



Environmental Governance and Implementation Gaps in Poultry Value Chains: Evidence from Brazil

Governança Ambiental e Lacunas de Implementação nas Cadeias de Valor da Avicultura: Evidências do Brasil

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ABSTRACT

This study analyzes environmental management practices in the poultry production chain, focusing on sustainability implementation within a vertically integrated agribusiness system in Goiás, Brazil. A qualitative case study approach was adopted based on primary and secondary data collected from nine agro-industrial units and 230 integrated farms, encompassing 816 broiler houses distributed across 43 municipalities. Data collection involved structured questionnaires, document analysis, and environmental indicators related to water and energy use, waste generation, emissions, and environmental management practices. The results reveal the absence of comprehensive emissions inventories, particularly in transport and boiler operations, limiting environmental monitoring and control capacity. Although initiatives such as environmental education, recycling programs, and reforestation efforts are in place, significant inconsistencies remain in the implementation of sustainability practices across decentralized production units. Environmental management systems are unevenly adopted among integrated farms, reflecting limitations in monitoring routines, traceability systems, and managerial coordination mechanisms. The findings indicate that sustainability outcomes in poultry production systems are influenced more by organizational and monitoring limitations than by technological constraints, revealing asymmetries between corporate environmental strategies and operational practices at the farm level. The study contributes to the literature by reinforcing the relevance of Environmental Management Accounting (EMA) and integrated management systems in supporting sustainability transitions in agri-food chains. Overall, the research highlights the importance of strengthening monitoring structures, environmental disclosure, and operational integration to improve sustainability performance in poultry production systems.

Keywords: Poultry Production Chain; Environmental Management Accounting; Sustainable Development.

RESUMO

Este estudo analisa práticas de gestão ambiental na cadeia produtiva avícola, com foco na implementação da sustentabilidade em um sistema agroindustrial verticalmente integrado no estado de Goiás, Brasil. Adotou-se uma abordagem qualitativa de estudo de caso, baseada em dados primários e secundários coletados em 9 unidades agroindustriais e 230 granjas integradas, abrangendo 816 aviários distribuídos em 43 municípios. A coleta de dados envolveu questionários estruturados, análise documental e indicadores ambientais relacionados ao uso de água e energia, à geração de resíduos, às emissões e às práticas de gestão ambiental. Os resultados evidenciam a ausência de inventários abrangentes de emissões, especialmente nas operações de transporte e de caldeiras, o que limita a capacidade de monitoramento e controle ambiental. Embora existam iniciativas voltadas à educação ambiental, reciclagem e reflorestamento, permanecem inconsistências relevantes na implementação das práticas de sustentabilidade entre as diferentes unidades produtivas. Os sistemas de gestão ambiental apresentam adoção desigual entre as granjas integradas, refletindo limitações relacionadas ao monitoramento, rastreabilidade e mecanismos de coordenação gerencial. Os achados indicam que os resultados de sustentabilidade nesses sistemas produtivos são mais influenciados por limitações organizacionais e de monitoramento do que por restrições tecnológicas, revelando assimetrias entre estratégias corporativas e práticas operacionais no nível das granjas. O estudo contribui para a literatura ao reforçar a relevância da Contabilidade da Gestão Ambiental (EMA) e dos sistemas integrados de gestão como instrumentos de apoio às transições sustentáveis nas cadeias agroalimentares. De forma geral, a pesquisa destaca a importância do fortalecimento das estruturas de monitoramento, transparência ambiental e integração operacional para aprimorar o desempenho sustentável da cadeia avícola.

Palavras-chave: Cadeia de produção avícola; Contabilidade de gestão ambiental; Desenvolvimento sustentável.

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1 INTRODUCTION

Brazil is one of the world's leading poultry producers and exporters, with the sector playing a strategic role in food supply, employment generation, and agribusiness development (ABPA, 2023). The poultry production chain operates through highly integrated systems involving grain production, feed manufacturing, hatcheries, integrated farms, slaughterhouses, processing plants, and distribution networks. This vertically integrated structure enables operational efficiency, scale gains, and coordination among production stages; however, it also increases the complexity of environmental management across interconnected operational units.

According to the Brazilian Animal Protein Association (ABPA, 2021), the poultry production chain includes grain producers, feed factories, broiler farms, transport systems, slaughterhouses, hatcheries, equipment suppliers, processing industries, and distribution networks. This production model operates under Law No. 13,288/2016, which regulates integration contracts between producers and agro-industrial companies and establishes responsibilities for production practices, environmental compliance, and operational coordination.

The Brazilian poultry sector has experienced substantial technological and organizational expansion over recent decades, contributing to productivity growth and international competitiveness (Katchova; Enlow, 2013; Erenstein et al., 2022). In 2023, Brazil produced more than 14 million tons of chicken meat, maintaining its position as one of the largest global exporters (ABPA, 2023). Figure 1 presents the main poultry-producing states in Brazil, highlighting the relevance of the South and Central-West regions in national production dynamics.

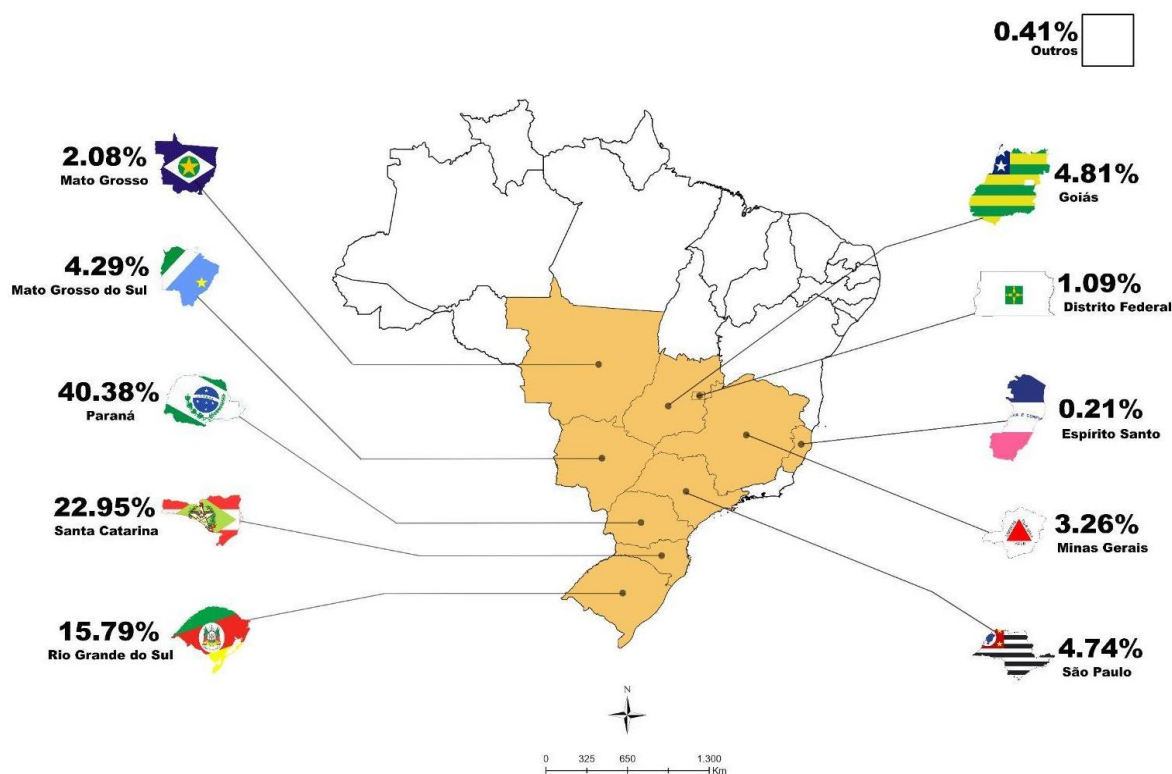


Figure 1. Main broiler-producing states in Brazil. Source: The authors, with data from ABPA (2021).

Despite the sector's economic relevance, poultry production generates significant environmental pressures associated with water consumption, energy demand, waste generation, emissions, and land use linked to feed production, especially soybean and maize cultivation (Palhares; Pezzopane, 2015; Alves et al., 2023). These environmental challenges are not restricted to local production processes but are increasingly associated with broader sustainability concerns involving climate change, resource efficiency, environmental compliance, and traceability demands imposed by global markets and regulatory frameworks (Costantini et al., 2021; Osei-Akoto et al., 2026).

Water management represents one of the primary environmental concerns in poultry systems. Poultry production requires substantial water use, not only for animal consumption and poultry house maintenance but also indirectly through feed production. Studies indicate that approximately 85% of the water footprint associated with poultry production derives from maize and soybean cultivation used in feed formulation (Palhares; Pezzopane, 2015). In addition, waste generation and emissions management remain central environmental challenges, particularly concerning poultry litter disposal, greenhouse gas emissions, and contamination risks associated with inadequate waste handling (Santos; Nogueira; Almeida, 2023).

Climatic variability in major grain-producing regions also affects feed availability, production costs, and environmental pressures associated with poultry systems, particularly regarding land use and resource efficiency in the Cerrado biome (Mais Soja, 2022; Embrapa, 2020). Figure 2 illustrates water and temperature conditions in the main grain-producing regions associated with feed supply dynamics for poultry production.

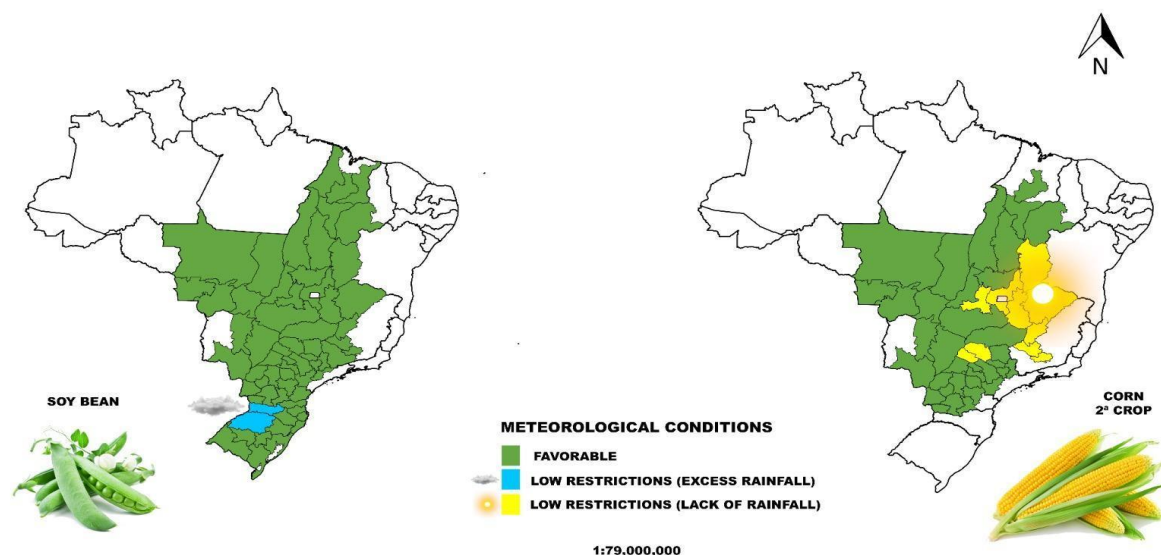


Figure 2. Water and temperature conditions in the main producing regions. Source: The authors with data from Mais Soja (2022).

In response to these environmental challenges, organizations increasingly adopt environmental management systems and Environmental Management Accounting (EMA) practices to improve sustainability performance, support decision-making, and respond to stakeholder pressure regarding environmental responsibility (Christ; Burritt, 2017; Rodrigues; Wander; Rosa, 2023). The literature indicates that environmental indicators,

sustainability reporting systems, environmental audits, cleaner production practices, and traceability mechanisms are becoming increasingly relevant in agribusiness systems (Wilson et al., 2021; Awoke et al., 2023).

Environmental management approaches vary according to how organizations respond to environmental pressures and sustainability demands. Barbieri (2016) classifies these approaches into three major categories: pollution control, pollution prevention, and strategic environmental management. These approaches differ regarding managerial behavior, organizational involvement, and the integration of environmental concerns into strategic decision-making processes (Table 1).

Table 1. Approaches to addressing environmental problems.

Characteristics	Approaches		
	Pollution control	Pollution prevention	Strategic
Basic concern	Adhering to laws and responding to community pressures	Efficient use of inputs	Competitiveness
Specific behaviors	Reactive	Adaptive	Proactive
Specific actions	Technologies for remediation and control at the end of processes for the application of safety standards	Corrective and preventive practices through conservation, input replacement, and clean technologies	Corrective, preventive, and anticipatory
Perception of entrepreneurs and managers	Additional charge	Cost reduction and productivity increase	Competitive advantages
Top management involvement	Sporadic	Journal	Permanent and systematic
Involved areas	Environmental practices are limited to productive areas	Increasing engagement in various other areas	Environmental activities disseminated by the organization

Source: Barbieri (2016) and Carvalho (2023).

From the perspective of Environmental Management Accounting, organizations increasingly seek mechanisms capable of diagnosing, monitoring, and evaluating environmental performance throughout production systems. However, recent studies suggest that sustainability challenges in agri-food systems are no longer associated exclusively with technological limitations. Increasingly, the literature highlights the relevance of institutional arrangements, operational alignment, monitoring structures, and enforcement mechanisms in determining environmental performance across decentralized production systems (Awoke et al., 2023; Osei-Akoto et al., 2026).

In poultry production chains, environmental strategies formally established at the corporate level are not always consistently implemented across integrated farms and operational units. As a result, asymmetries frequently emerge between organizational sustainability commitments and field-level operational practices, particularly regarding monitoring systems, environmental controls, and implementation consistency.

Although previous studies have examined environmental management and sustainability practices in agribusiness systems, limited attention has been given to how institutional arrangements influence the effective implementation of environmental strategies throughout poultry value chains. Most studies emphasize technological efficiency, waste management, or environmental indicators, while fewer investigations address monitoring limitations, operational asymmetries, and enforcement capacity across decentralized production networks.

This study addresses this research gap by analyzing environmental management practices in a poultry production chain in the state of Goiás, Brazil. The research adopts a value-chain perspective to investigate how practices related to water use, energy consumption, waste generation, emissions, and land use are implemented across different production stages and organizational arrangements.

The study contributes to the literature by advancing the discussion on sustainability implementation in agri-food systems, demonstrating that environmental performance is strongly influenced by monitoring capacity, operational alignment, and institutional effectiveness. Additionally, the research reinforces the relevance of Environmental Management Accounting as a strategic tool that supports environmental decision-making and sustainability transitions in agribusiness systems.

Finally, the article is organized into four sections: introduction, materials and methods, results and discussion, and conclusions.

2 MATERIALS AND METHODS

This study adopts a quali-quantitative approach to analyze environmental management practices within the poultry production chain, encompassing both the agribusiness-integrating company and its network of integrated farms. As highlighted by Starr (2014), integrating qualitative and quantitative methods enhances analytical robustness, particularly when combining structured data collection with interpretative analysis. In this sense, a case study strategy was employed due to its suitability for investigating complex agro-industrial systems characterized by multiple organizational interactions and environmental dimensions.

The empirical investigation was conducted within a poultry production chain located in the state of Goiás, Brazil. The study covered all production stages, including breeder farms, hatcheries, broiler production units, warehouses, feed factories, slaughterhouses, processing plants, flour and oil factories, and chemical effluent treatment stations. The research encompassed nine agro-industrial units and 230 integrated farms, totaling 816 poultry houses distributed across 43 municipalities, adopting a census-based approach that considered all backward and forward linkages within the selected case.

Data collection was carried out between 2021 and 2022 and structured into three complementary stages. The first stage consisted of secondary data collection through documentary analysis. Internal organizational documents were examined, including sustainability reports, environmental audits, Environmental Impact Assessments (EIA), Environmental Impact Reports (RIMA), accounting records, operational reports, and

environmental compliance documents. Additional information was obtained from institutional databases, including IBGE, IMB, ABPA, and CAR, allowing broader contextualization of the poultry production chain.

The second stage involved primary data collection through structured electronic questionnaires administered to representatives of agro-industrial units and integrated poultry producers. The instrument was organized into thematic blocks covering environmental coordination practices, water resource management, energy consumption, waste generation and destination, emissions management, environmental accounting practices, socio-environmental actions, and sustainability-related operational practices. The questionnaire consisted predominantly of closed-ended questions using categorical and ordinal response scales, enabling comparability across production units and production stages.

Prior to final application, the questionnaire underwent a pilot validation process involving specialists in environmental management and agribusiness, as well as preliminary testing with a small group of respondents from the poultry production chain. This procedure enabled adjustments related to clarity, consistency, and adequacy of the questions, increasing the reliability and consistency of the collected information.

The third stage comprised the construction of a materiality inventory and the development of environmental performance indicators and eco-controls based on empirical evidence collected throughout the production chain. The materiality inventory was used to identify critical environmental aspects associated with the poultry production system, while environmental indicators and eco-controls were applied to measure, classify, and monitor sustainability practices across different production stages. The analytical framework was grounded in Environmental Management Accounting (EMA), following contributions from Christ and Burritt (2017), Rodrigues (2020), Costantini et al. (2021), Wilson et al. (2021), Awoke et al. (2023), and Rodrigues, Wander and Rosa (2023).

The quantitative analysis was structured around environmental, economic, and social dimensions. The environmental dimension included indicators for water consumption, energy use, waste generation, emissions management, land use, environmental licensing, environmental investments, and the adoption of environmental management systems. The economic dimension considered operational efficiency, environmental expenditures, investments in environmental control technologies, and costs associated with environmental compliance. The social dimension included environmental education initiatives, employee training, socio-environmental engagement actions, community relationship practices, and dissemination of sustainability information.

To ensure analytical consistency, the materiality inventory was structured around five analytical categories: water use, energy consumption, waste generation, land use, and emissions. Each category was classified into three impact levels (high, medium, and low) based on the intensity of natural resource consumption, potential environmental impact, production scale, waste generation volume, and operational relevance within the production chain. The classification criteria were established based on specialized literature and empirical observations from field analysis, enabling comparability across different production stages.

Quantitative data were analyzed using descriptive statistics, frequency distribution, and comparative classification of impact intensity across production units and operational stages. The descriptive statistical analysis enabled the identification of sustainability patterns, environmental pressures, and operational asymmetries across different stages of the poultry production chain.

Qualitative data were analyzed using Bardin's (1977) methodological framework, encompassing pre-analysis, analytical description, and interpretative inference. This procedure enabled the identification of institutional limitations, implementation inconsistencies, and organizational patterns associated with sustainability practices and environmental coordination systems.

The adoption of descriptive and interpretative analytical procedures was considered appropriate given the exploratory and diagnostic nature of the study, prioritizing systemic understanding of sustainability dynamics and implementation challenges across the poultry value chain.

Finally, the methodological procedure followed four analytical stages: identification of sustainability practices, classification of environmental impacts, measurement through environmental indicators and eco-controls, and interpretation and disclosure of information to support environmental management and decision-making. This methodological structure enabled an integrated assessment of environmental performance across the poultry production chain, combining diagnostic, analytical, and interpretative perspectives from Environmental Management Accounting and institutional coordination structures in poultry production systems.

3 RESULTS AND DISCUSSION

In this research, the poultry production chain was analyzed from a systemic perspective encompassing grain storage units, feed factories, hatcheries, integrated poultry farms, slaughterhouses, processing plants, and waste treatment facilities. The diagnostic assessment enabled the identification of standardized environmental practices, operational dynamics, and sustainability-related challenges distributed across the different links of the value chain.

Figure 3 presents the structure of the poultry value chain analyzed in this study, illustrating the integration between feed production, hatcheries, broiler farms, slaughterhouses, processing units, waste treatment operations, and commercialization systems.

The value chain includes organizations responsible for storing strategic raw materials used in feed production, especially maize and soybeans, in addition to hatcheries, integrated farms operating under contractual arrangements with slaughterhouses, processing plants, and by-product recovery units. The system also incorporates composting structures, effluent treatment operations, and organic fertilizer production, reflecting the sector's increasing incorporation of circular economy practices.

The primary environmental practices identified throughout the production chain include water management, energy use control, waste management, emissions management, environmental auditing, and environmental reporting practices. These

activities are directly associated with environmental performance related to freshwater consumption, land use, waste generation, and resource efficiency across the poultry production system.

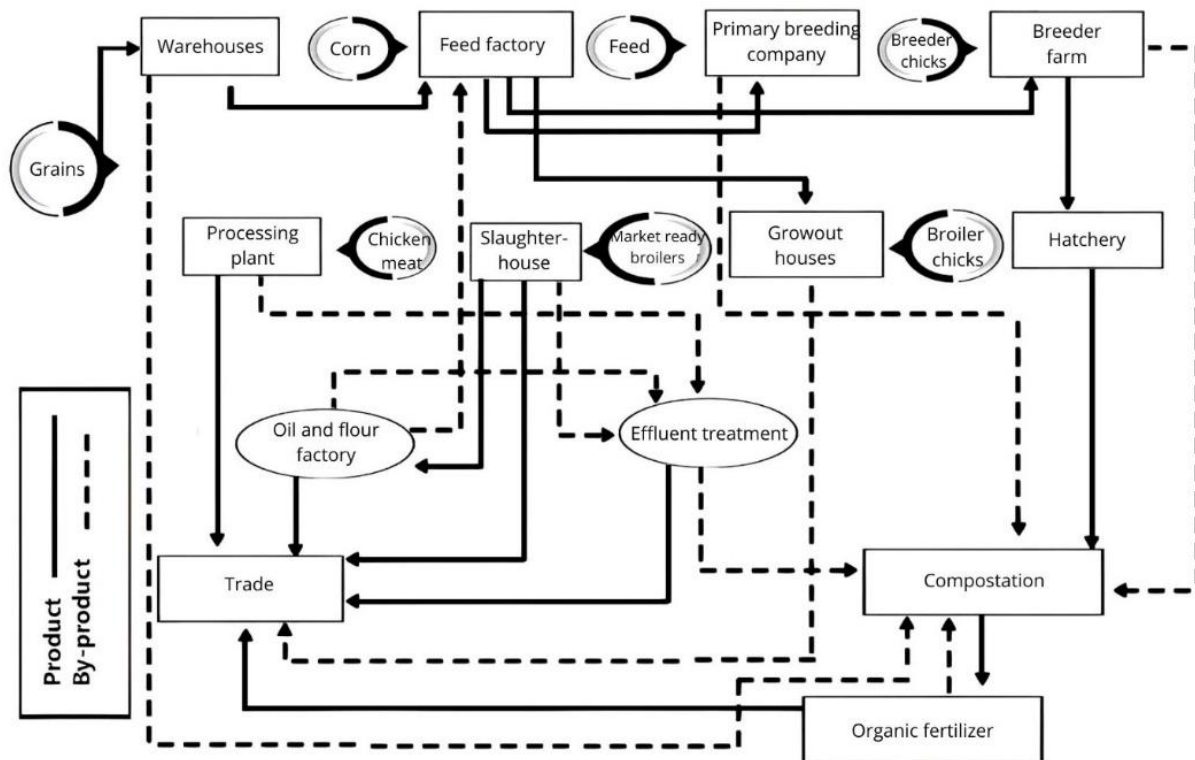


Figure 3. Broiler chicken value chain. Source: adapted from Rodrigues, Wander and Rosa (2023).

The agro-industrial complex demonstrates sustainability initiatives, including environmental education, recycling programs, reforestation, and environmental disclosure practices. However, the analysis also identified important institutional and operational limitations affecting the consistency of sustainability practices across decentralized production units.

Table 2 presents the main strengths and weaknesses identified in environmental management practices across the agro-industrial complex.

The evidence presented in Table 2 demonstrates that the main sustainability limitations identified throughout the poultry value chain are associated less with technological constraints and more with organizational consistency, traceability capacity, and managerial integration across decentralized production units.

Although sustainability initiatives are formally incorporated into the agro-industrial structure, their practical application varies substantially among integrated farms and operational segments. In several situations, environmental actions implemented at the operational level fall short of the quality and consistency of the information disclosed in corporate sustainability reports, revealing limitations in transparency procedures and internal communication systems.

Table 2. Strengths and weaknesses of the environmental management of the agro-industrial complex of poultry farming.

Dimension	Practice	Evidence (Case)	Institutional Limitation	Strategic Implication
Strategic Management	Use of external experts	Support for decision-making	Absence of ESG indicators in executive evaluation	Weak integration between sustainability performance and strategic decision-making
Transparency and Disclosure	Sustainability reporting (GRI)	Reports with defined goals	Low clarity and fragmented disclosure structure	Reduced stakeholder capacity to assess sustainability performance
Transparency and Disclosure	Disclosure versus operational practice	Environmental actions exceed disclosed information	Misalignment between operational practices and reporting	Reputational exposure and reduced reporting credibility
Supply Chain Coordination	Supplier selection	Adoption of socio-environmental criteria	Inconsistent application of sustainability criteria	Increased environmental exposure across suppliers
Supply Chain Coordination	Supplier monitoring	Limited monitoring procedures	Absence of continuous verification systems	Weak traceability and low enforcement capacity
Climate and Emissions Strategy	Emissions management	Achievement of reduction targets	Absence of structured carbon accounting systems	Limited positioning in environmental and carbon-related markets
Environmental Compliance	Regulatory adherence	Registration in environmental systems	Absence of certification requirements for integrated partners	Fragmented environmental compliance throughout the chain
Environmental Compliance	Environmental obligations	Payment of environmental fees	Limited verification and monitoring mechanisms	Reduced the effectiveness of environmental enforcement
Operational Implementation	Integrated farms	Promotion of environmental practices	Absence of monitoring and environmental control routines	Operational inconsistency between corporate strategy and field-level practices

Source: Research results.

The findings also indicate weaknesses in supplier verification routines and traceability mechanisms. While socio-environmental criteria are considered during supplier selection, the absence of continuous assessment procedures compromises implementation consistency across the production chain.

Another important aspect concerns emissions management. Although the agro-industrial complex demonstrates environmental commitments and reduction targets, the absence of comprehensive carbon accounting systems and structured emissions

inventories — especially regarding transport and boiler operations — restricts strategic environmental oversight and reduces the organization's ability to respond to emerging sustainability demands.

The analysis further demonstrates that environmental education programs, recycling initiatives, reforestation actions, and environmental auditing procedures are already incorporated into the organizational structure. However, the effectiveness of these initiatives depends strongly on continuity of supervision, technical follow-up, and integration among production stages.

From the perspective of Environmental Management Accounting (EMA), the findings reinforce the idea that sustainability outcomes depend not only on the existence of indicators or formal certifications, but also on their incorporation into managerial routines, accountability systems, and organizational decision-making processes. Although ISO 14001 guidelines are formally adopted, certification remains concentrated in specific operational units, indicating uneven dissemination of sustainability controls throughout the production chain.

The environmental impacts identified across the poultry value chain were unevenly distributed among production stages. The highest intensity levels were concentrated in biological production systems and industrial processing operations, particularly regarding freshwater demand, energy consumption, and waste generation.

Integrated poultry farms and feed factories also demonstrated elevated environmental pressures due to their dependence on maize and soybean production, reinforcing the relevance of chain-wide analytical approaches that integrate environmental, operational, and managerial dimensions across interconnected production stages.

This study contributes to the literature by advancing discussions on the implementation of sustainability in agri-food systems from a systemic perspective. Unlike studies that focus exclusively on isolated production stages or technological efficiency, the present research demonstrates that sustainability outcomes are strongly conditioned by managerial coordination, traceability structures, institutional capacity, and implementation consistency across interconnected operational actors.

The findings align with international studies that emphasize the growing relevance of transparency systems, certification mechanisms, circular-economy practices, and environmental accountability in global agri-food systems. In this context, sustainability transitions increasingly depend on organizational structures that ensure continuity, integration, supervision, and consistency across production networks.

Environmental impacts identified throughout the poultry value chain were classified according to the intensity of freshwater consumption, energy demand, waste generation, and land use associated with each production stage. Table 3 presents the comparative classification of environmental impacts across the production chain.

The results presented in Table 3 demonstrate that environmental impacts are unevenly distributed throughout the poultry production chain. The highest environmental intensity is concentrated in stages directly associated with biological production and industrial processing, particularly in freshwater demand, energy consumption, and waste generation.

Table 3. Impact of each chain level concerning water use, energy, and waste generation.

Links	CNAE ¹	Water use	Energy use	Waste generation	Land use
Hen houses	Agroindustry	High	High	High	High
Hatchery	Agroindustry	High	High	High	Low
Broiler chicken houses (integrated farms)	Producers	High	High	High	Medium-High
Warehouses	Storage	Low	High	Low	Low
Bone meal and oil factory	Agroindustry	High	High	Low	High
Chemical Effluent Treatment Station	Industry	Low	High	High	Low
Feed factory	Agroindustry	High	High	High	Medium-High
Slaughterhouse	Agroindustry	High	High	High	Low
Processing Plant	Agroindustry	High	High	High	Low

Source: Research results.

Integrated poultry farms and feed factories also impose elevated environmental pressures associated with land use and natural resource consumption, as they depend on maize and soybean production. These findings reinforce the importance of adopting chain-wide analytical approaches that integrate environmental, operational, and managerial dimensions across interconnected production stages.

The evidence further demonstrates that sustainability performance in poultry systems depends substantially on organizational alignment, environmental oversight practices, traceability systems, and coordination capacity distributed throughout decentralized operational arrangements.

This study contributes to the literature by advancing discussions regarding sustainability performance in agri-food value chains from a systemic perspective. Unlike studies focused exclusively on isolated production segments or technological efficiency, this research demonstrates that environmental outcomes are strongly influenced by managerial integration, institutional capacity, and operational consistency across multiple organizational actors.

The findings are also consistent with international studies emphasizing the growing relevance of transparency systems, traceability mechanisms, sustainability certification, and circular economy practices in global agri-food systems (Wilson et al., 2021; Vu et al., 2026). In this context, sustainability transitions increasingly depend on integrating environmental practices into organizational structures that ensure continuity, monitoring, and accountability throughout the production chain.

4 CONCLUSIONS

This study analyzed environmental management practices across the poultry value chain in Goiás, Brazil, adopting a systemic perspective encompassing integrated farms, agro-industrial units, and support operations associated with poultry production systems.

¹ National Classification of Economic Activities – CNAE.

The results demonstrate that sustainability challenges within poultry systems are associated not only with technological or productive aspects, but also with limitations related to traceability capacity, organizational integration, supervision routines, and consistency in sustainability implementation across decentralized operational units.

The study also identified asymmetries between formal sustainability commitments and field-level implementation. Although environmental initiatives such as recycling programs, environmental education, reforestation actions, and auditing procedures are formally adopted, their effectiveness varies depending on the level of technical monitoring and integration across production stages.

From the perspective of Environmental Management Accounting (EMA), the findings reinforce the importance of incorporating environmental indicators, monitoring structures, and accountability mechanisms into managerial decision-making systems that support continuity and consistency in sustainability practices throughout the production chain.

The research contributes to the literature by demonstrating that sustainability transitions in agri-food systems depend substantially on managerial coordination, organizational capacity, traceability systems, and integration mechanisms distributed across interconnected production units.

From a managerial standpoint, the findings highlight the importance of strengthening technical supervision systems, environmental disclosure practices, emissions inventories, and traceability mechanisms to support more consistent sustainability practices across poultry production systems.

Finally, future studies may expand this discussion through comparative investigations involving different agro-industrial chains, longitudinal analyses, and quantitative approaches capable of evaluating relationships between organizational structures and sustainability outcomes in decentralized production systems.

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