures.
- b Develop a national biosecurity framework to regulate livestock imports and minimize disease risks.
- c Promote rapid diagnostic tools for early disease detection and timely treatment.
- d Establish mobile veterinary units for improved disease surveillance in remote areas.
- e Encourage climate-smart housing and management practices to reduce environmental stress on animals.
- f Provide farmer training programs on best practices for animal welfare and disease prevention.
- g Improve veterinary facilities and increase the number of veterinarians to address healthcare needs.
- h Establish regional animal health centers for accessible and timely veterinary care.
- i Introduce subsidies or concessionary pricing for essential veterinary drugs, vaccines, and treatment services.
- j Implement livestock insurance schemes to help farmers manage veterinary costs.
- k Develop a national livestock health database to track disease outbreaks, vaccination records, and treatment histories.
- l Integrate digital record-keeping systems at provincial and national levels for real-time decision-making.
- m Implement a nationwide disease monitoring and control system with real-time reporting mechanisms.
- n Strengthen collaborations between veterinary research institutions, universities, and government agencies for improved disease management.
- o Upgrade national vaccine production facilities to ensure the availability of high-quality, cost-effective vaccines.
- p Promote public-private partnerships (PPPs) to enhance research and development (R&D) in vaccine production.
- q Establish emergency veterinary response teams to manage disease outbreaks effectively.

4.8 Information management system for record-keeping

- a Collect individual animal data on milk yield, disease, and reproduction events that can be used in breeding programs.

4.9 Human resource utilization

- a Create opportunities and provide encouragement for women and youth in agriculture.
- b Empower farmers to negotiate better farm gate prices.
- c Organize capacity-building programs to enhance farmers' technical skills.
- d Offer manpower development and training programs for farmers.

4.10 Research and development

- a Evaluate the performance and cost-effectiveness of different animal breeds and their crosses under various farming systems.
- b Assess the performance of indigenous animal categories to inform conservation decisions.
- c Analyze the nutritional composition of conventional and non-conventional feed resources available in farming regions.
- d Develop novel feedstuff from agro-industrial by-products and explore cost-effective feed formulation and processing technologies.
- e Focus on different management aspects such as nutrition, breeding, reproduction, health, disease control, and vaccine development.
- f Develop locally produced vaccines and improve their efficacy.
- g Evaluate methane emissions under different farming conditions and genotypes.
- h Assess good management practices in terms of climate smartness and animal welfare

4.11 Policy implementations and institutional supports

- a Dispose of unproductive animals based on science-based farm management practices, while considering religious concerns.
- b Strengthen the implementation of the National Breeding Policy.
- c Harmonize related policies to ensure steady implementation of livestock and poultry actions.
- d Create a policy environment that supports sector improvement.
- e Ensure access to natural grazing lands to prevent conflicts between dairy farmers and government officials.
- f Provide irrigation for forage cultivation, treating forage as a crop for animal farming.
- g Facilitate the importation of suitable forage seeds and planting materials for local conditions.
- h Establish forage breeding programs at DAPH with adequate manpower.

- i Introduce a payment system based on the microbial quality of milk, not just fat and SNF (Solids).
- j Implement prerequisite programs in the dairy value chain, such as Good Agricultural Practices (GAP), Good Hygienic Practices (GHP), Good Veterinary Practices (GVP), and Good Manufacturing Practices (GMP).
- k Focus export sector policies on improving the sophistication of livestock products.

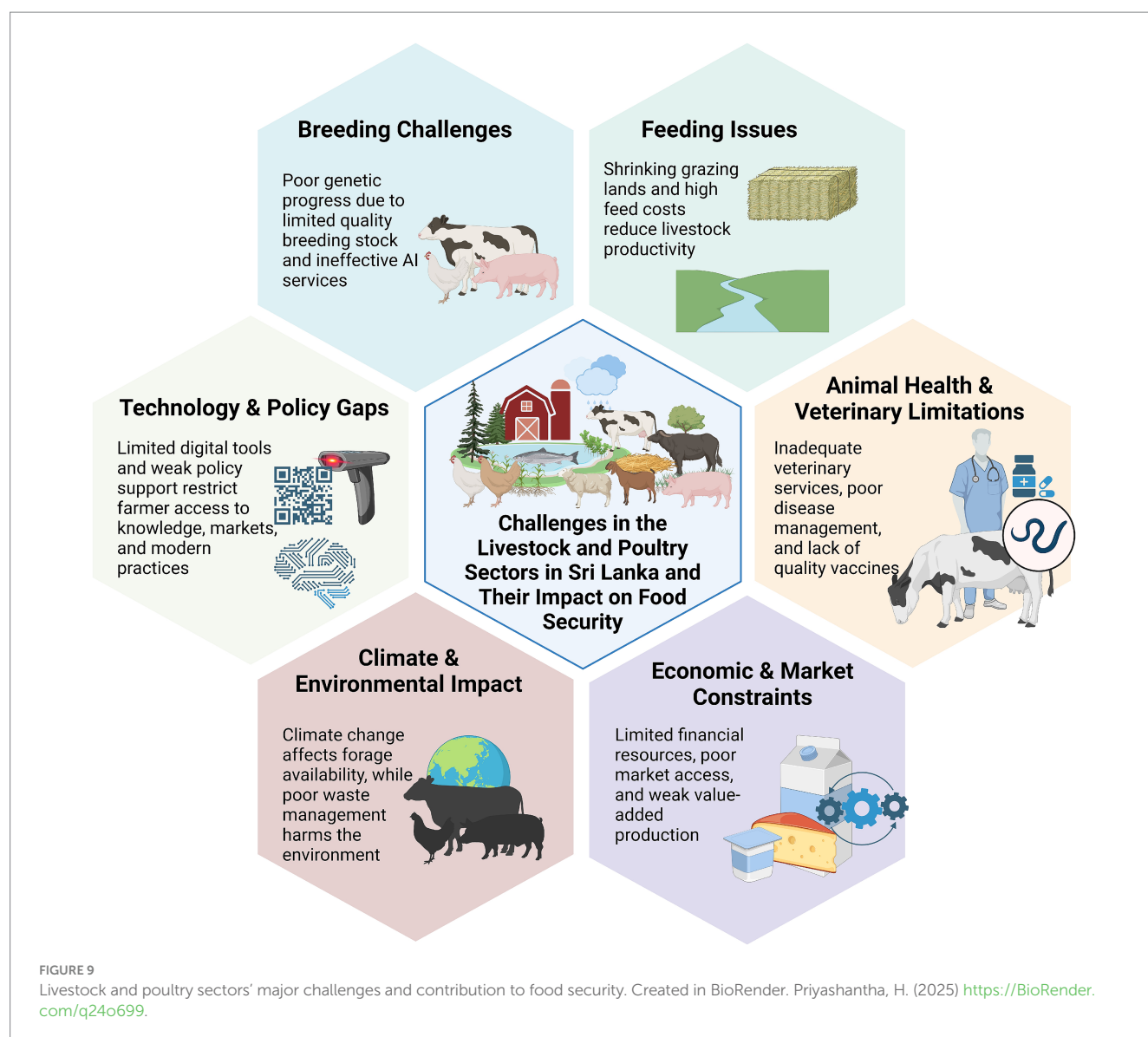
5 Discussion on challenges, insights and opportunities

The livestock and poultry sectors in Sri Lanka face several critical challenges that have significant implications for food security (Figure 9). The major constraints and limitations associated with cattle, buffalo, and other small ruminants can be broadly categorized into issues related to the shortage of quality breeding stock, inadequate nutrition, animal health concerns, reproductive inefficiencies, financial constraints, marketing difficulties, and other systemic challenges. Efficient reproductive performance in cows is essential for the sustainability of dairy production systems. Effective breeding strategies play a crucial role in ensuring the continuous production of genetically improved offspring and maintaining a steady supply of milk (Perera and Jayasuriya, 2008).

The improvement of Sri Lanka's national dairy herd is crucial for the sustainability of the dairy industry. Enhancing productivity while preserving the adaptive traits of indigenous breeds is essential for resilience in harsh environments with low-quality feed. Studies by Weerasingha et al. (2022a, 2022b) highlighted the significance of preserving the native breeds, such as Thamankaduwa White and Lankan Cattle in Sri Lanka, which outperform improved breeds like Friesian and Jersey in milk coagulation, higher casein content, and superior yoghurt texture, key factors in efficient dairy processing and food security.

Despite several efforts to improve the genetic potential of the national herds, Sri Lanka's animal breeding activities face challenges. The 1994 National Breeding Policy guidelines were formulated aiming to enhance livestock through grading and crossbreeding (Ministry of Livestock Development, 2010), with artificial insemination introduced as the primary method. However, genetic progress has been slow due to poor herd structure organization, lack of recording systems, and ineffective selection at the farm level. Systematic culling of low-performing animals and improving artificial insemination coordination, infrastructure, and farmer awareness are critical for progress. In areas where artificial insemination is inaccessible, the absence of a structured stud bull program hinders access to quality breeding stock. Moreover, welfare considerations in artificial insemination centers remain largely overlooked, despite evidence suggesting that stress negatively affects bull productivity, sperm quality, and reproductive performance (Cojic and Morrell, 2023).

Sustainable livestock production requires increasing the availability of animals suited to diverse environments and production systems. Breeding programs should focus on conserving indigenous livestock and developing structured genetic improvement initiatives. Establishing designated breeder farms, implementing performance testing, and estimating breeding values at the field level are vital steps.



Buffalo farming in Sri Lanka is predominantly practiced by smallholders relying on natural grazing and crop residues (Perera and Jayasuriya, 2008). However, land degradation and seasonal forage fluctuations affect milk yields, leading to reliance on costly concentrates. Limited farmer awareness of low-cost feed supplementation further exacerbates financial strain. The livestock sector must address these challenges through cost-effective feeding strategies, utilizing locally available feed resources, and promoting regenerative practices such as rotational grazing and biodiversity conservation. These approaches improve soil fertility, enhance resilience, and support sustainable rural livelihoods (Jayasinghe et al., 2023). Integrating silvopastoral systems, which combine pastures with shrubs and trees, can enhance biodiversity, improve feed conversion, and provide better animal welfare, presenting a viable alternative to conventional livestock systems (Broom et al., 2013). Figure 10 illustrates the synergies between soil health, biodiversity, and carbon sequestration in enhancing animal welfare and farm productivity through regenerative livestock practices.

Additionally, further research is needed to optimize feeding strategies, including analyzing the nutritional composition of conventional and non-conventional feed resources, preserving surplus forage for year-round use, and developing novel agro-industrial by-product feeds (Vidanarachchi et al., 2019). Ponnampalam et al. (2024) provided insights into how diet influences the fat composition, fatty acid profile, and sensory attributes of ruminant products, emphasizing the importance of feeding systems in determining nutritional quality and market appeal. Moreover, as illustrated in Figure 10, regenerative livestock systems show potential in enhancing soil biodiversity and livestock productivity. However, further studies are required to quantify long-term benefits and establish comprehensive natural capital accounting, as discussed by O'Grady et al. (2024).

Many farmers in Sri Lanka face financial constraints that hinder their ability to produce value-added products, posing significant challenges to food security. For instance, milk cooperatives operating small-scale dairies have limited capacity and cannot meet the growing demand for processed buffalo curd (*Meekiri*). Most farmers lack

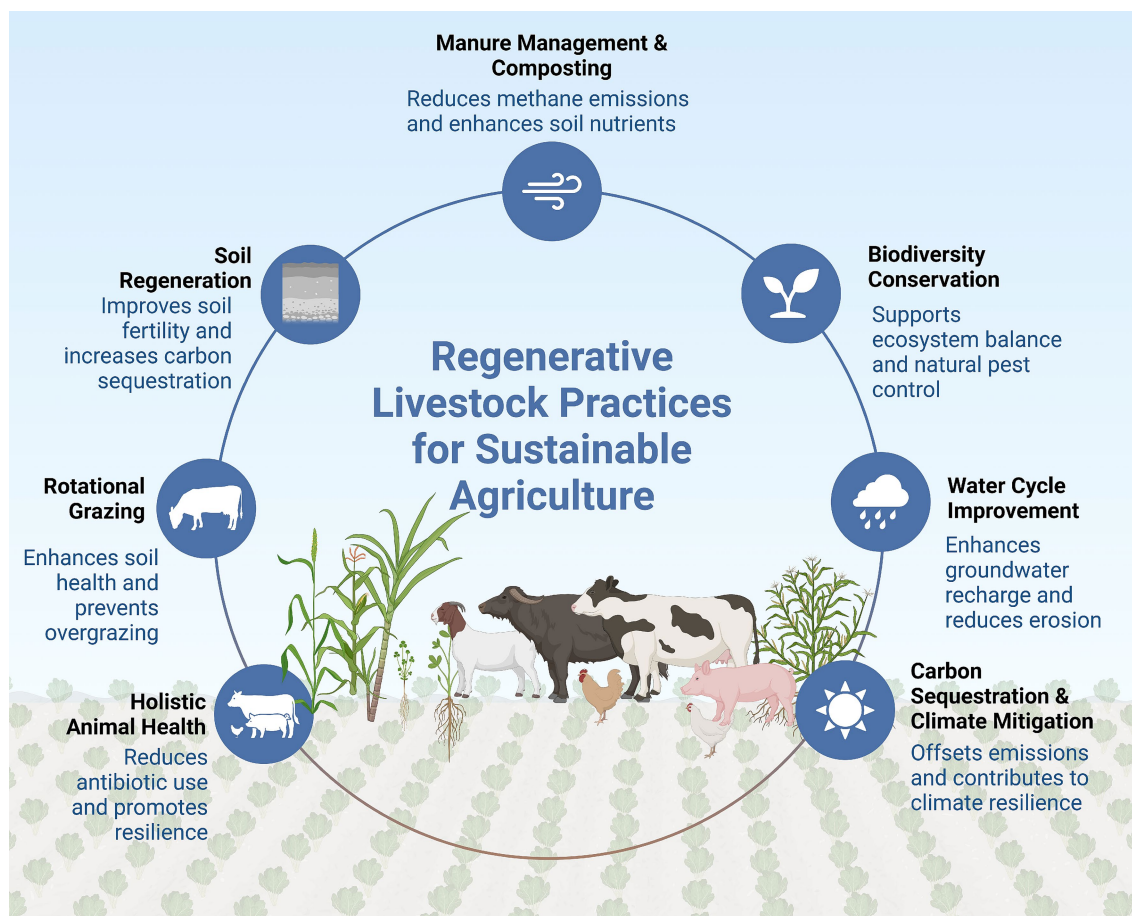


FIGURE 10

Regenerative livestock practices enhance soil health, biodiversity, and carbon sequestration while improving animal welfare and farm productivity. Created in BioRender. Priyashantha, H. (2025) <https://BioRender.com/a79q821>.

essential milk processing facilities such as storage, cooling, preservation, and heating at their farming premises (Priyashantha et al., 2021). Additionally, the absence of long-term governmental policies, inadequate extension services, insufficient veterinary healthcare coverage, high veterinary costs, and ineffective disease surveillance further constrain the cattle and buffalo industry (Vidanarachchi et al., 2019). Other challenges include poor milk collection and marketing systems, limited bargaining power of smallholders, animal theft, and inadequate technical training programs for farmers.

Small-scale livestock and poultry farmers also struggle to access quality semen, veterinary services, vaccines, and other essential inputs necessary for efficient production. These limitations negatively impact animal health and productivity, affecting both farmers' livelihoods and national food security (Hafez and Attia, 2020). Research aimed at disease control is crucial, as it provides the necessary data for policymakers to implement effective disease prevention and eradication strategies. Studies should focus on developing locally produced vaccines, improving their efficacy, ensuring the quality control of imported vaccines, and advancing methods for rapid disease diagnosis and surveillance to mitigate the risk of exotic disease outbreaks (Schat, 2014).

Moreover, Sri Lanka's vulnerability to climate change exacerbates the difficulties faced by the livestock sector. Variations in rainfall patterns, temperature fluctuations, and extreme weather events can disrupt the availability of forage and animal feed ingredients, impair reproductive efficiency, and threaten overall livestock productivity. Implementing climate-smart agricultural practices is essential to mitigate these adverse effects and ensure the sustainability of livestock and poultry farming (Godde et al., 2021).

Addressing these challenges requires a multifaceted approach, including government policy support, enhanced access to veterinary services, investment in research and innovation, and the promotion of sustainable livestock management practices. By fostering collaboration between farmers, policymakers, and researchers, Sri Lanka can work toward a resilient and productive livestock sector that contributes to long-term food security and rural economic development. Livestock and poultry waste management, especially in intensive farming systems, presents environmental challenges such as groundwater pollution, land degradation, eutrophication, and greenhouse gas emissions. These issues need to be addressed to ensure sustainable and environmentally friendly livestock and poultry production practices. Limited market access, inadequate infrastructure, and fragmented value chains hinder the growth and profitability of Sri Lanka's livestock sector, particularly for small-scale

producers. Strengthening market linkages, investing in infrastructure, and promoting value chain integration are essential to unlocking the sector's potential and enhancing food security. Market reforms must focus on improving the sophistication of livestock produce, processed products, and by-products to enhance domestic value addition and export competitiveness (Ruben, 2024). Strengthening bilateral agreements can further secure guaranteed export markets, enabling Micro, Small, and Medium Enterprises (MSMEs) to integrate into global value chains. Additionally, livestock processing companies should prioritize differentiation, value addition, branding, and food safety to align with regional and global supply chains, especially in emerging markets such as the Middle East, East Asia, and the European Union (Korale-Gedara et al., 2023).

To improve food safety compliance among dairy producers, capacity-building initiatives, financial incentives, and enhanced market demand are crucial. Studies indicate that farmers engaged in intensive dairy systems adopt food safety practices more readily than those in extensive systems. Training and financial incentives, such as subsidies for animal shed construction, can bridge the knowledge gap and promote safer milk production. However, market demand alone has not been sufficient to drive improvements, necessitating policy interventions to enhance compliance and market rewards for food safety attributes (Korale-Gedara et al., 2023). A transition toward circular food systems in livestock production can further strengthen sustainability. Utilizing low-opportunity-cost feed such as agricultural residues and by-products can enhance resource efficiency and reduce environmental impact. Studies show that policies promoting the use of such feed materials, including subsidies and domestic feed sourcing measures, can lower greenhouse gas emissions while supporting agricultural wages. However, budget-neutrality measures may drive land use changes, highlighting the need for complementary policies to balance economic and environmental objectives (Gatto et al., 2024). Integrating these strategies will not only improve the resilience of Sri Lanka's livestock sector but also drive economic growth, reduce poverty, and support sustainable livelihoods.

Sri Lanka should harness the potential of the Internet of Things (IoT) and rapidly integrate advancements in global digital technology within livestock and poultry operations to enhance efficiency and expand industry activities. Modern IoT and e-commerce tools offer cost-effective alternatives to traditional on-ground sales visits, facilitate technical advisory services, and streamline, organize, and automate livestock and poultry business operations (Ojo et al., 2022). AI-enabled IoT applications have demonstrated significant potential in intelligent automation, improving poultry health monitoring, disease outbreak prevention, and overall welfare management (Astill et al., 2020). To support this transformation, it is crucial to enhance capacity building and technical knowledge on IoT and e-commerce applications among livestock and poultry entrepreneurs, thereby opening new opportunities in the international market (Cheng et al., 2024).

Developing farmers' management and technical skills is essential for transforming them into successful entrepreneurs. This requires targeted research to create appropriate educational and extension materials, along with effective dissemination methods (Cheng et al., 2024). Establishing model livestock-raising villages could serve as a practical approach to promoting best husbandry practices. Additionally, educating farmers on value-added production, such as processing milk into dairy products rather than selling raw milk at

lower prices, can significantly improve profitability (Duguma, 2022). The indispensable connection between farming practices, milk quality, and the broader interconnection of dairy research highlights the need for a holistic approach to dairy production. On-farm management strategies directly influence milk composition, safety, and processing potential. As highlighted in the context of Sri Lanka's dairy sector and the special issue of "New Insights into Milk 2.0" (Priyashantha and Vidanarachchi, 2024a), factors such as feed quality, breed selection, animal health, and climate resilience play a crucial role in determining raw milk characteristics.

Addressing key challenges is critical for the sustainable development of Sri Lanka's livestock and poultry sectors. These challenges include dwindling grazing lands, the low productive potential of indigenous and local breeds, unstructured breeding systems, insufficient supply of superior breeding material, inadequate quality feed resources at affordable prices, endemic and emerging diseases, limited veterinary services, poorly developed milk collection networks, restricted access to farm inputs, climate change and environmental concerns, outdated technical knowledge, insufficient entrepreneurial skills, and limited access to value chains and markets, factors which are also described in other global contexts (Tchoukouang et al., 2024; Zaw Win et al., 2019). Climate change further exacerbates vulnerabilities in the food supply chain, affecting livestock productivity and resilience (Tchoukouang et al., 2024). By tackling these limitations, Sri Lanka can foster a resilient and sustainable livestock and poultry industry, ensuring long-term food security and economic stability for its population.

6 Conclusion

Sri Lanka's livestock and poultry sectors play a vital role in ensuring food security, economic development, and rural livelihoods. However, these industries face significant challenges, including limited access to quality breeding material, inadequate veterinary services, insufficient feed resources, disease outbreaks, market constraints, and the escalating impacts of climate change. Addressing these challenges requires a holistic approach that integrates technological advancements, policy reforms, and capacity-building initiatives. In line with the first KPI, investments must target scalable innovations in genetics, feed efficiency through precision feeding, and reproductive technologies such as advanced artificial insemination (AI) with sexed semen, cryopreservation of gametes and embryos, *in vitro* fertilization (IVF), and embryo transfer (ET) to increase animal productivity, especially among smallholder and backyard systems. Investing in modern and affordable scale digital tools such as the Internet of Things (IoT) and artificial intelligence (AI) can revolutionize livestock and poultry management, improving production efficiency, early disease monitoring, and supply chain integration. Moreover, enhancing farmer education and technical skills through targeted extension programs and research and data-driven innovations are essential for fostering entrepreneurship and increasing total animal productivity. To address the second KPI, policy measures should promote inclusive financing schemes, gender-sensitive extension services, and public-private partnerships that reduce input costs and expand market access for marginalized producers with reduced cost of production. Strengthening local milk collection networks with proper cold chain facilities, community-based poultry hatcheries, and

price stabilization mechanisms can ensure equitable access to animal-source foods.

Strengthening climate-resilient practices, including precision feeding, sustainable grazing, and regenerative agriculture, can further support long-term sustainability. Additionally, policy interventions must focus on improving value-chain integration, ensuring fair market access, and facilitating investment in infrastructure to bridge gaps in storage, processing, and distribution. To meet the third KPI, advancements in health, disease control, and climate adaptation, stakeholders should prioritize investments in disease surveillance, early warning systems, precision feeding and the promotion of locally developed vaccines to enhance biosecurity and mitigate risks associated with emerging infectious diseases. Strengthening disease surveillance networks and promoting locally developed vaccines can enhance biosecurity measures and mitigate the risks associated with emerging infectious diseases. Future research should explore digital agriculture solutions, AI-based disease diagnostics, blockchain for product traceability, and climate modeling for breed suitability. Interdisciplinary research combining veterinary science, agronomy, and rural sociology is needed to support evidence-based policy. In particular, research must focus on breed-environment interactions, cost-effective climate adaptation measures, and decentralized data-sharing platforms for real-time disease monitoring.

Future work should focus on evaluating greenhouse gas emissions across production systems, developing alternative feed resources like Azolla and insect proteins, and exploring breed-environment interactions. Research into AI-based disease diagnostics, blockchain for traceability, and climate modeling for breed suitability will enhance resilience. Socio-economic studies on farmer adaptation strategies and digital agriculture adoption are also essential for sustainable transformation. Ultimately, a collaborative effort between policymakers, researchers, industry stakeholders, and farmers is crucial for driving sustainable transformation in Sri Lanka's livestock and poultry industries. By adopting innovative, data-driven strategies and fostering resilience against environmental and economic challenges, the sector can contribute significantly to national food security, economic stability, and sustainable agricultural development.

Author contributions

HP: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project

administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. TS: Project administration, Validation, Writing – review & editing. IP: Writing – review & editing. GG: Data curation, Writing – review & editing. GS: Writing – review & editing. AA: Data curation, Writing – review & editing. SJ: Data curation, Writing – review & editing. JV: Project administration, Validation, Writing – review & editing.

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