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Sustainability Challenges, Transition Dynamics, and Collapse of Small-Scale Poultry Farming Systems: Economic, Technical, and Environmental Perspectives

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Abstract

Small-scale poultry farming plays a vital role in food security, income generation, and rural livelihoods globally. However, the sector is experiencing a rapid decline driven by interconnected economic, biological, environmental, and institutional challenges. This review synthesizes recent evidence and develops a systems-based framework to explain the depletion of small-scale poultry farms in the country. A dominant driver is the persistent cost–price imbalance, where rising input costs, particularly feed, are not matched by farm-gate prices, resulting in sustained negative profit margins. Market inefficiencies, including the dominance of intermediaries and weak bargaining power of farmers, further reduce income stability. Biological constraints, especially recurrent outbreaks of Avian Influenza and other infectious diseases, contribute to high mortality and production uncertainty, exacerbated by inadequate biosecurity and veterinary services. Climate-related stressors such as heat, humidity, and extreme weather events intensify these vulnerabilities by reducing productivity and increasing disease susceptibility. Additionally, technical limitations, including poor farm management and limited adoption of improved practices, further constrain production efficiency. Institutional and financial barriers, such as limited access to credit, absence of insurance mechanisms, and weak policy implementation, undermine the resilience of smallholders. These drivers interact to create a cycle of economic loss, reduced production, and eventual farm exit, leading to supply instability, price volatility, and broader socio-economic impacts. The review highlights that the depletion of small-scale poultry farms is not an isolated phenomenon but a systemic failure requiring integrated solutions. Strengthening value chains, improving biosecurity, enhancing climate resilience, and promoting technology adoption, including molecular biotechnology tools, are critical pathways for sustainable sectoral recovery.

Keywords: Climate stress, economic constraint, environmental pressure, poultry, smallholder farming, sustainability

INTRODUCTION

The poultry sector is one of the fastest-growing components of the livestock industry in the world, contributing significantly to national food security, employment, and economic development [1–2]. Small-scale poultry farms, in particular, form the backbone of this sector, supporting millions of rural households and providing an accessible source of animal protein [3–5]. Despite their importance, these farms are increasingly under threat due to a combination of structural, environmental, and biological pressures that challenge their sustainability. In recent years, poultry production systems have been exposed to multiple stressors, including rising feed costs, market price volatility, disease outbreaks, and climate variability [6–8].

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Traditional management and nutritional strategies are proving insufficient to address these complex and dynamic challenges. The growing frequency of diseases such as Avian Influenza, coupled with inadequate biosecurity measures, has increased production risks. At the same time, small-scale farmers face limited access to financial resources, modern technologies, and organized market systems, restricting their ability to adapt effectively [2, 6, 9]. Climate change further compounds these challenges by intensifying heat stress, disrupting production cycles, and increasing the incidence of diseases. These factors interact within a fragmented value chain characterized by inefficiencies and unequal distribution of benefits, placing smallholders at a disadvantage [3, 5, 8]. As a result, many farmers are experiencing declining profitability and are exiting the sector, raising concerns about long-term sustainability and food security.

This review advances the current literature by moving beyond single-factor explanations of small-scale poultry farm decline and presenting a systems-based analytical framework that integrates economic, biological, environmental, technical, and institutional dimensions into a unified model. Unlike previous studies that examine issues such as feed cost, disease outbreaks, or market inefficiencies in isolation, this work explicitly identifies causal linkages and reinforcing feedback loops that explain how these drivers interact to accelerate farm depletion. A key contribution is the conceptualization of farm exit as an emergent outcome of cumulative stress and constrained adaptive capacity rather than a series of independent shocks.

The study further contributes by contextualizing these dynamics within the rapidly transforming poultry sector of Bangladesh, highlighting how structural inequalities in value chains and limited institutional support disproportionately affect smallholders. It also bridges traditional production analysis with emerging perspectives by incorporating climate resilience and molecular biotechnology as strategic components of future interventions. By doing so, the review provides not only a diagnostic framework but also a forward-looking pathway for sustainable transformation. This integrated perspective offers practical relevance for researchers, policymakers, and development practitioners seeking to design coordinated, multi-level solutions for resilient and inclusive poultry systems.

METHODOLOGY

This study employed a narrative review design to synthesize existing evidence on the sustainability challenges and structural transition of small-scale poultry farming systems. Relevant literature published between 2000 and 2024 was systematically searched using databases such as Scopus, Web of Science, and Google Scholar, along with reports from international organizations including the Food and Agriculture Organization and the World Bank. Search terms included combinations of poultry sustainability, smallholder farming, feed cost, climate stress, disease outbreaks, and value chain inefficiency. Studies were selected based on relevance to small-scale poultry systems, with emphasis on developing countries and South Asian contexts, particularly Bangladesh. Peer-reviewed articles, policy reports, and sectoral analyses were included, while non-scholarly sources and studies lacking methodological clarity were excluded. The selected literature was analyzed using a thematic approach, categorizing findings into economic, biological, environmental, technical, and institutional dimensions. These themes were subsequently integrated into a systems-based conceptual framework to identify key drivers, feedback mechanisms, and pathways leading to farm depletion.

CONCEPTUAL FRAMEWORK

The conceptual framework explains the depletion of small-scale poultry farms as the result of interconnected economic, biological, environmental, technical, and institutional drivers operating through reinforcing feedback loops. The process is initiated by a persistent cost–price imbalance, where rising input costs and unstable farm-gate prices reduce profitability. This limits farmers ability to reinvest in feed quality, housing, and health management, leading to declining productivity. Simultaneously, biological risks such as Avian Influenza increase mortality and production uncertainty, particularly under weak biosecurity conditions. Environmental stressors including heat and extreme weather further reduce performance and heighten disease susceptibility. Technical limitations, such as poor management and limited knowledge, exacerbate inefficiencies, while institutional constraints, including restricted access to credit, insurance, and fair markets, reduce adaptive capacity. These factors interact to form self-reinforcing cycles of loss, reduced investment, and declining output, ultimately pushing farmers toward farm exit and driving structural transformation of the poultry sector in Bangladesh (Figure 1).

COST–PRICE SQUEEZE AND NEGATIVE PROFIT MARGINS

One of the most immediate and damaging drivers of small-scale poultry farm depletion in the world is the persistent mismatch between production costs and farm-gate prices [10–12]. Empirical observations from recent years indicate that farmers frequently sell eggs and broilers below their actual cost of production, resulting in continuous financial losses. Feed alone accounts for nearly 60–70% of total production costs, and when combined with expenses for chicks, labor, housing, and veterinary inputs, the total cost per unit often exceeds the prevailing market price [13–15]. This structural imbalance is not temporary but recurrent, reflecting deeper inefficiencies in pricing mechanisms and supply chain coordination. Small-scale farmers, lacking financial buffers, are particularly vulnerable to such sustained losses. The consequences of negative profit margins extend beyond short-term income reduction and translate into long-term structural exit from the sector. Farmers are forced to liquidate assets, reduce flock size, or discontinue production entirely. Unlike large integrated farms, smallholders do not possess the capital reserves or diversification strategies necessary to absorb repeated shocks [8–9, 16–17]. Over time, this cost–price squeeze erodes confidence in poultry farming as a viable livelihood option. The result is a gradual but steady contraction of the smallholder base, contributing to increased market concentration and reduced resilience of the overall poultry sector.

FEED COST INFLATION AND INPUT MARKET INSTABILITY

Feed cost inflation remains a central driver of economic stress in the poultry sector. Poultry industry relies heavily on imported raw materials such as soybean meal and maize, making feed prices highly sensitive to global market fluctuations, currency depreciation, and trade disruptions [11, 18–20]. Even when international prices decline, domestic feed markets often fail to adjust proportionately due to inefficiencies, oligopolistic behavior, and supply chain rigidities. This creates an artificially elevated cost environment that disproportionately affects small-scale producers who lack access to bulk purchasing or alternative sourcing strategies. The instability of input markets further compounds the problem. Issues such as feed adulteration, inconsistent quality, and mycotoxin contamination reduce feed efficiency and compromise bird health [5, 15, 21]. Smallholders, who often rely on local feed dealers, are particularly exposed to such risks. Inadequate storage facilities and limited knowledge of feed management exacerbate losses. As feed conversion efficiency declines, the cost per unit of output increases, intensifying financial pressure. This cycle of high input cost and reduced productivity significantly accelerates farm depletion [2, 12, 16]

MARKET INTERMEDIARIES AND VALUE CHAIN INEFFICIENCY

The dominance of intermediaries in the poultry value chain represents a major structural constraint. Small-scale farmers typically lack direct access to retail markets and are therefore dependent on middlemen for the sale of eggs and broilers [6, 22, 23]. These intermediaries often exert significant control over pricing, leading to a wide gap between farm-gate and consumer prices. Farmers receive only a fraction of the final retail value, limiting their ability to recover production costs or generate profit. This imbalance in value distribution discourages investment and innovation at the farm level [17, 19, 24]. Without fair price realization, farmers have little incentive to adopt improved technologies or expand production. Moreover, the absence of organized cooperatives or farmer associations weakens collective bargaining power. The resulting inefficiency is not merely economic but systemic, as it perpetuates inequity within the value chain [8, 25, 26, 27]. Addressing this issue requires structural reforms that enhance market transparency, promote direct marketing channels, and strengthen farmer organizations.

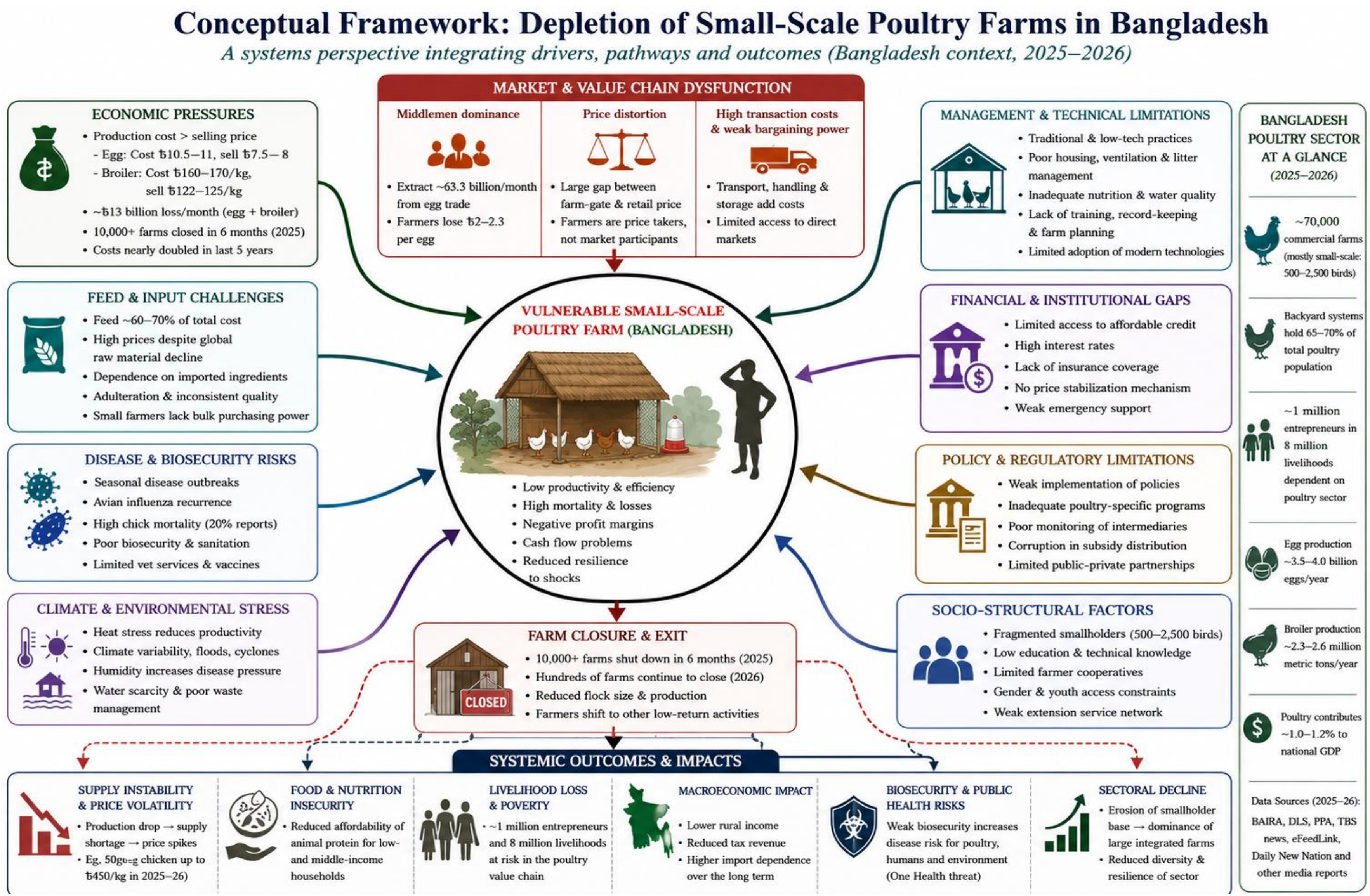

Figure 1. Conceptual framework showing driving factors determining depletion dynamics of small-scale poultry farming systems.

DISEASE BURDEN AND BIOSECURITY LIMITATIONS

Disease outbreaks remain a persistent threat to poultry production, with recurring incidences of Avian Influenza and other infectious conditions causing significant mortality and production losses. Small-scale farms are particularly vulnerable due to inadequate biosecurity measures, including poor sanitation, uncontrolled farm access, and lack of quarantine practices. Limited access to veterinary services and diagnostic facilities further delays disease detection and response, increasing the scale of outbreaks [17–18]. The economic impact of disease is multifaceted, encompassing direct losses from mortality as well as indirect costs related to treatment, reduced productivity, and market restrictions. The misuse of antibiotics, often driven by lack of knowledge or regulatory oversight, contributes to antimicrobial resistance, complicating disease management. These biological risks interact with economic constraints, creating a feedback loop where financial limitations hinder investment in biosecurity, thereby increasing disease susceptibility and further losses [5, 8, 17–18].

CLIMATE STRESS AND ENVIRONMENTAL VULNERABILITY

Climatic conditions pose significant challenges to poultry farming, particularly for small-scale operations. High ambient temperatures and humidity levels induce heat stress, which reduces feed intake, impairs growth, and compromises immune function in birds. Extreme weather events such as floods and cyclones can destroy infrastructure, disrupt supply chains, and cause sudden loss of flocks [7, 10, 14, 17]. These environmental stressors are becoming more frequent and intense due to climate variability, increasing the vulnerability of poultry systems. Small-scale farmers often lack the resources to implement climate-adaptive measures such as improved housing, ventilation systems, or cooling technologies. As a result, their production systems remain highly sensitive to environmental fluctuations. The combined effects of heat stress and disease susceptibility lead to reduced productivity and increased mortality. Over time, repeated exposure to such shocks undermines the sustainability of smallholder operations and contributes to their gradual exit from the sector [1, 11, 23, 25, 28–29].

LIMITED ACCESS TO CREDIT AND FINANCIAL SERVICES

Access to affordable credit is a critical determinant of farm resilience, yet small-scale poultry farmers face significant financial constraints. Formal banking institutions often require collateral and documentation that smallholders cannot provide, forcing them to rely on informal lenders with high interest rates [11, 21, 30]. This increases the cost of capital and reduces the feasibility of investment in improved infrastructure, quality inputs, or expansion. The absence of insurance mechanisms further exacerbates financial vulnerability. In the event of disease outbreaks, market crashes, or environmental disasters, farmers bear the full burden of losses. Without risk-sharing instruments, even a single adverse event can lead to complete financial collapse. Limited financial literacy and lack of access to tailored financial products also hinder effective resource management. These constraints collectively reduce the capacity of smallholders to withstand shocks and sustain operations [8, 15, 26].

KNOWLEDGE GAPS AND POOR FARM MANAGEMENT

Technical and managerial limitations significantly affect productivity and efficiency in small-scale poultry farming [31–32]. Many farmers rely on traditional practices with limited understanding of modern production techniques, including optimal feeding strategies, disease prevention, and environmental control. Inadequate training and extension services restrict the dissemination of best practices, leaving farmers ill-equipped to emerging challenges. Poor farm management practices, such as improper brooding, inadequate ventilation, and suboptimal stocking density, directly impact bird health and performance [1, 4, 17]. Lack of record-keeping further impedes decision-making and performance monitoring. These inefficiencies result in higher production costs and lower output, reducing overall profitability. Addressing knowledge gaps through targeted training and extension programs is essential for improving farm sustainability.

WEAK INSTITUTIONAL SUPPORT AND POLICY IMPLEMENTATION

Institutional weaknesses play a central role in the depletion of small-scale poultry farms. Although policies exist to support the livestock sector, their implementation is often inconsistent and ineffective. Regulatory oversight of feed quality, veterinary services, and market practices remains limited, allowing inefficiencies and malpractices to persist [1, 14, 23, 31–33]. The absence of coordinated policy frameworks reduces the effectiveness of interventions and limits their reach. Furthermore, inadequate investment in rural infrastructure, research, and extension services constrains sectoral development. Public–private partnerships, which could facilitate technology transfer and service delivery, remain underdeveloped. The lack of a comprehensive support system leaves smallholders without the necessary resources to adapt to changing conditions. Strengthening institutional capacity and policy coherence is therefore critical for reversing farm depletion [22, 25, 34–35].

SUPPLY CHAIN DISRUPTIONS AND PRICE VOLATILITY

The global small-scale poultry sector is characterized by significant supply chain instability, leading to pronounced price volatility [3, 22, 24, 36]. Fluctuations in production levels, driven by disease outbreaks, seasonal factors, and farmer exit, create imbalances between supply and demand. These imbalances result in cycles of low prices during oversupply and high prices during shortages, undermining market stability. For small-scale farmers, such volatility increases risk and uncertainty. Without access to storage facilities or price stabilization mechanisms, farmers are forced to sell their products at unfavourable prices. This unpredictability discourages investment and long-term planning [9, 15, 25, 27]. Over time, repeated exposure to volatile market conditions contributes to the erosion of smallholder participation and the consolidation of the sector.

SOCIO-STRUCTURAL CONSTRAINTS AND LIVELIHOOD PRESSURES

Socio-structural factors, including fragmented landholdings, limited education, and weak social networks, further constrain the viability of small-scale poultry farming [13, 19, 31–32]. Many farmers operate on a small scale with limited resources, making it difficult to achieve economies of scale or adopt advanced technologies. Low levels of education and technical literacy hinder the adoption of improved practices and reduce adaptability. Additionally, poultry farming is often one of multiple livelihood activities, and when profitability declines, farmers may shift to alternative income sources [1, 14, 17, 34]. Gender and youth participation constraints also limit labor availability and innovation within the sector. The cumulative effect of these socio-structural challenges is a gradual disengagement from poultry farming, contributing to the overall depletion of small-scale operations.

FUTURE DIRECTIONS

Future research and development efforts should adopt a systems-oriented and solution-driven approach to address the multi-dimensional challenges facing small-scale poultry farming in Bangladesh. First, there is a need for longitudinal and data-driven studies that quantify farm-level dynamics, including profitability trends, disease incidence, and climate impacts, to validate and refine the proposed conceptual framework. Second, research should focus on developing locally adapted, low-cost feed alternatives and improving feed efficiency through precision nutrition and resource optimization to reduce dependence on volatile global markets.

Third, advancing disease surveillance and biosecurity innovation is essential, including the use of rapid diagnostics, digital monitoring tools, and improved vaccination strategies to control endemic and emerging diseases such as Avian Influenza. Fourth, greater emphasis should be placed on climate-resilient poultry systems, including heat-tolerant breeds, adaptive housing designs, and environment-responsive management practices. Fifth, interdisciplinary research integrating molecular biotechnology, such as genomics and microbiome-based interventions, should be explored to enhance disease resistance, productivity, and overall resilience.

Sixth, future work should examine inclusive value chain models, including cooperative structures, contract farming, and digital marketplaces, to improve price realization and reduce intermediary dominance. Seventh, there is a need to design and evaluate innovative financial instruments, such as index-based livestock insurance and accessible credit schemes tailored to smallholders. Finally, policy-focused research should assess the effectiveness of existing interventions and develop evidence-based governance frameworks that enhance coordination among public institutions, private stakeholders, and development partners. Collectively, these directions will support a transition toward a more resilient, efficient, and inclusive poultry production system.

CONCLUSION

Small-scale poultry farming in Bangladesh is undergoing a structural transition driven by tightly linked economic, biological, environmental, technical, and institutional constraints. Persistent cost–price imbalances, recurrent disease risks such as Avian Influenza, increasing climate stress, and weak support systems have collectively reduced profitability and adaptive capacity, accelerating farm exit. The analysis demonstrates that this decline is systemic, emerging from reinforcing feedback loops rather than isolated shocks, and therefore requires coordinated and multi-level interventions.

Actionable pathways for recovery should prioritize: (i) economic stabilization, through price support mechanisms, transparent market information systems, and promotion of farmer cooperatives to strengthen bargaining power; (ii) input system reform, including regulation of feed quality, encouragement of local feed production, and reduction of import dependency; (iii) disease risk reduction, via strengthened biosecurity, expanded veterinary extension, and improved surveillance and vaccination programs; (iv) climate adaptation, through investment in heat-resilient housing, ventilation technologies, and climate-smart management practices; (v) financial inclusion, by expanding access to low-interest credit, introducing livestock insurance schemes, and developing tailored financial products for smallholders; and (vi) capacity building and innovation, through targeted training, digital advisory services, and integration of advanced tools such as molecular biotechnology for disease resistance and productivity enhancement.

At the policy level, greater coordination between public institutions, private sector actors, and development organizations is essential to ensure effective implementation and scaling of interventions. Strengthening value chain integration, improving infrastructure, and enhancing regulatory oversight will be critical to creating an enabling environment for smallholders. Without timely and integrated action, the continued decline of small-scale poultry systems may undermine rural livelihoods, reduce production diversity, and increase vulnerability within the national food system.

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