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Factors Influencing Enterprise Profit among Agribusiness Green Technology Adopters in Ibadan, Oyo State, Nigeria

Abstract. The increasing promotion of green technologies in agriculture is often justified on environmental grounds, yet empirical evidence on their economic implications for agribusiness enterprises in Nigeria remains limited. This study was therefore justified by the need to understand whether and under what conditions green technology adoption translates into improved enterprise profitability. The purpose of the study was to examine the selected factors influencing the profitability of agribusiness enterprises in Ibadan, Oyo State, Nigeria that have adopted green technology. A descriptive survey design was adopted, and primary data were collected from 120 agribusiness green technology adopters using a structured questionnaire. Data were analysed using descriptive statistics and multiple linear regression. The results revealed that age and work experience significantly and positively influenced enterprise profit, while household size and educational status were not significant. Among adoption-related factors, government support and market access positively affected profitability, whereas high technology cost, inadequate resources, and ineffective access to information constrained profit. The model explained about 42% of the variation in enterprise profit. The study concludes that green technology adoption alone does not guarantee higher profitability; rather, supportive institutional frameworks, affordable technologies, adequate resources, and market linkages are critical for translating environmental innovations into economic gains. Policy interventions should therefore integrate financial, informational, and market-support mechanisms to enhance both the profitability and sustainability of agribusinesses.

Keywords: green technology adoption, agribusiness profitability, socio-economic factors, institutional factors, sustainability, Nigeria

JEL Classification: Q12, Q16, Q56, O13

Introduction

The agricultural sector in Nigeria plays a pivotal role in national development, particularly in terms of food security, employment generation, and economic diversification (Ndiomaluke et al., 2025). In recent years, the environmental implications of conventional agricultural practices have prompted a global shift toward sustainable and climate-smart agricultural methods (Hussain et al., 2024). While the global shift toward environmentally sustainable agriculture has encouraged the development of green technologies, it is important to recognise that the adoption of such technologies does not automatically translate into reduced environmental degradation or higher productivity. Their effectiveness depends on the scale of adoption, user capability, and contextual factors such as resource availability and policy support (Adolph et al., 2021; Singh et al., 2025). Some technologies may yield limited or mixed results when agrarians face technical, financial, or institutional constraints (Fadeyi et al., 2022). Therefore, the role of green technologies should be understood within these limitations rather than assumed as universally beneficial.

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In urban and peri-urban areas such as Ibadan, Oyo State, agribusiness operators have increasingly embraced these technologies (Popoola, 2022). However, while their environmental benefits are widely acknowledged, there remains a paucity of empirical evidence on the economic implications of green technology adoption, specifically in relation to enterprise profitability (Tijani, 2022). This study seeks to bridge this gap by investigating the socio-economic characteristics of adopters, the motivations and challenges associated with adoption, and the factors influencing enterprise profit among green technology adopters in agribusiness.

Despite policy efforts and increasing awareness surrounding sustainable agriculture, green technology adoption remains uneven across Nigeria's agribusiness landscape (Ikuemonisan, 2024). More importantly, the impact of such adoption on enterprise profitability is underexplored, particularly within urban agricultural systems (Oyewole & Oyewole, 2023). While previous studies (Olawale et al., 2021; Zeng et al., 2022; Fadeyi et al., 2022; Khurshid et al., 2024) have highlighted factors such as access to information, cost of technology, and market access as influencing adoption, there is limited analysis of how these variables translate into economic performance. Without empirical insights into the factors influencing enterprise profit, stakeholders, including policymakers, practitioners, and researchers, are constrained in designing effective strategies to promote sustainable agricultural practices. This study addresses this critical knowledge gap by evaluating the drivers of profitability among green technology adopters in agribusinesses within Ibadan, Oyo State.

In this study, enterprise profitability is defined as the monetary gain generated by an agribusiness over a specified period, measured as the average quarterly enterprise profit reported by respondents. This variable reflects net income after deducting production and operating costs. Profit refers to the net income derived from agribusiness operations after deducting variable and fixed costs. This operational definition is consistent with agribusiness profitability assessments used in previous studies (Mensah et al., 2021; Oyewole & Oyewole, 2023). The general objective of this study was to assess the factors influencing enterprise profit among agribusiness green technology adopters in Ibadan, Oyo State, Nigeria. In recent years, the adoption of green technologies has gained prominence as a sustainable approach to enhancing productivity while minimising environmental degradation. However, understanding the factors that influenced enterprise profitability among adopters remains crucial for guiding policy decisions and improving business outcomes in the agricultural sector.

Specifically, the study sought to describe the socio-economic characteristics of agribusiness owners who had adopted green technologies. This included variables such as age, work experience, average quarterly enterprise profit, household size, sex, educational status, and type of agribusiness enterprise. These characteristics played significant roles in shaping adoption behaviour and profitability outcomes. The study also aimed to identify the types of green technologies adopted, such as renewable energy systems, organic farming practices, eco-friendly packaging, water-efficient irrigation, and the motivational factors that drove their use.

Furthermore, the research evaluated the key perceived factors that influenced the adoption of green technologies among agribusinesses in Ibadan. These factors included accessibility to information, cost of technology, availability of resources, government support, and market access. The study also examined the perceived benefits and challenges experienced after adoption, providing insights into how these technologies affected

operational efficiency, cost savings, and environmental performance, as well as the constraints that limited their full potential.

In addition, the study assessed the perceived impact of green technology adoption on enterprise productivity and sustainability. This analysis explored how environmentally friendly innovations contributed to improved yields, reduced waste, and long-term business resilience. Finally, the study determined the socio-economic and technological factors that influenced enterprise profit among adopters. By identifying the most significant socio-economic and adoption-related factors associated with the profitability of enterprises that use green technologies in Ibadan, Oyo State, the research provides valuable recommendations for policymakers, entrepreneurs, and development agencies aiming to promote sustainable agribusiness growth in Oyo State and beyond.

The aim of this study is to examine how selected socio-economic and adoption-related factors are associated with the profitability of enterprises that use green technologies in Ibadan, Oyo State. The study does not seek to explain all factors influencing profitability but focuses on a limited set of variables relevant to the study context.

Thus, the specific objectives are to:

1. Describe the socio-economic characteristics of agribusiness operators who use green technologies in Ibadan.
2. Identify the types of green technologies adopted and the motivations for their adoption.
3. Examine respondents' perceptions of factors influencing green technology uptake.
4. Assess the perceived benefits and challenges of green technology use.
5. Analyse how selected socio-economic and adoption-related factors are associated with enterprise profit among green technology adopters.

The following null hypotheses were tested in the course of this study:

H_{01}: There is no significant association between the selected socio-economic characteristics (age, household size, education and work experience) of agribusiness green technology adopters and their enterprise profit.

H_{02}: There is no significant association between specific green technology–related adoption factors (access to information, cost of technology, availability of resources, government support, and market access) and enterprise profit.

Thus, this study is timely and relevant in the context of growing global concerns about environmental degradation, climate change, and the sustainability of agricultural systems. The insights derived from this research contribute to the empirical literature on green technology adoption by linking it to enterprise-level economic outcomes. Identifying the factors influencing the enterprise profit among green technology adopters provides a basis for evidence-driven interventions aimed at enhancing the viability of green practices in agribusiness.

Furthermore, the findings have practical implications for a wide range of stakeholders. For policymakers, the results offer guidance on how to support green technology uptake through targeted subsidies, training programmes, and infrastructure development. For agribusiness entrepreneurs, the study highlights profitable pathways to sustainable practice. Lastly, for researchers and development practitioners, it establishes a framework for further investigations into the socio-economic and environmental benefits of green technologies in Nigeria and similar contexts.

Literature review

The concept of green technology adoption in agriculture has gained increasing attention as a response to global environmental challenges and the demand for sustainable food systems. Green technologies, such as organic fertilisers, renewable energy systems, drip irrigation, and biogas digesters, are designed to enhance productivity while minimising ecological footprints (Singh et al., 2025). According to Adolph et al. (2021), the adoption of these technologies represents a strategic shift toward sustainable intensification, which balances productivity gains with resource conservation. In Nigeria, where agriculture remains the backbone of the economy, green innovation is viewed as an essential pathway for achieving both environmental resilience and economic efficiency (Agbana, 2023). However, the adoption process is influenced by multiple socio-economic and institutional factors, including access to credit, education, training, and policy support (Ahmed & Ahmed, 2023). These influencing factors give emphasis to the interconnectedness between innovation capacity, environmental awareness, and agribusiness performance.

Empirical studies across Africa have shown that socio-economic characteristics play a pivotal role in the adoption and profitability of green technologies. For instance, Rizzo et al. (2024) found that age, farming experience, and education significantly affect farmers' willingness and ability to adopt sustainable innovations, as older and more experienced operators tend to perceive lower risks and make informed decisions. Similarly, Mendes et al. (2024) reported that farmers with higher education levels and better access to information channels exhibit greater adoption intensity and achieve higher profitability levels. Household size and gender dynamics also influence adoption behaviour, with male-headed households often having greater access to resources and decision-making autonomy (Mpiira et al., 2024). Nonetheless, recent evidence suggests a gradual increase in female participation in sustainable agribusiness, driven by empowerment initiatives and access to microcredit (Pal & Gupta, 2023). These socio-economic variables thus provide a foundation for understanding variations in profitability outcomes among adopters.

Beyond individual characteristics, institutional and market-related factors have been identified as key drivers of successful green technology adoption. Ndekwa et al. (2023) and Jayne et al. (2022) emphasised the role of information accessibility, cost of technology, and market demand in shaping adoption patterns among smallholder and medium-scale agribusinesses. Studies by Ahmadi-Gh & Bello-Pintado (2022) and Afum et al. (2023) further noted that adoption decisions are often motivated by the perceived benefits of environmental sustainability, productivity gains, and improved market competitiveness. However, the high initial investment cost, inadequate policy support, and technical complexity of some technologies remain significant barriers. According to Ukwuaba et al. (2025), the lack of structured financial incentives and poor extension service delivery in Nigeria have slowed the diffusion of eco-friendly innovations. Hence, while awareness of sustainable practices is growing, the economic viability and institutional support structures largely determine the extent to which agribusinesses can integrate green technologies into their operations.

The profitability outcomes of green technology adoption have been the subject of growing empirical investigation. Studies such as those by Ma et al. (2024) and Soomro et al. (2024) have shown that adopters experience improved yields, reduced input costs, and enhanced market access, translating into higher enterprise profitability and sustainability. Conversely, other scholars, including Akash et al. (2024), have cautioned that profitability gains are not automatic, as they depend on contextual factors such as the scale of adoption,

enterprise type, and the efficiency of technology utilisation. Mensah et al. (2021) and Abdulai (2023) observed that profitability tends to increase when adopters receive consistent training, technical guidance, and access to reliable markets. In Nigeria's evolving agribusiness landscape, the intersection between socio-economic variables, technological readiness, and institutional frameworks determines the success of green technology adoption. Therefore, understanding the factors influencing enterprise profit among green technology adopters not only provides empirical grounding for sustainable agricultural transformation but also offers actionable insights for designing targeted policies that align environmental sustainability with economic resilience.

Thus, the analytical framework of this study is based on the assumption that enterprise profitability is shaped by both the personal attributes of agribusiness operators and the conditions that enable or constrain the use of green technologies. Accordingly, the socio-economic characteristics and the green technology adoption factors included in this study have been clearly defined and applied consistently throughout the analysis to avoid ambiguity and ensure methodological coherence.

Methodology

The study was conducted in Ibadan, the capital of Oyo State in southwestern Nigeria. Ibadan is located between latitudes 7°20′ and 7°40′ N and longitudes 3°50′ and 4°10′ E. It falls within the rainforest ecological zone, characterised by a tropical wet and dry climate with an average annual rainfall of 1,200–1,300 mm and temperatures ranging from 24°C to 34°C. Ibadan is a major urban centre with a mix of rural and peri-urban communities engaged in diverse agribusiness activities, including crop production, livestock farming, agro-processing, and agri-marketing. The city provides a strategic context for studying green technology adoption due to its blend of traditional and modern agricultural practices, increasing environmental awareness, and access to agricultural innovation platforms.

The study adopted a descriptive survey research design. This design was deemed appropriate for capturing the current practices, perceptions, and experiences of agribusiness operators regarding the adoption and impact of green technologies. It enabled the collection of standardised data across a broad sample, facilitating quantitative analysis of patterns and relationships.

A multistage sampling technique was employed to select respondents. In the first stage, four (4) Local Government Areas (LGAs) were purposively selected from the eleven LGAs in Ibadan. The selection was based on two criteria: (i) the concentration of active agribusiness enterprises, and (ii) documented evidence of green technology awareness and usage, as identified in extension office records.

In the second stage, within each selected LGA, two communities with notable agribusiness activity were chosen using purposive sampling based on agribusiness density.

In the third stage, lists of registered agribusiness operators were obtained from community agricultural offices and local associations. From these lists, systematic random sampling was applied using a sampling interval determined by dividing the total number of registered operators by the required number of respondents per community. This ensured proportional representation of different agribusiness types. A total of 120 respondents were selected using this procedure.

This structured approach ensured that the sample was representative of active agribusiness operators with potential exposure to green technologies.

Primary data were collected using a structured questionnaire, which included both closed- and open-ended questions. The questionnaire was segmented into sections covering socio-economic characteristics, types and motivations for green technology adoption, perceived benefits and challenges, and enterprise profit indicators. To ensure validity and reliability, the instrument was reviewed by agricultural extension and agribusiness experts, and a pilot test was conducted with 10 respondents in a similar setting. Necessary adjustments were made before the final administration.

Descriptive statistics such as frequencies, percentages, means, and standard deviations were used to summarise respondents' characteristics, motivations, benefits, and challenges associated with green technology adoption. Inferential statistics were employed to test hypotheses and determine relationships between variables.

Perceived factors influencing green technology adoption were measured using a structured five-point Likert-type rating scale. Respondents were asked to indicate the extent to which each factor influenced their adoption of green technologies. Access to information and the cost of technology were measured using a five-point Likert-type scale ranging from low (1) to high (5), with higher scores indicating a stronger perceived influence on enterprise profit. Higher values for access to information reflect improved information flow that is expected to enhance green technology adoption and profitability, whereas higher values for technology cost indicate increased financial burden, which is expected to negatively affect profit through higher production expenses. Availability of resources and government support were assessed on a five-point scale ranging from inadequate (1) to adequate (5), such that higher scores represent greater availability of resources and stronger institutional support. These factors are a priori expected to positively influence profit by facilitating the adoption and effective utilisation of green technologies. Market access was measured on a five-point Likert-type scale ranging from difficult (1) to easy (5), capturing respondents' ease of accessing markets for products produced using green technologies. Higher scores indicate better market access, which is expected to contribute positively to enterprise profitability through improved sales opportunities. Each factor was treated as an independent explanatory variable in the regression analysis to allow assessment of its individual association with enterprise profit.

A multiple linear regression model was estimated to examine associations between enterprise profit and selected socio-economic and adoption-related variables. The adoption factors were included as separate variables (access to information, cost of technology, availability of resources, market access, and government support) rather than as a single aggregated index. This disaggregation prevents potential cancellation effects and allows clearer interpretation of each factor's contribution.

Specifically, multiple linear regression analysis was used to identify the significant factors influencing enterprise profit among agribusiness green technology adopters in Ibadan, Oyo State, Nigeria. The significance of explanatory variables was assessed at the 5% level using t-tests, while the overall model fit was evaluated using R-squared and F-statistics.

The multiple linear regression model was specified to examine the association between selected socio-economic characteristics, as well as green technology adoption-related factors and enterprise profit, defined as the average quarterly enterprise profit of agribusiness operators. The model is expressed as:

$$EP=\beta0+\beta1X1+\beta2X2+\beta3X3+\beta4X4+\beta5X5+\beta6X6+\beta7X7+\beta8X8+\beta9X9+\varepsilon \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where:
EP – Enterprise Profit, which is the dependent variable measured in monetary terms, and the explanatory variables are defined and justified as follows:
X1 – Age: Measured in years, age reflects maturity and accumulated life experience. Older agribusiness operators are expected to possess better decision-making capacity and risk management skills, which may positively influence enterprise profit.
X2 – Work Experience: Measured as years of involvement in agribusiness activities. Experience enhances managerial efficiency, resource allocation, and familiarity with production and marketing systems, making it a key determinant of enterprise performance.
X3 – Household Size: Measured as the number of persons in the household. Household size may have a dual effect on profit: larger households can provide family labour, but may also increase consumption pressure, making its net effect theoretically ambiguous.
X4 – Education: Measured by the highest level of formal education attained. Education improves cognitive skills, access to information, and the ability to adopt and effectively use new technologies, thereby potentially enhancing enterprise profitability.
X5 – Access to Information: Measured using a five-point Likert-type scale reflecting respondents' access to extension services, training, and market information. Better access to information facilitates informed decision-making and efficient use of green technologies.
X6 – Cost of Technology: Measured on a five-point Likert-type scale capturing respondents' perceptions of the cost burden associated with green technologies. High technology costs may reduce profit by increasing production expenses and limiting adoption intensity.
X7 – Availability of Resources: Measured on a five-point Likert-type scale reflecting the adequacy of inputs, infrastructure, and complementary resources required for green technology adoption. Adequate resources are expected to enhance productivity and profitability.
X8 – Government Support: Measured using a five-point Likert-type scale capturing perceptions of policy support, subsidies, and institutional assistance. Government support can reduce adoption barriers and improve enterprise outcomes.
X9 – Market Access: Measured on a five-point Likert-type scale reflecting the ease of accessing output markets. Improved market access enhances sales opportunities, price realisation, and ultimately enterprise profit.

In the model, β represents the regression coefficients that measure the magnitude and direction of the effect of each explanatory variable (X_1–X_9) on enterprise profit (EP), with β_0 as the intercept and ε as the error term that captures the effects of unobserved factors not explicitly included in the model but which may influence enterprise profit.

It is a priori expected that enterprise profit is influenced by both socio-economic characteristics and factors related to green technology adoption. Age and work experience are anticipated to positively affect profit through accumulated knowledge and managerial skills, while education enhances decision-making capacity. Household size may either provide additional labour or increase the financial burden. Among green technology-related factors, access to information, resource availability, government support, and market access are expected to positively influence profit by facilitating adoption and business operations, whereas high technology costs may negatively affect profit by raising production expenses. Overall, both sets of factors are hypothesised to significantly determine enterprise profitability.

The chosen set of independent variables reflects a balance between explanatory relevance and model adequacy. Previous empirical studies (Olawale et al., 2021; Mustapha et al., 2023) have used similar socio-economic indicators to explain variability in agribusiness income and technology-related performance. Given the study's focus on selected factors rather than an exhaustive determination of profitability, the selected variables provide an analytically coherent framework for exploring associations within the study context.

All quantitative analyses, including descriptive statistics and regression modelling, were conducted using Statistical Package for the Social Sciences (SPSS) version 26.

Results and Discussion

Table 1 presents the socio-economic profile of agribusiness green technology adopters in Ibadan. The average age of respondents was 49.1 years, with the majority (56.6%) aged between 36 and 50 years, indicating that green technology adopters are primarily middle-aged and likely to be economically active. Most respondents had 6–10 years of agribusiness experience (68.3%), with a mean of 7.6 years, suggesting moderate exposure to agricultural practices and innovation. The mean household size was 6 persons, and over three-quarters (77.5%) had households larger than four, which could potentially affect labour availability and household-level decision-making.

Table 1. Socio-economic characteristics of respondents

Socio-Economic Characteristics of Respondents		Frequency	Percentage
Age of Green Technology Adopter in Agribusiness (Years); Mean = 49.1 Years	<=35	8	6.7
	36 – 50	68	56.6
	>50	44	36.7
Work Experience (Years); Mean = 7.6 Years	<=5	24	20.0
	6 – 10	82	68.3
	>10	14	11.7
Average Quarterly Enterprise Profit (Naira); Mean = ₦ 486,500	<=350,000	39	32.5
	350,001 - 500,000	48	40.0
	>500,000	33	27.5
Household Size; Mean = 6 Persons	<=4	27	22.5
	>4	93	77.5
Sex of Green Technology Adopters in Agribusiness	Male	63	52.5
	Female	57	47.5
Educational Status of Green Technology Adopters in Agribusiness	No Formal Education	3	2.5
	Primary	26	21.7
	Secondary	61	50.8
	Tertiary	30	25.0
Type of Agribusiness Enterprise of Green Technology Adopters in Agribusiness	Crop Production	88	73.3
	Livestock Farming	100	83.3
	Agro-Processing	13	10.8
	Agri-Marketing	82	68.3
	Others	2	1.7

Sources: Authors' computation, 2025.

In terms of income, the average quarterly enterprise profit was ₦486,500, with 40% earning between ₦350,001 and ₦500,000. Males constituted a slight majority (52.5%), while the educational background was relatively high, with 75.8% having at least a secondary education. In terms of agribusiness types, livestock farming (83.3%), crop production (73.3%), and agri-marketing (68.3%) were the most common, while agro-processing (10.8%) and others (1.7%) were less represented. These results indicate a diverse but livestock-leaning agribusiness landscape among green technology adopters.

Types of Green Technologies Adopted and Motivational Factors

As shown in Table 2, organic fertilisers (75.0%) and biogas systems (58.3%) were the most widely adopted green technologies, followed by drip irrigation (45.8%) and renewable energy (43.3%). This preference reflects the practical relevance and increasing accessibility of these technologies for productivity enhancement and environmental conservation. Solar dryers and other technologies had lower adoption rates.

Table 2. Types of adopted green technologies and motivational factors for adoption

Variables		Frequency	Percentage
Adopted green technologies	Solar Dryers	26	21.7
	Organic Fertilisers	90	75.0
	Drip Water-Efficient Irrigation	55	45.8
	Renewable Energy	52	43.3
	Biogas Systems	70	58.3
	Others (eco-friendly packaging)	16	13.3
Motivation to adopt green technologies	Environmental Sustainability	85	70.8
	Cost Efficiency	43	35.8
	Government Policies	30	25.0
	Market Demand	81	67.5
	Others	7	5.8

Source: Authors' computation, 2025.

Motivational factors for adoption were led by environmental sustainability (70.8%) and market demand (67.5%), while cost efficiency (35.8%) and government policies (25.0%) were less influential. These findings align with the hypothesis that ecological consciousness and market-driven forces are primary motivators for green technology adoption in agribusiness.

Perceived Factors Influencing Green Technology Adoption

Table 3 shows that access to information recorded the highest mean score (Mean = 4.21), indicating a high level of information availability and a strong influence on green technology adoption among agribusiness operators. The cost of technology also had a high mean value (Mean = 4.19), suggesting that the high cost of acquiring and maintaining green technologies strongly influences adoption decisions. Availability of resources followed with a mean score of 4.03, reflecting respondents' perception that essential resources for green technology adoption are largely inadequate, thereby constituting a notable constraint.

Table 3. Perceived factors influencing green technology adoption

Perceived Factors	Mean	Interpretation of Mean Value
Access to Information	4.21	High level of access to information, indicating strong influence on green technology adoption
Cost of Technology	4.19	High cost of technology perceived to strongly influence adoption decisions
Availability of Resources	4.03	Resources perceived as largely inadequate, indicating notable constraints to adoption
Government Support	3.52	Government support perceived as moderately inadequate
Market Access	3.43	Market access perceived as moderately difficult

Note: Mean values were computed from a five-point Likert-type scale. For access to information and the cost of technology, higher values indicate a stronger influence. For availability of resources and government support, higher values indicate greater perceived inadequacy. For market access, higher values indicate greater difficulty.

Source: Author's computation, 2025.

In contrast, government support (Mean = 3.52) and market access (Mean = 3.43) recorded relatively lower mean values, indicating that government support is perceived as moderately inadequate and market access as moderately difficult. Overall, these results suggest that while information access plays a facilitating role, financial and resource-related constraints—particularly high technology costs and inadequate resources—pose significant barriers to green technology adoption. These findings are consistent with earlier studies by Arowosegbe et al. (2024) and Ifeanyi-Obi et al. (2022), which emphasise the importance of effective extension services and improved financial access in promoting the diffusion of agricultural technologies.

Benefits and Challenges of Green Technology Adoption

As shown in Table 4, increased productivity (66.7%) and improved market access (57.5%) were the most cited perceived benefits, followed by cost reduction (51.7%) and environmental protection (45.0%). These outcomes suggest a multi-dimensional gain from green technology adoption, supporting findings by Bello et al. (2021), who reported similar productivity and market improvements among adopters in southwestern Nigeria.

Table 4. Perceived benefits experienced after adopting green technologies

Perceived benefits experienced	Frequency	Percentage
Increased Productivity	80	66.7
Improved Market Access	69	57.5
Reduced Costs	62	51.7
Environmental Protection	54	45.0
Others	29	24.2

Note: Multiple responses.

Source: Author's computation, 2025.

Perceived Challenges Experienced After Adopting Green Technologies

However, some perceived challenges remained. As shown in Table 5, technical complexity (74.2%) and high costs (62.5%) were identified as the most prominent obstacles to the adoption of green technologies. Inadequate support (27.5%) and lack of awareness (16.7%) were also reported by respondents. These constraints emphasise the need for continuous capacity-building initiatives, cost-sharing mechanisms, and targeted awareness campaigns to promote wider adoption and effective utilisation of green technologies among agribusiness enterprises.

Table 5. Perceived challenges experienced after adopting green technologies

Perceived challenges experienced	Frequency	Percentage
Technical Complexity	89	74.2
High Cost	75	62.5
Inadequate Support	33	27.5
Lack of Awareness	20	16.7
Others	49	40.8

Note: Multiple responses.

Source: Author's computation, 2025.

Perceived Impact on Enterprise Productivity and Sustainability

Table 6 shows that the majority (83.2%) of respondents perceived and reported improved enterprise productivity and sustainability following the adoption of green technologies. A smaller proportion (15.1%) indicated slight improvement, while only a marginal 1.7% reported no improvement. These findings highlight the transformative potential of green innovations in enhancing agribusiness performance, operational efficiency, and long-term sustainability.

Table 6. Perceived impact of green technology adoption on enterprise productivity and sustainability

Impact Level	Frequency	Percentage
Not Improved	2	1.7
Slightly Improved	18	15.1
Improved	99	83.2

Source: Author's computation, 2025.

To provide clearer insight into the profitability levels used as the dependent variable in the regression model, Figure 1 presents the distribution of average quarterly enterprise profit among respondents.

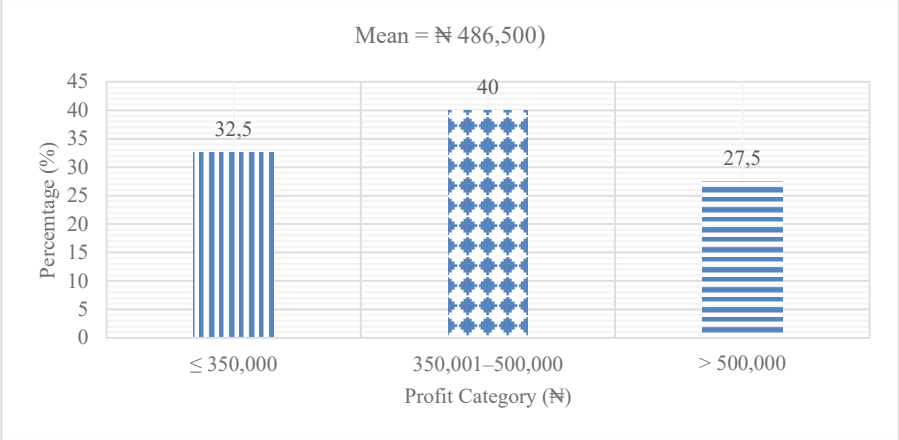

Fig. 1. Distribution of quarterly enterprise profit among respondents

Source: Author's computation, 2025.

Factors Influencing Enterprise Profit among Green Technology Adopters in Agribusiness

The regression results presented in Table 7 show that the model provides a reasonably good fit to the data, with an R^2 value of 0.421, indicating that approximately 42.1% of the variation in average quarterly enterprise profit among green technology adopters is explained by the included socio-economic and adoption-related variables. The F-statistic (F = 8.796) is statistically significant, confirming the overall validity of the model. This suggests that the selected variables jointly provide meaningful explanatory power, although a substantial proportion of profit variation remains attributable to factors outside the scope of the study, such as enterprise scale, capital intensity, and market volatility.

Among the socio-economic variables, age has a positive and statistically significant effect on enterprise profit ($\beta = 0.071$, $p = 0.001$). This finding implies that older agribusiness operators tend to earn higher profits, likely due to accumulated experience, better risk management, and stronger social and market networks. This result is consistent with the findings of Rizzo et al. (2024) and Mustapha et al. (2023), who reported that age is positively associated with managerial competence and enterprise performance in agribusiness contexts.

Similarly, work experience shows a strong positive and highly significant relationship with enterprise profit ($\beta = 0.329$, $p < 0.001$). This indicates that years of engagement in agribusiness substantially enhance profitability, reflecting improved technical knowledge, operational efficiency, and decision-making capacity. This finding aligns with previous studies by Mensah et al. (2021) and Abdulai (2023), which emphasise experience as a critical driver of productivity and profitability in agricultural enterprises.

In contrast, household size has a negative but statistically insignificant effect on enterprise profit ($\beta = -0.047$, $p = 0.711$). This suggests that household size does not play a decisive role in determining profitability among green technology adopters in the study area. The result may reflect a balance between potential family labour contributions and increased consumption pressure, leading to a neutral net effect. Similar inconclusive effects of

household size have been reported in related agribusiness profitability studies (Mpiira et al., 2024).

Educational status exhibits a positive but statistically insignificant relationship with enterprise profit ($\beta = 0.254$, $p = 0.254$). While education is theoretically expected to enhance technology adoption and managerial capacity, its lack of statistical significance in this model suggests that formal education alone may not translate directly into higher profits without complementary factors such as access to capital, extension services, and markets. This finding supports observations by Olawale et al. (2021) and Oyewole and Oyewole (2023), who argue that education improves adoption propensity but does not always guarantee profitability gains.

Regarding adoption-related factors, access to information shows a negative and statistically significant coefficient ($\beta = -0.249$, $p = 0.001$). Given the scale direction used in this study—where higher values reflect stronger influence—this result suggests that inadequate or costly access to information may reduce enterprise profit. It highlights that the mere availability of information is insufficient; the quality, relevance, and timeliness of information are critical for profitable technology use. This finding reinforces the arguments of Arowosegbe et al. (2024) and Ifeanyi-Obi et al. (2022), who stress that ineffective extension systems can limit the economic benefits of agricultural innovations.

Cost of technology has a positive and statistically significant coefficient ($\beta = 0.250$, $p < 0.001$). Given that higher scores represent greater cost influence, this result implies that technology cost plays a decisive role in shaping profitability outcomes. High costs may restrict adoption intensity or divert resources from other productive investments, thereby affecting net returns. This outcome aligns with Fadeyi et al. (2022) and Ukwuaba et al. (2025), who identified cost as a major barrier to profitable adoption of green technologies in Nigeria.

Availability of resources has a negative and statistically significant effect on enterprise profit ($\beta = -0.219$, $p = 0.043$). Since higher values indicate greater perceived inadequacy, this finding suggests that insufficient inputs, infrastructure, and complementary resources constrain the profitability of green technology adoption. This result calls attention to the importance of resource availability for translating technological adoption into economic gains, consistent with findings by Ndekwa et al. (2023) and Jayne et al. (2022).

Conversely, government support exerts a positive and statistically significant influence on enterprise profit ($\beta = 0.216$, $p = 0.037$). This indicates that policies, subsidies, and institutional assistance play an enabling role in enhancing the profitability of agribusinesses adopting green technologies. This finding corroborates earlier evidence from Ahmed and Ahmed (2023) and Ikuemonisan (2024), who emphasise the importance of supportive policy frameworks in promoting sustainable agribusiness performance.

Finally, market access shows a positive and statistically significant relationship with enterprise profit ($\beta = 0.173$, $p = 0.001$). This suggests that easier access to output markets enhances revenue generation and price realisation, thereby improving profitability. Improved market access enables adopters to capture value from green technologies, especially where consumers reward environmentally friendly production. This result is consistent with Ma et al. (2024) and Soomro et al. (2024), who highlight market linkages as a key channel through which technology adoption translates into economic benefits.

Therefore, since some socio-economic characteristics (age and work experience) significantly influence enterprise profit while others (household size and education) do not, the null hypothesis (H_{01}) is partially rejected. This indicates that selected socio-economic

characteristics matter, but their effects are not uniform. Also, given that multiple adoption-related factors significantly affect enterprise profit, the null hypothesis (H_{02}) is rejected.

Overall, the results indicate that profitability among green technology adopters is shaped by a combination of human capital attributes—particularly age and work experience—and adoption-enabling institutional and market conditions, rather than by technology adoption alone. While green technologies offer potential productivity and environmental benefits, their translation into higher enterprise profit depends critically on affordable technology costs, effective access to relevant information, adequate supporting resources, government support, and accessible markets. Experience and maturity enhance managerial efficiency and decision-making, but without complementary infrastructure and institutional backing, the economic gains from green technology adoption remain constrained. These findings highlight the need for integrated policy and development strategies that go beyond the promotion of green technologies to address underlying structural, financial, and market-related constraints, thereby supporting both profitable and sustainable agribusiness practices.

Table 7. Factors influencing enterprise profit among green technology adopters in agribusiness

Variables	β	t	Sig.
(Constant)	-1.425	-0.931	0.354
Age of Green Technology Adopters in Agribusiness (Years)	0.071	3.507	0.001
Work Experience of Green Technology Adopters in Agribusiness (Years)	0.329	5.381	0.000
Household Size of Green Technology Adopters in Agribusiness (Persons)	-0.047	-0.372	0.711
Educational Status of Green Technology Adopters in Agribusiness	0.254	1.148	0.254
Access to Information	-0.249	-1.516	0.001
Cost of Technology	0.250	1.194	0.000
Availability of Resources	-0.219	-1.124	0.043
Government Support	0.216	1.522	0.037
Market Access	0.173	1.340	0.001
R value		0.649	
R Square		0.421	
Adjusted R Square		0.373	
F value		8.796	

Dependent Variable: Average Quarterly Enterprise Profit of Green Technology Adopters in Agribusiness (per ₦100,000).

Source: Author's computation, 2025.

Thus, the findings of this study have important theoretical implications for agri-environmental systems sustainability and development management. The significant influence of age, work experience, and adoption-related factors on enterprise profit reinforces innovation diffusion and human capital theories, which posit that knowledge, experience, and access to information enhance technology uptake and enterprise performance. The high adoption of organic fertilisers and biogas systems calls attention to the integration of ecological modernisation principles into agribusiness operations, where environmental consciousness aligns with economic objectives. Moreover, the link between information

accessibility and adoption effectiveness expands the theoretical understanding of how socio-economic variables interact with environmental innovations to drive sustainable development in rural agri-food systems.

From a practical and policy standpoint, the results suggest that enhancing agri-environmental sustainability requires multifaceted interventions that improve access to affordable green technologies, strengthen extension systems, and incentivise environmentally responsible practices. Policymakers should design targeted subsidies, training programmes, and market incentives to reduce the technical and financial barriers identified, especially for small-scale operators. Practitioners and agribusiness managers must integrate sustainability-driven innovations into business models to achieve profitability and resilience in the face of climate and market shocks. In the broader context of rural development, these findings advocate for institutional collaboration that links technology providers, financial institutions, and extension agencies to promote a circular, inclusive, and sustainable agri-food economy.

While the findings provide useful insights into the profitability of agribusinesses adopting green technologies in Ibadan, they should not be generalised to other regions of Nigeria or beyond. The study focuses on a specific urban–peri-urban context with unique socio-economic and environmental characteristics. Broader generalisations would require multi-regional or nationally representative studies.

Conclusion and Recommendations

The study examined the socio-economic characteristics, types of adopted green technologies, motivational factors, perceived benefits and challenges, and the factors influencing enterprise profit among green technology adopters in agribusiness.

The findings revealed that a majority of adopters were middle-aged, with substantial work experience, and household sizes exceeding four members. Both male and female entrepreneurs participated almost equally, with the majority having at least a secondary education. Crop production and livestock farming were the most common agribusiness enterprises adopting green technologies.

In terms of technology adoption, organic fertilisers, biogas systems, and drip water-efficient irrigation were widely embraced, primarily motivated by environmental sustainability and market demand. Respondents perceived access to information and the cost of technology as the most significant factors influencing adoption, while availability of resources, government support, and market access were identified as moderate constraints. After adoption, enterprise owners reported notable benefits, particularly increased productivity, improved market access, and reduced operational costs. However, technical complexity, high cost, and inadequate support were key challenges faced by adopters. Notably, the majority of respondents indicated that green technology adoption led to measurable improvements in enterprise productivity and sustainability.

Regression analysis further highlighted that socio-economic characteristics and green technology adoption-related factors significantly influenced enterprise profit. Specifically, age, work experience, cost of technology, government support, and market access had significant positive impacts, whereas access to information and resource inadequacy exerted negative influences. Household size and educational status, however, showed no significant effect. Overall, the study calls attention to green technology adoption, which, when supported

by favourable socio-economic conditions, policy frameworks, and resource accessibility, can enhance profitability and sustainability in agribusiness.

However, the study does not capture all possible factors influencing profitability, and many external factors remain unaccounted for. Given the study's limitations, these results should be interpreted with caution and restricted to the specific context of agribusiness enterprises in Ibadan. These results affirm the relevance of green technologies in enhancing agribusiness performance, but also point to systemic gaps in support, capacity building, and affordability that require policy and institutional attention.

This study is limited by its sample size (120 respondents) and by its focus on four purposively selected LGAs in Ibadan. As a result, findings cannot be generalised beyond the study area. In addition, the cross-sectional design does not allow causal inference; the results reflect associations only. Some relevant factors influencing profitability—such as enterprise scale, capital investment, market volatility, and managerial capacity—were not measured, which limits the comprehensiveness of the model. These limitations should be considered when interpreting the findings.

Based on the findings, some policy measures are recommended to promote green technology adoption and enhance agribusiness profitability:

1. Enhance Access to Information and Awareness Campaigns: Extension services, agricultural agencies, and private sector actors should intensify outreach programmes to educate farmers about the benefits, usage, and cost-effectiveness of green technologies. Improved awareness will help reduce misinformation and foster adoption.
2. Financial Incentives and Subsidies: Policymakers should consider providing subsidies, low-interest loans, or grants for green technology adoption. Given that high technology costs remain a critical barrier, such financial interventions can incentivise more agribusiness entrepreneurs to adopt sustainable solutions.
3. Strengthen Government Support and Infrastructure: There is a need for robust government support, including the provision of technical assistance, resource facilitation, and supportive policies that encourage investment in green technologies. This includes improving market access through better infrastructure, storage facilities, and linkages to local and international markets.
4. Capacity Building and Technical Training: Since technical complexity is a major challenge, specialised training programmes should be implemented to equip agribusiness entrepreneurs with the skills needed to operate, maintain, and optimise green technologies.
5. Promotion of Sustainable Practices: Policymakers should integrate green technology adoption into broader agricultural and environmental sustainability strategies. Encouraging eco-friendly practices can simultaneously boost productivity, profitability, and environmental conservation.
6. Monitoring and Evaluation: Continuous monitoring of adopted green technologies and their impacts on productivity and profitability is essential. Data-driven evaluation can guide future interventions and ensure the sustainability of technology adoption programmes.

In brief, this study emphasises that the profitability and sustainability of agribusiness enterprises can be significantly enhanced through strategic adoption of green technologies, provided that the necessary socio-economic, policy, and resource conditions are established and maintained. The adoption of green technologies is not only economically viable but also critical for environmental sustainability and long-term resilience in the agricultural sector.

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