
Strategies for Transforming the Poultry Industry in Kenya Through Participatory Modelling

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Abstract: Sustainable development of the poultry industry in Kenya can significantly contribute to economic growth while also improving the livelihoods of millions of people who keep poultry for a living. To achieve this impact, strategies that will advance the industry across all value chain segments are required. In this study, we developed strategies to transform the Kenyan poultry industry through a system dynamic modelling, participatory approach that included Focus Discussion Groups (FDGs) and Key Informant Interviews (KII), with the findings validated through a workshop. These findings are depicted in causal loop diagrams to show how the proposed poultry industry's elements interact in a systematic manner. Using this methodology, it was observed that strengthening socioeconomic factors such as legal framework in associations and cooperatives can significantly improve the industry. The legal framework can provide a clear and stable environment for the operation of these organizations, helping to ensure that they function efficiently and effectively. This, in turn, can improve the competitiveness and sustainability of the poultry industry, as well as support the growth and development of the wider economy. Having a strong legal framework can help to ensure that the rights and interests of producers and other stakeholders are protected, which can increase trust and confidence in the industry. This can lead to greater investment and collaboration and can support the development of new and innovative solutions to the challenges facing poultry value chain actors. Additionally, modern technologies, innovations, and management practices can play a crucial role in improving efficiency along the value chain. These innovations can help to increase productivity, reduce costs, improve the quality and safety of poultry products, and meet the changing needs and preferences of consumers.

Keywords: Poultry, Causal Loop Diagram, Value Chain, Transformation, System Dynamic Modeling

1. Introduction

In Kenya, a large portion of the population lives in rural areas where many households rely on small-scale chicken farming for food and income. Chicken products are a crucial source of protein for many families, and chicken farming can provide a source of income for rural households through the sale of eggs and meat [9]. Indigenous chicken production has been identified as a means of improving rural livelihoods through the provision of income from the sales of the surplus thus creating employment [9] as well as food and nutrition security. Jepkoech,

2020 observed that chicken enterprises help to meet the socioeconomic and nutritional needs of rural and peri-urban residents. Despite this potential, chicken production continues to face low and declining outputs. This could be attributed to a lack of adoption of technological innovations [18] and inefficient marketing structures [2, 13], making forecasting future trade relations difficult. Population growth, and increasing food demand, combined with the need to meet the Sustainable Development Goals (SDG), necessitate more efficient innovations to meet consumers' demand for animal products in both quantity and quality. Furthermore, by maximizing social,

economic, and environmental benefits, these innovations are expected to contribute to the poultry industry's transition to sustainability [5].

It is necessary for researchers to determine how different poultry value chain variables interact and how this affects profitability. Understanding the interdependence of various variables within a system requires a systematic approach. This participatory model brought all actors and stakeholders in the poultry value chain together to create the complex context needed to turn Kenya's poultry industry into a profitable venture.

1.1. System Dynamics (SD) Modelling

This model uses information from stakeholders to study interaction between different poultry's aspects, which creates a system indicating dynamics when one of the aspects is altered. System Dynamics (SD) modeling is a method used to analyze and understand complex systems. SD models are used to study a wide range of complex systems, including social, economic, environmental, and technological systems. They can be used to understand the interconnections between different components of a system and to analyze the feedback loops that shape the behavior of the system over time. It is a type of computer-based simulation that helps to understand the behavior of dynamic systems over time. SD modeling uses a set of mathematical equations and computer algorithms to represent the behavior of systems and their interactions over time.

SD modeling is particularly useful in situations where it is

difficult to observe the behavior of a system directly, or where the interactions between components are complex and difficult to understand. By using SD models, it is possible to explore the potential impact of different policies and interventions on the behavior of a system and to identify strategies for improving the performance of a system over time.

1.2. Causal Loop Diagrams (CLDs)

A causal loop diagram qualitatively depicts the dynamic change between variables in a complex system [21]. The unit of analysis in CLDs of dynamic behaviour in a system is feedback loops which represent causality between model variables and are characterized by either reinforcing (virtuous) or balancing (stabilizing). When poultry production becomes more profitable, producers increase their reinvestment capacity, which often results in greater adoption of modern practices and technologies, as well as greater access to quality inputs and services. This results in better product compliance with quality standards, which boosts profitability. A balancing feedback loop occurs when increasing producers' reinvestment capacity results in the adoption of new technologies that enable more efficient value addition through efficient product storage and processing while increasing product differentiation. Although this increases the retail price, it also enhances operational costs, bringing the poultry value chain profitability back into balance (See Figure 1 below).

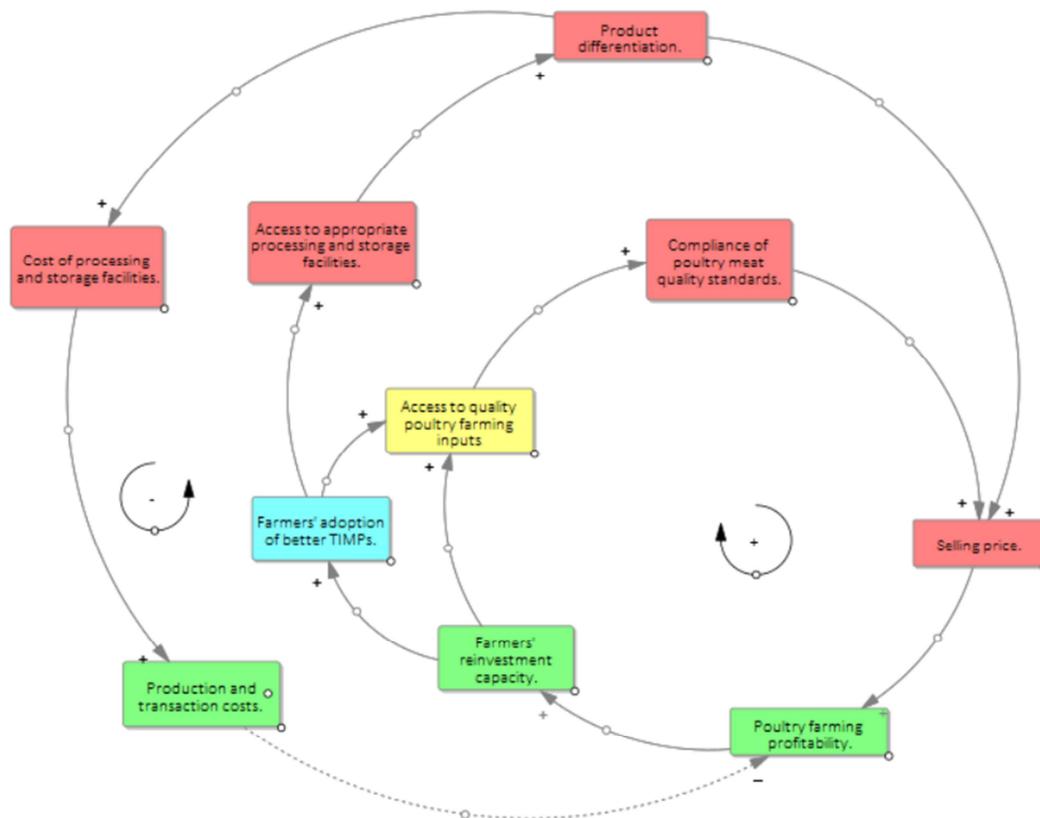


Figure 1. A casual loop diagram depicting interrelation of Poultry Industry in Kenya.

The arrows show an influence where the change in a variable will trigger a change in the second variable. A plus (+) reflects that the change is in the same direction [an increase (decrease) in *x* will cause the second variable *y* increase (decrease)], while minus (-) means the direction is in opposite direction [an increase (decrease) in *x* will cause the second variable *y* decrease (Increase)] (Galarneau *et al.*, 2020).

This paper presents CLDs from Kenya's poultry value chain, highlighting the interactions between variables such as chicken demand, feed cost, and number of birds/flock sizes. The CLD will provide insight into the value chain's feedback loops and identify potential areas for improvement and growth. It will also consider other related factors such as disease outbreaks, climate change, and government regulations. This research will assist industry stakeholders, policymakers, and researchers gain a comprehensive understanding of the dynamics of Kenya's poultry industry.

2. Materials and Methods

A system dynamics approach was used to understand the intricate connections between various aspects of Kenya's poultry value chain. The model uses causal loop diagrams (CLDs) qualitatively to present the dynamic influences between variables thought to influence a given system behaviour ([3, 16, 21]). Focus Group Discussions (FGDs), Key Informant Interviews (KIIs), workshops, and secondary data provided inputs for the model development process and highlighted the trends and challenges in the poultry sector.

The FGDs and KIIs were held in 19 counties supported by

the National Agricultural and Rural Inclusive Growth Project (NARIGP). A validation workshop was held at the KALRO Kandara, in Murang'a County with participants from across the poultry value chain stakeholders that included input suppliers, producers, processors, marketers, both private and public extension staff, and members of the Kenya Poultry Farmers Association (KEPOFA).

During the workshop, the model and CLDs depicting the behavioural patterns and interrelations of different variables within the poultry value chain context were presented for stakeholders' validation and feedback. In addition, potential pathways for transforming the industry were proposed and discussed.

Stakeholders were classified based on the value chain functions. Each group had six key players representing each value chain function (Input suppliers, producers, processors and marketers, regulators, and researchers). They were led through an exercise in which they validated the interrelationships between key variables along the value chain. Each group discussed the causal loop diagrams and addressed any concerns that emerged.

3. Results and Discussion

Figure one depicts the current state of the Kenyan chicken industry, with all relevant aspects and elements organized around clusters. The map demonstrates how different variables relate to the value chain functions using information from previous participatory processes and secondary data.

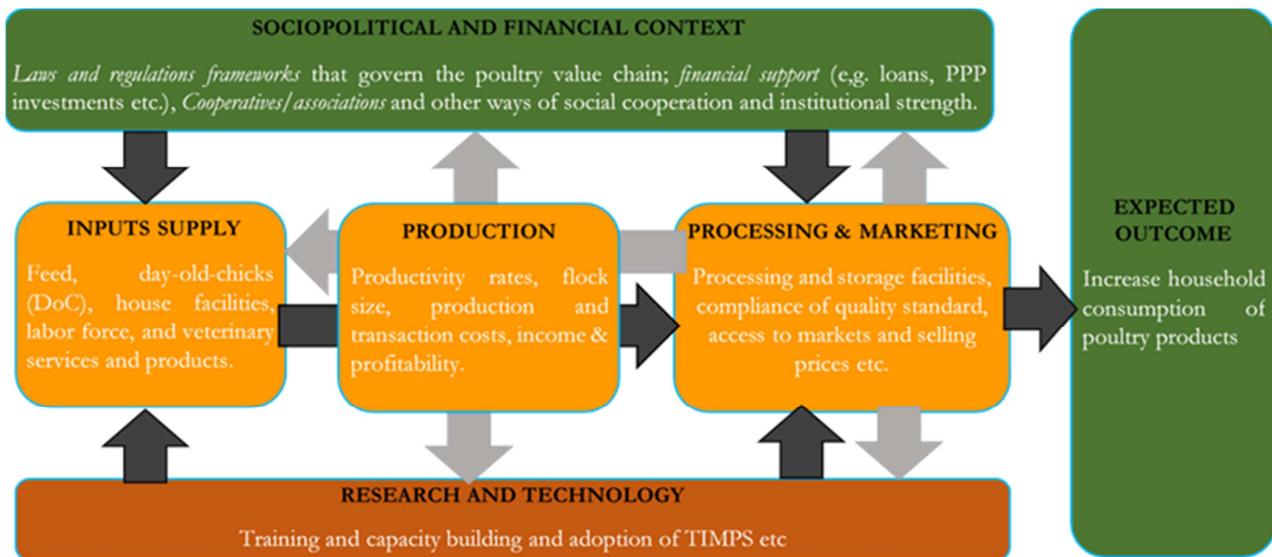


Figure 2. Overview of the poultry system elements.

3.1. Social, Political, and Economic Perspectives of the Poultry Value Chain

Social, political, and economic perspectives can all have an impact on the performance of the poultry value chain.

Laws and regulatory frameworks, financial aid and support, and organized associations and social cooperation can all help value chain actors improve productivity and gain access to more profitable markets. Abro, Z. *et al.* and Guèye, E. F. [1] and [4] established that poultry farmers in co-operative and associations indicated to access high quality feeds and day-

old-chick and hence there poultry enterprises were more productive than those working off the association with other producers. Besides this, the CLD in this study has shown that government assistance and interventions can aid in the creation of these enabling conditions. It is critical to note that to achieve the desired results, government policies must be well-designed and implemented.

Additionally, vertical integration can also help companies to better manage their supply chain and reduce their exposure to market fluctuations. For example, a vertically integrated poultry company may be able to negotiate better prices for feed and other inputs, as well as sell its products at a higher price due to the improved quality and consistency of the product. This can result in increased profitability and a more stable business model.

Vertical integration a key aspect of successful poultry industries worldwide can also lead to increased efficiency in production processes [7]. By having control over multiple stages of the value chain, organized groups can better coordinate the production process, reducing waste and increasing the overall efficiency of the operation. This can lead to lower costs and higher productivity, ultimately improving the competitiveness of the company. However, vertical integration can also have its drawbacks. For example, it may be difficult for smaller groups to establish the necessary infrastructure and relationships to successfully implement a vertically integrated model. Additionally, the increased control and power held by a single entity can lead to a lack of competition in the market, potentially leading to higher prices for consumers. While vertical integration can provide many benefits to the Kenyan poultry industry, organized groups/companies must carefully consider the potential risks and benefits before implementing this type of business model.

On the other hand, horizontal integration refers to the control of multiple businesses or operations within the same stage of production or distribution by a single entity [8]. In the poultry industry, this can include owning multiple farms, hatcheries, feed mills or processing plants. Horizontal integration can lead to economies of scale and increased market power, allowing organized groups to better compete

with rivals.

Both vertical and horizontal integration can impact the poultry value chain, as they can lead to increased efficiency and cost savings for the integrating firms [7]. However, they can also lead to increased market concentration and reduced competition in the industry. This can have negative implications for farmers, consumers, and other stakeholders. There is a growing body of literature that discusses the pros and cons of integration in the poultry industry and its impact on the value chain.

Since agriculture is a devolved function in Kenya, County governments can implement policies and regulations that protect domestic poultry production and markets by limiting or allowing the importation of key inputs to reduce production and transaction costs, and by controlling the quality and quantity of imports [14]. This can be achieved by offering subsidies and tax exemptions/reductions on key inputs along the value chain, as well as by improving regulation implementation and monitoring to ensure that poultry inputs, facilities, and services meet established standards [15]. To increase access to credit, financial institutions should lower interest rates and design facilities that are tailored to the poultry processes. Using cooperatives or microfinance institutions as platforms for actors to save money and access loans at lower interest rates can be more beneficial than using traditional financial institutions [17]. The government can also ensure the availability and access to high-quality key inputs such as day-old chicks, feed, and veterinary products for farmers to improve poultry performance and reduce losses.

The national and county governments play critical roles in transforming the poultry industry. This can be accomplished through the combined efforts of several regulatory bodies, including the Kenya Bureau of Standards (KEBS), the Association of Kenya Feed Manufacturers (AKEFEMA), and the Director of Veterinary Services (DVS), as well as their affiliated organizations. Such organizations need strengthening to ensure the quality and safety of poultry inputs, facilities, and services, as well as in aiding value chain actors in the form of subsidies and tax exemptions/reductions.

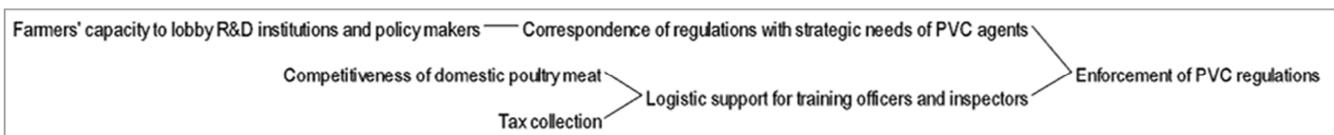


Figure 3. Enforcement of poultry value chain regulations.

3.2. Research and Technology

Research and technology play a significant role in modern poultry production. They are crucial in developing and improving various aspects of the industry, including genetics, feed, health, and environmental management. In genetics, research and technology have helped to improve the quality and productivity of local chicken breeds. For example, through selective breeding and genetic engineering, breeders can now

produce birds that are more resistant to diseases, have improved feed conversion ratios, and better meat quality. This has led to increased efficiency and profitability in the poultry industry. In feed, research and technology have led to the development of specialized diets that are optimized for poultry growth and health. The use of computerized feed management systems has also enabled farmers to better control the feed mix, reducing waste and improving feed conversion efficiency. In health, research and technology have helped to develop vaccines and other health management practices to prevent and

control diseases in poultry. The use of sensors and other monitoring systems has also improved the early detection and management of disease outbreaks, reducing the impact on bird health and the industry. In environmental management, research and technology have played a crucial role in reducing the environmental impact of poultry production. For example, the development of efficient ventilation systems has improved air quality in poultry houses, reducing the risk of respiratory diseases and improving the overall health of the birds. Additionally, waste management systems have been developed to reduce the amount of waste generated by the industry, reducing the environmental impact, and improving sustainability. Such advancements lead to increased efficiency, improved quality, and reduced environmental impact, ultimately benefiting both the industry and consumers.

By gaining access to extension services via established research-extension platforms or linkages, small scale poultry producers will improve their knowledge and skills to achieve efficient production systems. Belonging to a well-organized association or cooperative allows for easy access to new or modern technology [11, 12]. County governments play an important role in ensuring that both public and private extension service providers transfer proven technologies, innovations, and management practises. This will increase adoption rates of modern technology, enhance productivity and provide access to high-value markets. Increased productivity will encourage product aggregation in cold storage to better respond to market price and demand fluctuations [10]. Such findings are consistent with previous research that found that adopting new technologies and forming membership groups or associations can significantly improve productivity among

rural households that keep poultry for a living [19, 20]. Farmer field schools, demonstration farms, exhibitions, and exchange visits for organised groups are examples of extension service capacity building initiatives.

3.3. Input Supply

Input supply play a crucial role in the poultry value chain as they provide the materials and resources necessary for the production process (Figure 4). The main input suppliers in the poultry value chain include; i) Feed suppliers who are a critical component of the production process that constitutes 70-80% of the production costs. Feed suppliers often offer a variety of feed types, including starter, grower, and finisher feeds, to meet the specific nutritional needs of the birds at different stages of production; ii) Genetics suppliers who provide the breeding stock used to produce the birds in the industry. This includes both the parent stock used for breeding and the day-old chicks used for growing; iii) Equipment suppliers who provide the equipment necessary for the poultry production process, including feeders, drinkers, ventilation systems, and lighting systems; iv) Health and veterinary supplies who supply the vaccines and antimicrobial agents which are critical to maintaining the health and well-being of the birds.; v) Housing and infrastructure suppliers who provide the buildings and structures necessary for the production process and lastly vi) Energy and utility suppliers who provide energy and utilities necessary for the production process, including electricity, water, and gas. A strong relationship with input suppliers can help organized groups to better manage their costs, reduce risk, and improve the quality and consistency of their products.

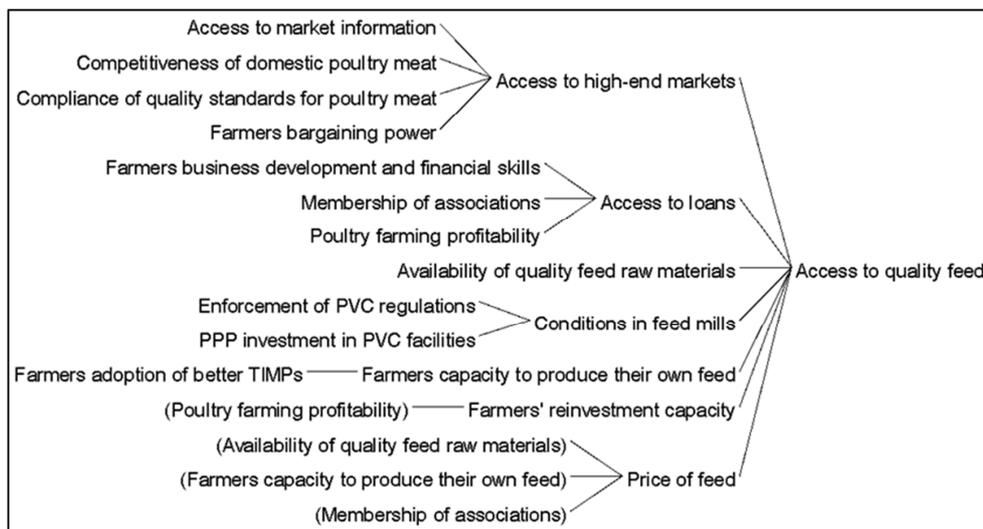


Figure 4. Access to quality feed.

The availability and affordability of high-quality inputs determines poultry farmers' accessibility. The price of inputs has a negative impact on affordability; the higher the price of inputs, the lower the affordability; on the other hand, access to credit, reinvestment capacity, and access to high-value markets have a positive impact on affordability. This confirms [13] findings that the affordability of poultry

production inputs can significantly improve poultry industry productivity. Having a stable and profitable market often makes it easier for producers to invest in high-quality inputs. In the case of feeds, the availability of raw materials also influences access to high-quality feeds, allowing poultry farmers greater access.

The quality of day-old chicks is determined by genetics

and disease control measures implemented in hatcheries and breeding farms. Using CLD, the current study established that improving breeding conditions in local breeding farms and hatcheries reduced the cost of day-old chicks and increases hatching efficiency, allowing farmers to pay lower prices for products comparable to imported chicks. The lack of cold chain facilities was identified as a barrier to maintaining vaccine quality at the point of use. The absence of cold chain facilities increased the cost of veterinary services while lowering the quality of vaccine.

3.4. Production

The size of a flock in poultry production can impact the profitability of a poultry operation. In general, larger flocks can benefit from economies of scale, such as lower feed costs per bird and lower labor costs per bird, as the fixed costs of production can be spread over a larger number of birds. This can result in lower cost per bird and higher profitability. However, larger flocks also come with their own set of challenges. For example, larger flocks can require higher investments in the form of specialized equipment and facilities, such as more efficient ventilation systems, feed delivery systems, and waste management systems. Larger flocks also increase the risk of disease outbreaks, which can be costly in terms of both time and money to control.

An optimal flock size will depend on the specific poultry operation, its goals, and the market prices. For example, a small, specialty operation may prioritize product quality over economies of scale and choose to maintain a smaller flock size. On the other hand, a large commercial operation may prioritize efficiency and choose to maintain a larger flock size. Ultimately, the profitability of a poultry operation depends on a number of factors, including flock size, feed costs, bird health, bird productivity, and market prices. A poultry producer must carefully consider these factors when deciding on the optimal flock size for their operation.

Nationally, 60% of poultry farmers have less than 500 birds, 30% have 500 to 10,000 birds, and only 10% have 10,000 birds or more. These low operational levels present several challenges that can affect the profitability and sustainability of the enterprise. Production costs among small-scale farmers per bird are higher than those who keep larger numbers of birds [23]. The fixed costs of production, such as building and equipment expenses, are spread across fewer birds in smaller flocks, resulting in higher costs per bird. This can make achieving profitability, as well as competing with larger operations difficult. Taking advantage of economies of scale in areas such as feed procurement, labour, and equipment is also challenging. As a result, costs may rise and profits may fall. Access to markets for their poultry products, particularly if they are in rural/remote areas or lack the resources to effectively market their products is also a challenge.

Identifying and targeting a specific market niche, such as organic or specialty poultry products, can help small scale producers differentiate themselves from larger

operations. Direct sales to consumers, such as farmers' markets, community-supported agriculture programs, or a direct-to-consumer website, can facilitate small-scale producers in reaching customers and receiving a premium price for their products. Relationships with local retailers and restaurants can enable small-scale producers in opening up new markets and increasing brand recognition. Small-scale producers can access high-value markets through technologies or by forming cooperatives and associations to be able to access contract poultry production [23]. Developing a distinct brand and packaging can enable small-scale producers in standing out in the market. Networking with other small-scale producers, such as through trade associations or cooperatives, can help producers share resources and knowledge while also increasing their market bargaining power. Having an online presence, such as a website or social media, can assist small-scale producers in reaching a larger audience and communicating their brand story to potential customers.

3.5. Processing and Marketing

Value addition of poultry products through processing and packaging, branding, traceability, product differentiation, nutritional information, and food safety can help producers increase their revenue and competitiveness in the market. By focusing on value addition, producers, traders, and processors can attract and retain customers and build a successful and sustainable business.

Small-scale poultry producers can benefit from value addition in several ways, including increased revenue and market competitiveness. Small-scale producers can command a higher price and increase their revenue by adding value to their products. This can assist them in achieving profitability and maintaining their business. Poultry producers can compete with larger operations and appeal to customers who want high-quality, unique, or premium products by differentiating their products [23]. Small-scale producers can increase brand recognition and customer trust by developing a strong brand and providing customers with information about the quality and safety of their products. They can reach customers who are looking for unique premium poultry products. Small-scale producers can enhance their credibility and build customer trust by implementing strict food safety standards and providing customers with information about the safety of their products. Access to advanced processing plants, including storage facilities, is required for value addition. Most poultry meat in Kenya is produced by small-scale farmers who process and sell their own products. A few public and private large-scale commercial poultry processing plants exist in several counties. Poultry processing faces challenges such as a lack of infrastructure, a lack of credit, and a lack of processing products, all of which limit the ability of processors to expand and improve their operations.

Poultry consumption in Kenya has been on the rise and is projected to grow driven by increasing population, urbanization, and growing incomes. FAO in 2012 reported

per capita consumption of chicken meat in 2021 was estimated at 1.31 kg and 45 eggs. Overall, there is a growing gap between poultry consumption and production in Kenya, as the demand for poultry products continues to outstrip domestic supply. Cooperatives will play a critical role in gaining access to processing and storage facilities. However,

private investors must be involved to support infrastructure and ensure sustainability. In this sense, a stable market will encourage poultry farmers to implement more efficient and sustainable farm practices and technologies, as well as to add value/process the poultry products.

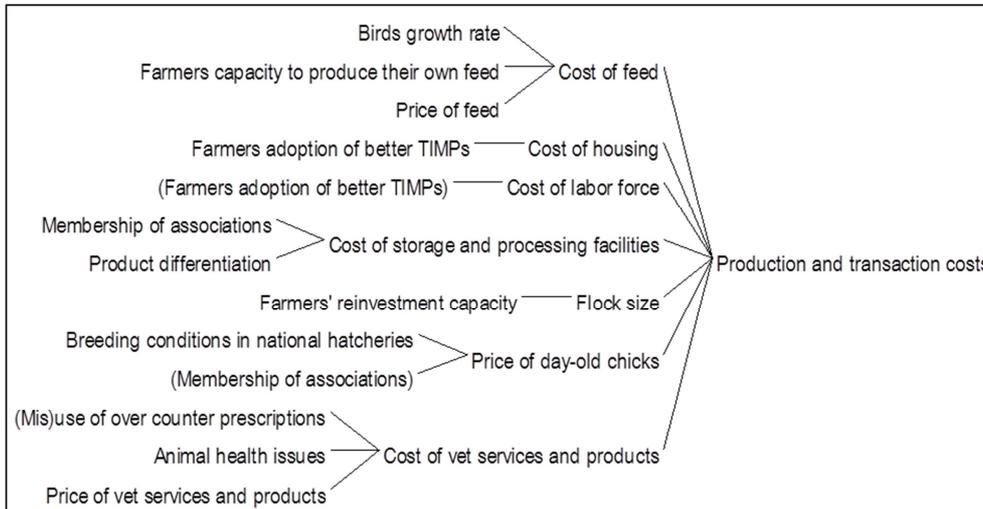


Figure 5. A causal loop diagram in poultry production.

4. Conclusion and Recommendations

The Kenyan poultry industry has continued to decline in production despite increasing food demand. We sought to represent the poultry industry as a system and from it derive how different policies and interventions affect the poultry value chain as a whole. From many scenarios generated were came up with strategies that will transform the industry. The four pillars that will be critical in transforming Kenya's poultry industry are depicted in Figure 6. Although each pillar is important in the development of the poultry system,

this study emphasizes the importance of fostering a favorable socio-political and financial environment, as well as having access to quality inputs and services, to improve the performance of the value chain functions. Technologies, innovations, and management practises that have been disseminated will be implemented to improve knowledge and skills. Finally, greater integration and value addition will be incorporated so that poultry products can enter new, more profitable markets. To summarise, political will, government advocacy, and the presence of credible and strong producer associations or cooperatives are required for the transformation of the poultry value chain.

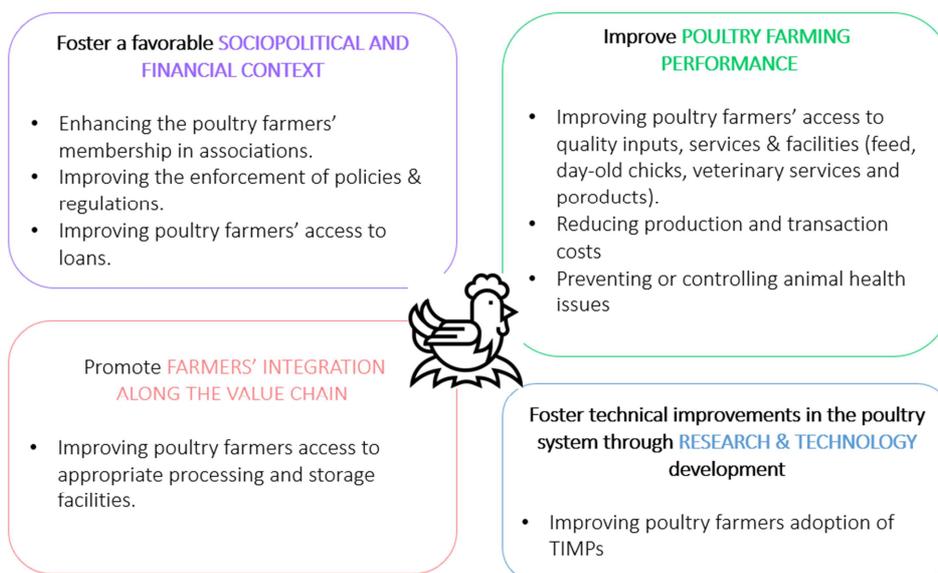


Figure 6. Potential pathways to transform the poultry system.

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