

# Life Cycle Assessment of Poultry Production in Nigeria: A Review of Sustainability and Evaluation Studies

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Poultry industry in Nigeria is one of the largest and fastest-growing sub-sectors of the agricultural sector, providing a significant source of income and protein to the country's population. However, there are concerns about the environmental and social impact of poultry production, and the need to evaluate its sustainability. The objective of this review article is to examine the sustainability and evaluation studies of the life cycle assessment (LCA) of poultry production in Nigeria. Literature review was employed in this study. The findings of this study indicate that the LCA approach is a valuable tool for evaluating the sustainability of poultry production in Nigeria. The findings revealed that poultry production in Nigeria has significant environmental impacts, primarily driven by methane emissions contributing to global warming potential. The industry also presents social and economic challenges, including concerns related to animal welfare, disease outbreaks resulting in economic losses, and inadequate support for farmers, emphasizing the importance of implementing sustainable practices and policy interventions. However, the review of existing literature indicates that there are still limitations in terms of data quality and methodological approaches within the research conducted on the subject matter. Therefore, this review recommends further research to address these limitations, and to develop more sustainable poultry production systems in Nigeria. Overall, this study highlights the need for a more holistic approach to evaluating the sustainability of poultry production, and the importance of promoting public awareness of the environmental and social impacts of this industry.

## 1. Introduction

The poultry industry is a key sub-sector of the agricultural industry in Nigeria, contributing significantly to the country's economy and food security. Poultry production in Nigeria is predominantly smallholder-based, with backyard farming accounting for a significant proportion of total production (Bamidele and Amole, 2021; Birhanu et al., 2023). Commercial poultry production is also on the rise, with large-scale farms producing broiler chickens and eggs for both domestic and export markets (Yusuf et al., 2016). The demand for poultry products, including chicken and eggs, is high due to population growth, urbanization, and changing dietary patterns (Ding and Kinnucan, 2011). Poultry farming has created employment opportunities for millions of Nigerians, particularly in rural areas, where job opportunities are limited (Ohajianya et al., 2013). The industry also supports other sectors such as feed production, transportation, and veterinary services (Attia et al., 2022). The rapid growth of the poultry industry in recent years has raised concerns about its environmental and social impacts, including greenhouse gas emissions, water pollution, land degradation, and deforestation (Payandeh et al., 2017). Poultry production requires significant inputs of resources, such as feed, water, and land, and generates large quantities of waste products, such as manure and poultry litter (Gerber et al., 2007). There are concerns about the welfare of the birds, the use of antibiotics and other drugs, and the potential for disease transmission. In response to these concerns, there has been increasing interest in the application of life cycle assessment (LCA) methodology to evaluate the sustainability of poultry production in Nigeria (Ewemoje et al., 2013). LCA evaluates the environmental impacts of a product or activity across its entire life cycle, from raw material extraction to end-of-life disposal (Payandeh et al., 2017).

Previous studies have primarily focused on environmental impact assessments related to poultry production in Nigeria. These assessments have considered various aspects such as the environmental impact assessment of a single point-of-lay chicken (Ewemoje et al., 2013), broader environmental impact assessments (Hydrotech, 2022), environmental impact assessments with some consideration of social factors (Gbotosho and Burt, 2013), as well as studies that address social and economic impact assessments, along with social sustainability (Costantini et al., 2021). Furthermore, there have been studies addressing sustainability evaluation (Ja'afar-Furo and Gabdo, 2010) and those specifically focusing on sustainability and evaluation studies (Adisa and Akinkunmi, 2012). In general, there are limited studies on life cycle assessment on poultry production in Nigeria. However, a notable gap exists in the literature as there is limited comprehensive assessment of the complete life cycle assessment (LCA) of poultry production in Nigeria. While environmental aspects have been covered to some extent, there is a need to consider a broader spectrum of sustainability factors, including economic, social, and environmental dimensions. The literature lacks integration and detailed data on socioeconomic and environmental dimensions in poultry production. Therefore, the objective of this review is to examine the sustainability and evaluation studies associated with the entire life cycle assessment (LCA) of poultry production in Nigeria. This will encompass not only environmental aspects but also social, economic, and ethical considerations to provide a more comprehensive view of the sustainability of poultry production in the country. This review in Nigeria's poultry industry has wide-reaching benefits for policymakers, researchers, farmers, and consumers. Policymakers can shape sustainable policies, researchers can expand knowledge, farmers can improve practices, and consumers can make informed choices, all based on its findings, contributing to a more sustainable and responsible poultry industry.

## **2. Environmental Impact Assessment**

The environmental impacts of poultry production in Nigeria include land use, soil degradation, water consumption, air pollution, and waste generation. Ewemoje et al. (2013) used a cradle-to-gate approach to evaluate the environmental impacts of the poultry production system in Nigeria. Further, the study found that methane (CH<sub>4</sub>) is the largest contributor to the global warming potential, accounting for 90.64 % of the emissions, while carbon dioxide (CO<sub>2</sub>) accounts for 8.76 % of the total emissions, and nitrous oxide (N<sub>2</sub>O) accounts for 0.7 %. Feed production is a major contributor to CO<sub>2</sub> emissions, accounting for 2.5 % of the total emissions, while diesel generators account for the majority of CO<sub>2</sub> emissions at 73.96 %. Water pumping also contributes to CO<sub>2</sub> emissions, accounting for 1.13 % of the total emissions. The study also highlights the potential environmental impact of black carbon (soot) on global warming (Ewemoje et al., 2013)

According to a study conducted by Hydrotech (2022), the production of 1 kg of poultry meat requires 4,325 L of water and generates 3.6 kg CO<sub>2</sub>-eq emissions. Study by Gerber et al. (2007) found that the use of antibiotics and other agrochemicals in poultry production could lead to the contamination of water resources and soil degradation.

Another study by Gbotosho and Burt (2013), the environmental and health impacts of poultry manure disposal methods in Nigeria and found that intensive poultry farming practices lead to high levels of ammonia emissions, which contribute to air pollution. Ammonia was identified as the major air pollutant, causing discomfort among farmers, including sneezing, eye irritation, coughing, headache, stomach ache, and diarrhea (Gbotosho and Burt, 2013). The study also highlighted the negative effects of waste disposal practices on the environment, such as soil and water contamination and greenhouse gas emissions.

### **2.1 Social and Economic Impact Assessment**

The social impacts of poultry production in Nigeria include economic benefits, employment opportunities, and food security. The industry also poses challenges such as animal welfare concerns and health risks to farmers and consumers. A study by Anosike et al. (2020) found that poultry farmers in Nigeria face various challenges, including inadequate access to finance, high cost of feed, and lack of technical support. The study also highlighted the importance of promoting animal welfare in the industry to ensure sustainable production practices. Another study by Lawal et al. (2009) identified some constraints to poultry farming, including unavailability of loans, problem of manure disposal, pilfering, transportation, lack of quality feed ingredients, and unavailability of local drugs and vaccines. Conducting a social sustainability assessment using LCA can help to promote sustainable poultry production practices that benefit both the industry and the communities in which it operates (Costantini et al., 2021). Poultry farming can provide employment opportunities and improve rural livelihoods (Akinola and Essien, 2011). The industry can also be subject to labor exploitation, gender inequities, and community conflict. To evaluate the social sustainability of poultry production in Nigeria, farmers need to ensure that their operations are socially responsible, provide fair wages and benefits, and engage with their communities in a transparent and collaborative manner.

Despite the economic benefits of poultry production, the industry faces several challenges, including high production costs, disease outbreaks, and inadequate infrastructure. These challenges can limit the growth of the industry and reduce its potential economic impact. Study by Sadiq and Mohammed (2017) assess the economic impact of Newcastle disease (ND), Infectious bursal disease (IBD), and Avian influenza (AI) on poultry farms in Abuja, Nigeria. This study categorized the economic losses into the monetary value of birds lost, drop in production, and loss of jobs. The results showed that ND, AI, and IBD made up 587.6 %, and 33 % of the recorded outbreaks. The outbreaks of ND resulted in the highest cumulative losses of N13 million, while AI caused more losses when evaluated per outbreak, with NGN 2 million in monetary terms. Another study by Mohammed and Sunday (2015) report the direct and indirect economic losses associated with coccidiosis in poultry including the cost of control measures, production losses, and potential consequences to poultry health from resistance to chemoprophylaxis. The losses are estimated to be in millions of Naira, which is a significant impact on the poultry production industry. Yusuf et al. (2016) examined the economics of poultry production in Kwara State, Nigeria, by analyzing the costs and returns of egg and broiler production. The study found that the "gross income and net income for egg production were NGN 4,062,422 and NGN 1,255,965, while the gross and net incomes for broiler production were NGN 1,683,209 and NGN 499,187.

## 2.2 Sustainability Evaluation

There are several factors that contribute to sustainable poultry production among farmers in Nigeria including access to high-quality feed and water, proper housing, disease prevention and control, adequate ventilation and lighting, proper waste management, proper record-keeping, and access to market and financial support (Ja'afar-Furo and Gabdo, 2010). The sustainability of poultry production in Nigeria is evaluated based on its economic, environmental, and social impacts. A study by Adisa and Akinkunmi (2012) assessed the sustainability of rural women participation in commercial poultry production activities in Oyo State, Nigeria. The results revealed that women participate more in production and marketing activities but less in processing. Agbonlahor et al. (2003), argued that sustainable poultry-based integrated food crop production system, if given more attention by farmers and backed up by policy, may be an acceptable and feasible way of stemming the declining trend in soil productivity in southern Nigeria. Ja'afar-Furo and Gabdo (2010) conducted a study in Nigeria to determine the key factors contributing to the sustainability of poultry production among farmers. The researchers focused on the utilization of improved methods in this agricultural enterprise. The study found that the industry's economic benefits are significant, but its environmental and social impacts need to be addressed through sustainable production practices, policy interventions, and stakeholder engagement. Geidam et al. (2007) argued that assessment of day-old-chick's quality is essential for the sustainability of the poultry industry in Nigeria. By implementing best practices in breeding, nutrition, management, sanitation, and disease prevention, hatcheries can ensure the production of high-quality day-old-chicks.

## 2.3 Sustainability and Evaluation Studies

Few sustainability and evaluation studies have been conducted on the life cycle assessment of poultry production in Nigeria. A study by akanni and benson (2014), on the assessment of poultry waste management strategies found that poultry production practices, and waste management strategies significantly influence the level of environmental pollution and human health impacts associated with poultry farming in Ogun State, Nigeria. The study suggests the need for effective monitoring and enforcement of environmental regulations by the government to ensure that poultry farmers operate in compliance with environmental standards.

A study by Ewemoje et al. (2017) assessed the point-of-lay birds to frozen chicken production in a tropical environment (including Nigeria) using LCA The study concludes that the use of 100 % purchased electricity in all processing activities is the most environmentally sustainable scenario, while the use of diesel generators for electricity generation results in the highest environmental impacts.

Another study by Adekunle et al. (2020) evaluated the environmental and economic sustainability of poultry production in Nigeria using LCA and economic analysis. The study found that the environmental impacts of poultry production could be reduced by improving feed quality, reducing waste generation, and using renewable energy sources. The study also recommended the adoption of sustainable practices, such as the use of organic fertilizer and improved animal welfare standards, to improve the sustainability of the industry. The study highlights the importance of reducing energy consumption during the freezing process, which was identified as the major source of global warming potential. This can be achieved through the use of more energy-efficient freezing technologies or by reducing the amount of time required for freezing.

Ewemoje et al. (2011) conducted a study to evaluate the environmental impacts of hatchery production processes up to the point-of-lay stage. The researchers also investigated the effects of different scenarios on the environmental load impacts through a life cycle assessment (LCA) approach. The authors found egg-point of lay system has significant environmental impacts, particularly in terms of global warming potential and acidification. The system was found to contribute 9.708 kg of CO<sub>2</sub> equivalents, 11.34 kg of CH<sub>4</sub> equivalent, and

0.2 kg of N<sub>2</sub>O to global warming. Acidification was also significant, with 2,713 x10<sup>-4</sup> kg of SO<sub>2</sub> equivalents, 1.948 x 10<sup>-3</sup> kg of NH<sub>3</sub> equivalents, and 2.167 x 10<sup>-3</sup> kg of NO<sub>x</sub> equivalents.

### 3. Prospect and Challenges

Poultry production in Nigeria has a promising future due to several factors, including the high demand for poultry products, the availability of local and international markets, and the potential for job creation and economic growth. However, the industry also faces several challenges that could hinder its growth and sustainability.

#### 3.1 Prospects of Poultry Production in Nigeria

The demand for poultry products in Nigeria is growing rapidly due to population growth, urbanization, and changing dietary habits. This presents an excellent opportunity for farmers to increase their production and generate income (Heise et al., 2015). Commercial poultry production is also on the rise, with large-scale farms producing broiler chickens and eggs for both domestic and export markets (Yusuf et al., 2016; Kassali et al., 2022).

Nigeria, located in the tropical region of West Africa, boasts a climate that is highly conducive to poultry farming. With its year-round growing season, abundant rainfall, and favourable temperatures, the country offers an ideal environment for the successful rearing of poultry (Elijah and Adedapo, 2006). One of the key factors that make Nigeria's climate suitable for poultry farming is the absence of extreme seasonal variations. The country experiences a relatively stable and consistent temperature throughout the year, with average temperatures ranging from 27 °C to 29 °C (Ajetomobi and Abiodun, 2010). Such temperatures provide a comfortable environment for poultry, allowing them to thrive and grow efficiently.

There is a ready market for poultry products both locally and internationally. Nigeria has a large domestic market, and there is increasing demand for Nigerian poultry products in other African countries, Europe, and Asia (Heise et al., 2015). With a large population and a growing middle class, Nigeria provides a ready market for poultry products within its borders. The demand for poultry products such as chicken, eggs, and turkey remain consistently high due to their affordability and versatility in various culinary traditions.

Poultry production has the potential to create jobs in Nigeria, particularly in rural areas, where there are fewer employment opportunities (Odum and Chukwuji, 2022). It fosters local value chain development, involving supporting industries and creating more jobs. Smallholders can participate with low investment, empowering women and benefiting the community. Meeting the demand and potential for poultry exports can further expand the market and generate additional jobs.

The use of improved production technologies and management practices can enhance the efficiency and productivity of poultry farming in Nigeria (Olaniyi et al., 2008). These include modern housing systems, improved breeds, advanced feeding techniques, disease prevention measures, data-driven management, efficient waste management, and continuous training and education for farmers.

#### 3.2 Challenges of Poultry Production in Nigeria

Poultry production requires significant investment in inputs such as feed, medication, and equipment, which can be costly and prohibitive for small-scale farmers (Ojo, 2003). Poultry farms in Nigeria are often plagued by disease outbreaks, which can cause significant losses and affect the quality of products (Akintunde and Adeoti, 2014).

Inadequate infrastructure, including roads, electricity, and water supply, can make it difficult for farmers to access inputs, markets, and other essential services (Heise et al., 2015). Limited access to credit and financial services makes it challenging for farmers to invest in their businesses, upgrade their facilities, and expand their operations (Akpan et al., 2013).

Nigeria's poultry industry faces stiff competition from imported products, which are often cheaper due to subsidies and favorable trade agreements (Tijani et al., 2006). The lack of adequate policy support and government intervention hampers the development of the poultry industry in Nigeria (Adeyonu et al., 2017).

### 4. Implications for Policy and Practice

Sustainable poultry production in Nigeria requires a concerted effort involving policymakers, practitioners, and stakeholders. Key implications for policy and practice must be addressed. Firstly, the government should develop policies promoting eco-friendly production methods and animal welfare standards. Encouraging the adoption of sustainable practices is vital, with training and education programs fostering improved technologies and management practices.

Furthermore, incentivizing investment in sustainable poultry production is essential. Tax benefits, subsidies, and financial support should be offered to attract investors. Collaboration among various stakeholders is crucial to

identify industry challenges and develop appropriate solutions. Reducing poultry imports through policies like tariffs can stimulate local production.

Promotion of sustainable farming practices is vital, encompassing organic farming, integrated pest management, and alternative energy sources. In essence, a holistic approach involving policy, education, investment, collaboration, and sustainable practices is essential to achieve sustainable poultry production in Nigeria.

## 5. Conclusions

Poultry production in Nigeria has significant environmental and social impacts that need to be addressed through sustainable production practices, policy interventions, and stakeholder engagement. This review of sustainability and evaluation studies on the life cycle assessment of poultry production in Nigeria highlights the need for sustainable practices to reduce the environmental impacts of the industry. Life Cycle Assessment is a useful tool for evaluating the environmental impacts of poultry production and identifying areas for improvement. The studies reviewed in this paper recommend the adoption of sustainable practices, such as the use of renewable energy sources, improved waste management practices, and the use of organic fertilizers, to improve the sustainability of the industry. Policies and regulations to promote sustainable practices in the poultry industry are also recommended to ensure its long-term sustainability. This study also recommends the adoption of sustainable waste management practices by poultry farmers, including the use of composting, vermicomposting, and biogas production technologies. It also suggests the need for effective monitoring and enforcement of environmental regulations by the government to ensure that poultry farmers operate in compliance with environmental standards. The findings of various studies emphasize the need for promoting sustainable poultry production practices to ensure the industry's long-term sustainability. Further research is required to explore the potential of innovative technologies and practices that can reduce the environmental and social impacts of poultry production in Nigeria.

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