



SOCIO-ECONOMIC FACTORS INFLUENCING THE ADOPTION OF AI-INTEGRATED WASTE MANAGEMENT SYSTEMS AMONG COMMERCIAL BROILER FARMERS IN DELTA STATE, NIGERIA

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Journal of Research in Vocational and Technical Education (JORVTED), 2026, 5(1), 57–65

Publication history: Received on 23 January 2026; revised on 07 March 2025; accepted on 10 May 2026

Article DOI: <https://doi.org/10.5281/zenodo.20179373>

Abstract

Nigeria's expanding commercial broiler production has led to a sharp increase in poultry waste products, which are generating problems for the environment and public health. Artificial intelligence (AI)-based waste management systems offer innovative approaches to efficient resource use, environmental monitoring, and trash management. However, poultry producers are still not using this technology. This study looked at the socioeconomic variables affecting commercial broiler farmers in Nigeria's Delta State's adoption of AI-integrated waste management systems. 240 commercial broiler producers provided primary data using structured questionnaires as part of a descriptive survey research approach. Data were examined using descriptive statistics like means, frequencies, percentages, and ranking indices. The findings showed that adoption was significantly influenced by perceived cost-benefit, farm size, education level, credit availability, and extension contact. In a bid to increase the adoption of AI-driven waste management systems, the study indicates that socioeconomic factors significantly influence farmers' technology adoption behavior and suggests focused capacity building, increased access to financing, and enhanced extension services.

Keywords: Artificial Intelligence, Waste Management, Socio-Economic Factors, Broiler Farming, Technology Adoption.

Introduction

One of Nigeria's fastest-growing livestock subsectors is poultry production, with commercial broiler farming playing a major role in Nigeria's meat supply, employment, and revenue generation (Adeyonu et al., 2021). Poultry waste, including litter, manure, and wastewater, has accumulated more in Delta State as a result of the quick growth of commercial broiler operations. Pollution of the environment, greenhouse gas emissions, unpleasant scents, and the spread of disease are all caused by improper waste management (Somani, 2023). Innovative waste management solutions featuring real-time monitoring, automated waste segregation, predictive analysis, and efficient disposal systems were made possible by recent developments in artificial intelligence (AI). Waste management solutions with AI integration increase productivity, lower environmental risks, and boost agricultural sustainability (Olawade et al., 2024). Despite these benefits, adoption is still low among poultry farmers in developing nations, which raises questions regarding the socioeconomic hurdles influencing uptake.

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Statement of the Problems

Notwithstanding the fact that AI-integrated waste management systems have shown promise in enhancing the handling of poultry waste, commercial broiler farmers in Delta State have not adopted them. Many farmers still use ineffective, environmentally unsustainable old waste disposal techniques. Adoption decisions may be influenced by elements including scarce financial resources, insufficient technical expertise, farm characteristics, and a lack of institutional support. However, this study is required because there isn't enough real data specific to Delta State.

Objectives of the Study

The primary objective of this research is to investigate the socioeconomic variables affecting commercial broiler farmers in Nigeria's Delta State's adoption of AI-integrated waste management systems.

Specific objects are:

1. To describe the socioeconomic traits of commercial broiler farmers in Delta State
2. To find out the level of adoption of AI-integrated waste management systems among commercial broiler farmers in Delta State
3. To determine the socioeconomic factors affecting the adoption of waste management systems with AI integration in Delta State
4. To examine the barriers preventing commercial broiler farmers from implementing AI-integrated waste management systems in Delta State.

Research Questions

The study will answer the following research questions:

1. What are the socioeconomic traits of commercial broiler farmers in Delta State?
2. What's the level or extent of adoption of AI-integrated waste management systems by commercial broiler farmers in Delta State?
3. What are the socioeconomic Factors that are affecting the adoption of AI-integrated waste management systems in Delta State?
4. What are the barriers that are preventing commercial broiler farmers from implementing AI-integrated waste management systems in Delta State?

Significance of the Study

The findings of this study will provide empirical data on factors influencing the adoption of AI-integrated waste management technologies, which would be beneficial to policymakers, poultry farmers, extension service agencies, and technology developers.



Literature Review

Concept of AI-Integrated Waste Management in Poultry Production

"AI-integrated waste management in poultry production" refers to the use of artificial intelligence technology to enhance the handling, tracking, and disposal of poultry waste (Onyeaka et al., 2023). Through integrating sensors, data analytics, and machine learning algorithms, these systems produce real-time data on waste volume, moisture content, ammonia levels, and decomposition rates. The produced data is examined to forecast trends in trash generation and enable timely decisions regarding waste collection, treatment, and disposal (Poonkuzhali et al., 2024). Through regulating waste handling procedures, including controlled composting, drying manure, and turning chicken litter into organic fertilizer, automation built into AI-integrated systems improves efficiency. These solutions limit the risk of disease outbreaks linked to inadequate waste management, minimize environmental impact, and lessen reliance on manpower for commercial broiler producers (Zhao et al., 2023).

Socio-Economic Factors Influencing the Adoption

The socioeconomic traits of commercial broiler farmers have a significant impact on their adoption of AI-integrated waste management systems. Education is important because farmers with more education are better equipped to comprehend, assess, and utilize advanced technologies, such as AI-based systems. Adoption is also greatly influenced by farm size and income level, as larger, more profitable broiler farms can afford the high upfront expenses associated with AI technologies (Mafimisebi et al., 2006). Through removing financial barriers and facilitating investment in capital-intensive waste management technologies, loan availability further increases adoption. Furthermore, extension services are essential for creating awareness, providing technical advice, and disseminating information, all of which boost farmers' confidence in implementing new technology (Hameed & Sawicka, 2023). The degree of technological innovation and sustainability of commercial broiler production in Delta State is ultimately influenced by these socioeconomic factors, which collectively influence farmers' ability and willingness to use AI-integrated waste management systems.

Theoretical Framework

The Diffusion of Innovations Theory, which describes how new technologies are introduced, disseminated, and embraced within a social system over time, serves as the foundation for this study. According to the hypothesis, both individual traits and the innovation's perceived qualities have an impact on adoption decisions (Guo & Huang, 2024). Socioeconomic factors like education, income level, farm size, credit availability, and contact with extension services influence farmers' capacity to obtain information, evaluate technological options, and cover adoption costs in a setting of AI-integrated waste management systems among commercial broiler farmers in Delta State. The theory also highlights the fact that farmers are more willing to accept innovations when they see definite benefits, such as enhanced profitability, decreased environmental risks, and greater waste disposal efficiency (Gedikoglu & McCann, 2012). This study offers a systematic explanation of how socioeconomic factors and perceived benefits interact to influence the adoption of AI-based waste management solutions in commercial broiler production systems by utilizing the Diffusion of Innovations Theory.

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Empirical Review

The role of socioeconomic factors in influencing farmers' willingness and capacity to adopt innovative techniques has been repeatedly established through empirical studies on agricultural technology adoption. Adoption of technology is significantly influenced by education level, according to studies conducted in developing countries (Zegeye et al., 2022). This is because educated farmers are better able to obtain information, comprehend complicated technologies, and weigh the advantages and disadvantages of each alternative. Empirical data suggest that farmers with greater levels of education are more likely to adopt automation and advanced waste management technology in poultry farming systems. Adoption has also been found to be significantly influenced by farm size and income level. Due to their larger production size, higher rate of waste generation, and greater financial capacity to engage in capital-intensive systems, larger commercial farms are more likely to embrace modern technologies (Pruitt et al., 2012). Since it lowers financial barriers and encourages investment in new technologies, financing availability has been generally cited as a major facilitator of technology adoption. Additionally, research shows that farmers who have regular access to extension services are more likely to adopt improved agricultural technologies because they receive more technical assistance, training, and knowledge (Ikoyo-Eweto et al., 2024). Adoption decisions are strongly influenced by perceived economic and environmental benefits, according to empirical studies relevant to waste management in livestock and poultry operations (Vigoroso, 2023). Farmers are more likely to use better waste management systems if they see increases in productivity, lower labor costs, greater biosecurity, and compliance with environmental standards. Few empirical studies specifically address AI-integrated waste management systems in Nigerian commercial broiler production, notwithstanding these findings. This disadvantage highlights the need for context-specific research to better understand adoption patterns and socioeconomic variables among commercial broiler growers in Delta State.

Methodology

The study was carried out in Nigeria's Delta State, which is popularly known for the production of large quantities of poultry and has significant commercial broiler farming operations in the cities, including Asaba, Warri, Ughelli, and Sapele. A descriptive survey research design was employed to gather quantitative data on farmers' characteristics, adoption rates, and influencing factors without changing variables. The population consisted of all registered commercial broiler producers in Delta State. A multistage sampling strategy was used to choose 240 commercial broiler growers from certain agricultural zones in the state. Data was collected using a standardized questionnaire that included questions on the barriers, contributory variables, adoption level, and socioeconomic traits. Descriptive statistics, such as frequencies, percentages, mean scores, and ranking approaches, were used to analyze the data.



Results and Discussion

Table 1: Socioeconomic Traits of Respondents (commercial broiler farmers) in Delta State (n240)

Variables	Category	Frequency	Percentage (%)
Age	Below 30 years	32	13.3
	30 – 40 years	125	52.1
	41 – 50 years	72	30.0
	Above 50 years	11	4.6
Sex	Male	168	70.0
	Female	72	30.0
Marital Status	Married	157	65.4
	Single	83	34.6
Education Level	Primary	32	13.3
	Secondary	66	27.5
	Tertiary	142	59.2
Farm Size	Below 500	52	21.7
	500 – 1000	66	27.5
	Above 1000	122	50.8

Source: Field Survey 2025

The distribution of socio-economic traits shows that both sexes are underrepresented. In the commercial broiler farming sector, males still predominate. The majority of respondents fell into the economically active age group of 30 to 40 years old, according to the findings, suggesting a productive population that can accept new technology. A positive ability to comprehend and invest in AI-integrated waste management systems is indicated by the high percentage of broiler farmers with postsecondary education and medium to large farm sizes.

Table 2: Level of Adoption of AI-Integrated Waste Management Systems by Commercial Broiler Farmers in Delta State

Adoption Status	Frequency	Percentage (%)
Adopted	50	20.8
Not Adopted	190	79.2
Total	240	100.0

Source: Field Survey 2025

Only 50 commercial broiler farmers have used AI-integrated waste management systems, according to the findings. The high cost of basic automated waste monitoring tools was a major barrier to adoption, showing low overall penetration of sophisticated AI technology in poultry waste management.



Table 3: Socioeconomic Factors Influencing the Adoption of Waste Management Systems with AI-integration in Delta State

Factor	Mean Score (based on 4-point Likert scale)	Rank
Education level	3.64	1st
Farm Size	3.48	3rd
Access to a loan or credit	3.32	4th
Extension contact	3.16	5th
Farming experience	2.71	6th
Perceived economic gains	3.56	2nd

Source: Field Survey 2025

The findings highlight the importance of knowledge and technical proficiency while utilizing AI-based systems, with education level emerging as the most significant aspect or component. Farm size and perceived economic gains were placed third (3) and second (2), respectively, suggesting that farmers who operate on a commercial scale and anticipate profitability benefits are more inclined to employ AI technologies. By reducing financial and informational obstacles, access to credit, loans, and extension services also promotes adoption.

Table 4: Barriers that are Preventing Commercial Broiler Farmers from Implementing AI-integrated Waste Management Systems in Delta State

Barrier	Frequency	Percentage (%)
High cost of AI systems	192	80.0
Poor power supply	180	75.0
Poor technical know-how	166	69.2
Poor access to a loan or credit	142	59.2
Inadequate extension service support	123	51.3

Source: Field Survey 2025

The findings underscore the capital-intensive nature of AI technologies by indicating that the most frequently mentioned obstacle is the high cost of AI systems. The state's weak or insufficient power supply and lack of technical expertise further hinder adoption. Farmers' exposure to AI technologies is restricted by limited financing availability and inadequate extension service support, underscoring the necessity of institutional actions to boost adoption.

Discussion

According to earlier research on agricultural technology adoption, the results of this study show that socioeconomic factors have a significant impact on commercial broiler farmers in Delta State's adoption of AI-integrated waste management. The economically active age group (30–40 years old) is dominated by young adult farmers, indicating a physically productive and innovative populace. This result is consistent with earlier studies that found that younger and middle-aged farmers are more inclined to adopt new agricultural technologies because they have longer planning horizons and a higher risk

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tolerance (Lee et al., 2022). The high degree of tertiary (postsecondary) education among respondents indicates that agricultural technology adoption has a great deal of potential. Farmers can better handle AI-based technology, assess advantages, and comprehend complex systems with the aid of education. These results support the study by Omole & Fasina (2024), who found that adoption of agricultural innovations is significantly influenced by education. AI-integrated waste management systems have not yet received much attention or broad implementation, despite these advantages. This suggests that without substantial institutional and financial support, knowledge and capacity are inadequate.

Farm size and perceived economic gains were second and third, respectively, while medium- and large-scale farmers were more likely to deploy AI systems because of their higher financial capacity and high waste management demands. Studies on the adoption of technology in cattle have shown similar results (Khanna et al., 2024). The adoption was significantly impacted by the availability of loans or credit and extension service help, highlighting the significance of institutional support in overcoming obstacles related to money and expertise. According to Ibrahim et al. (2024), extension contacts improve awareness, training, and trust in new technology. The primary barriers that farmers face when putting capital-intensive AI technologies into practice are the high cost of AI systems, insufficient power supplies, a lack of technical know-how, and limited financing options. Overall, the results confirm the significance of the Diffusion of Innovations theory, showing that perceived advantages and socioeconomic considerations have a major impact on the adoption of AI-integrated waste management systems in commercial broiler production.

Limitations

This study's descriptive survey design makes it challenging to draw conclusions about causality. The use of self-reported data may lead to response bias, and the primary focus on Delta State restricts the generalizability to other geographical areas. Furthermore, the study focused mostly on socioeconomic issues, ignoring significant technological and regulatory implications on adoption.

Practical Recommendations

To increase the adoption of AI-integrated waste management systems, farmers should have access to targeted training programs that enhance their technical proficiency. Affordable loans, lending facilities, and subsidies are necessary to overcome the high cost of AI systems. Commercial broiler growers may be able to obtain reasonably priced, regionally specific AI solutions through public-private partnerships. Technical and awareness support will be improved by bolstering extension services.

Conclusion

Based on the study's findings, socioeconomic considerations are a major reason for the slow adoption of AI-integrated waste management systems by commercial broiler farmers in Delta State. Perceived economic gains, farm size, education level, credit availability, help from extension services, and inadequate power supply are some of the factors that affect adoption. Technical know-how and high costs are additional obstacles to adoption. It is crucial to increase institutional support, financial accessibility, and technical expertise to encourage broader use and accomplish sustainable poultry waste

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