ID: 824

Adoption of Improved Technologies amongst Plantain Farmers in Bayelsa State

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Abstract

Despite the economic significance of plantain and the availability of yield-enhancing technologies, productivity remains low due to limited adoption of technologies. This study examined the factors affecting plantain farmers' use of improved technologies in Bayelsa State, Nigeria. The study specifically described farmers' socio-economic characteristics, identified technologies available and used, examined the level of adoption, analyzed factors influencing the use of technologies, and identified constraints. A multi-stage sampling technique was used to select 100 plantain farmers, from whom primary data were collected using a structured questionnaire. Data were analyzed using descriptive statistics and a logistic regression model. The results revealed a predominantly female (70%), middle-aged (mean=45 years), and reasonably educated farming population (mean =14 years), operating small-scale farms (mean=2.1 ha) with limited access to credit (27%) and extension services (25%). While awareness of technologies (92%) was high, adoption was highest for low-cost practices (mulching: 81%) and lowest for capital-intensive ones (tissue culture: 12%). The regression analysis identified education, farm size, access to credit, and extension services as significant positive drivers of adoption, while older age, high perceived cost, and complexity were significant negative barriers. The major constraints were high input cost (85%), inadequate extension support (75%), and lack of credit access (73%). The study concludes that technology adoption in Bayelsa State is influenced by a complex mix of socioeconomic, institutional, and perceptual factors. It is recommended that policy interventions focus on providing input subsidies, improving access to credit, and revitalizing agricultural extension services. Extension agencies should promote farmer-centric low-cost technologies and leverage farmer cooperatives for effective dissemination. Addressing these barriers is crucial for enhancing technology adoption, improving plantain productivity, and ensuring sustainable agricultural development in the region.

Keywords: *adoption; improved technologies; plantain farmers; logistic regression; Bayelsa State*

Introduction

Agricultural transformation remains a critical pathway for economic growth, food security, and poverty reduction in Nigeria. Among the staple crops that contribute significantly to livelihoods and nutritional security in Southern Nigeria is plantain (*Musa paradisiaca*). Plantain is a vital food crop and income generator for rural households, particularly in the humid forest zones of Nigeria, including Bayelsa State. It serves both as a staple food and a cash crop, with its demand increasing in urban and peri-urban markets (Nwaobiala & Chikaire, 2020). Despite its importance, the productivity of plantain remains below potential due to a combination of socio-economic, institutional, and technical constraints.

According to Jimmy et al., (2026), although plantain has a huge export potential, Nigeria has not met the demand for local consumption, making domestic demand for plantain very high, with supply struggling to meet demand thus making the crop a highly sort after commodity in our markets. They further opined that even though Nigeria has vase land for the cultivation of plantain, depending on land area alone for higher production is not sustainable because of other competing crops, and needs such as urbanization, hence the need for the use of improved technologies. Although Nigeria still ranks top in terms of plantain production in Africa, the yield per hectare of plantain is low compared to that of other neighbouring countries like Ghana and Cameroun (Jimmy et al., 2026)

In response to low productivity and post-harvest losses, agricultural researchers and development organizations have promoted a variety of improved technologies, including hybrid cultivars, sucker treatment techniques, mulch application, improved spacing, organic and inorganic fertilization, and post-harvest handling technologies (Okoro et al., 2021). These technologies aim to enhance plant health, increase yields, and boost market competitiveness. However, the adoption and sustained use of these technologies among plantain farmers have been relatively limited and inconsistent in many parts of Nigeria, especially in the Niger Delta region.

Bayelsa State is blessed with fertile alluvial soils and suitable climatic conditions for plantain cultivation. The area plays a significant role in local food systems and provides employment opportunities through smallholder plantain farming. Yet, the full benefits of improved technologies have not been realized due to varying levels of adoption among farmers. Factors such as age, gender, education, farm size, extension contact, credit access, and market access influence technology choice and adoption (Onu & Madukwe, 2020; Nwachukwu et al., 2022).

Proper knowledge of the factors affecting farmers' decision to adopt improved technologies is therefore essential for designing appropriate interventions that are context-specific and farmer-friendly. A better understanding of these determinants will not only enhance the adoption process but also contribute to sustainable agricultural productivity and food security in the region (Akinbile et al., 2021). This research will focus on the socio-economic, institutional, and technological factors influencing plantain farmers' choices and adoption of improved agricultural technologies in Bayelsa State.

Despite the recognized potential of plantain as a staple crop and its economic significance, farmers continue to experience low yields, high post-harvest losses, and market constraints. Several improved agricultural technologies have been introduced to address these challenges, but their adoption remains limited and inconsistent among smallholder plantain farmers. This disparity raises critical questions regarding what influences farmers' choices and the uptake of these innovations.

In Bayelsa State, many farmers rely on traditional practices which often result in low productivity, increased vulnerability to pests and diseases, and inefficient resource utilization (Ugbomeh & Modebelu, 2023). Although technologies such as improved cultivars, sucker treatment, composting, and modern spacing techniques have proven to be effective, their low usage suggests the presence of barriers to adoption.

Previous studies like that of Okoye et al., (2020); Ibeawuchi et al., (2022) have suggested that variables such as limited access to credit, inadequate extension services, low literacy levels, land tenure issues, and cultural practices play vital roles in influencing technology adoption. Jimmy et al., (2026), compared the efficiencies between adopters and non-adopters of improved technologies by plantain farmers in South- South, Nigeria. However, this study differs significantly from the earlier study by Jimmy et al; 2026 because this study examined only 9 technologies, and was carried out solely in Bayelsa State. In reference to the above, there is a paucity of localized data specifically targeting plantain farmers in Bayelsa State, necessitating empirical investigation.

The broad objective of this study was to examine the factors affecting plantain farmers' use of improved agricultural technologies in Bayelsa State, Nigeria.

Specifically, the study seeks to identify the types of improved agricultural technologies available and used by plantain farmers; examine the level of adoption of improved agricultural technologies among plantain farmers; analyze the factors influencing farmers' adoption of improved technologies; and identify the constraints hindering the adoption of improved plantain production technologies in the study area. The study was guided by the null hypothesis: socioeconomic characteristics do not significantly influence plantain farmers' use of improved agricultural technologies in Bayelsa State

Materials and Method

This study was conducted in Bayelsa State, situated in the South-South region of Nigeria, geographically located within the tropical rainforest zone and is characterized by a humid climate, high rainfall (2,500–4,000 mm annually), and average temperatures ranging from 24°C to 32°C, which provide favourable agro ecological conditions for plantain cultivation (NiMet, 2023). Bayelsa is located at Latitude 4^0 15' North and 5^0 15' South and Longitude 5^0 22' West and 6^0 45' East, bounded in the West and South by the Atlantic Ocean, bounded by the East by River State and the North by Delta State.

The people are predominantly of Ijaw ethnic origin and depend heavily on farming and fishing for livelihood. Plantain is a major crop cultivated across the State. Serving both as a staple food and income-generating commodity.

This study adopted a multi-stage random sampling technique. In the first stage 4 Local Government Areas (LGAs) were randomly selected from the 8 LGAs of the State. The selected Local government area were Yenagoa, Southern Ijaw, Ogbia and Sagbama LGAs. The second stage involved the random selection of 5 communities from each of the LGAs making a total of 20 communities. The final stage involved the random selection of 5 plantain farmers from each of the selected communities making a total of 100 plantain farmers for the study. The sample frame for this study was gotten from registered plantain farmers list from Bayelsa Agricultural Development Programme (BSADP). Random selection was done using the lottery method to ensure that all LGAs, communities and farmers have equal chances of being sampled. The study relied on primary data, which were collected through the use of a structured questionnaire designed to capture the key variables in the study objectives and hypotheses. The questionnaire included both closed and open-ended questions and was organized into sections.

Table 1 Summary of Sampling Procedure

LGAs in Bayelsa State	*Randomly selected LGAs*	*Randomly selected communities*	*Randomly selected farmers (5 per Comm)*
Yenagoa	Yenagoa	Beseni, Akaibiri, Akaba Ikolo Agudama- Ekpetiama	25
Sagbama	Sagbama	Ofoni, Ebedebiri, Trofani, Adagbabiri Bulu-Orua	25
Southern Ijaw	Southern Ijaw	Korokosei, Otuan, Peremabiri, Amassoma Ayama	25
Brass	Brass	Odioma, Sangana, Okpoama, Twon-Brass, Olodiama	25
Nembe			
Kolokuma/Opokuma			
Ekeremor			
Ogbia			
8 LGAs	4 LGAs	20 communities	100 farmers

Data collected were analyzed using both descriptive and inferential statistical techniques. Frequencies, percentages, means, and standard deviations were used to summarize socio-economic characteristics of plantain farmers, identify the types of improved plantain technologies available and used, assessed the levels of adoption and identify constraints to adoption.

Binary logistic regression analysis was used to examine the determinants of farmers' adoption of improved technologies. Logistic regression is appropriate when the dependent variable is binary, i.e., whether or not a farmer adopted improved technologies.

Logistic Model Equation:

$$Logit\ (P) = In\ \left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k + \varepsilon \quad \text{---------- (1)}$$

Where:

- P = Probability that a farmer adopts improved plantain technologies
- $\left(\frac{P}{1-P}\right)$ = Odds ratio of adoption
- ln= Natural logarithm

Dependent Variable (Y):

- Adoption of improved technology
  - 1 = Adopter
  - 0 = Non-Adopter
- β_0 = Intercept
- $\beta_1 \ldots \beta_k$ = Coefficients of the independent variables
- $X_1 \ldots X_k$ = Independent variables
- ε = Error term

Table 2. Independent Variables (X):

Variable	*Code*	*Measurement*
Age of farmer	X_1	Years
Gender	X_2	1 = Male, 0 = Female
Marital status	X_3	1 = Married, 0 = Otherwise
Educational level	X_4	Years of formal education
Farming experience	X_5	Years
Household size	X_6	Number of persons
Farm size	X_7	Hectares
Access to credit	X_8	1 = Yes, 0 = No
Access to extension services	X_9	1 = Yes, 0 = No
Membership of cooperative	X_{10}	1 = Yes, 0 = No
Perceived cost of technology	X_{11}	1 = High, 0 = Low
Compatibility with current practices	X_{12}	1 = Compatible, 0 = Not Compatible
Relative advantage	X_{13}	1 = Perceived as better, 0 = Not better
Complexity	X_{14}	1 = Complex, 0 = Simple

Results and Discussion

Socio-economic characteristics of Plantain Farmers

The results on Table 3 reveals that the typical plantain farmer in Bayelsa State is a middle-aged female, married with secondary education, over 20 years of farming experience, and manages a small-scale farm of about 2 hectares. There is limited access to cooperatives, credit, and extension services. Specifically, 70% of respondents were female, with a mean age of 44.8 years. A large majority (75%) were married and had an average household size of 7 members. Educationally, most farmers were literate, with 52% having secondary education and 34% possessing tertiary education. The farmers were highly experienced, averaging 21.5 years in plantain cultivation. The average farm size was 2.1 hectares, classifying the majority (64%) as smallholders. Critically, access to institutional support was low: only 22% were in cooperatives, 27% had access to credit, and a mere 25% had contact with extension services.

The dominance of women in plantain farming aligns with their significant role in food production and post-harvest activities in Southern Nigeria, where they are often central to subsistence and small-scale commercial agriculture (Okello et al., 2020). The reasonably high literacy level is a positive finding, as education enhances the ability to understand and apply technical information related to new technologies (Sheahan & Barrett, 2017). However, the limited access to cooperatives, credit, and extension services represents a significant bottleneck. This institutional weakness has been identified as a major impediment to agricultural development in the Niger Delta region, as it limits farmers' exposure to innovations and their capacity to finance them (Ogunlade et al., 2020; Okoroafor & Akpan, 2021).

Table 3: Socio-economic Characteristics of Respondents (n=100)

Variable	*Category*	*Frequency*	*Percentage (%)*	*Mean*	*Std. Deviation*
Sex	Male	30	30.0	-	-
	Female	70	70.0	-	-
Age (Years)	Youth (18-35)	23	23.0	44.8	15.7
	Middle-aged (36-55)	52	52.0		
	Elderly (>55)	25	25.0		
Marital Status	Single	17	17.0	-	-
	Married	75	75.0	-	-
	Widowed/Divorced	8	8.0	-	-
Level of Education	No Formal Education	6	6.0	-	-
	Primary Education	8	8.0	-	-
	Secondary Education	52	52.0	-	-
	Tertiary Education	34	34.0	-	-
Household Size	1-5 members	37	37.0	7.2	3.1
	6-10 members	52	52.0		
	>10 members	11	11.0		
Farming Experience (Years)	1-10 years	30	30.0	21.5	13.4
	11-20 years	24	24.0		
	>20 years	46	46.0		
Farm Size (Hectares)	Small (<2 Ha)	64	64.0	2.1	1.3
	Medium (2-5 Ha)	33	33.0		
	Large (>5 Ha)	3	3.0		
Membership in Cooperative	Yes	22	22.0	-	-
	No	78	78.0	-	-
Access to Credit	Yes	27	27.0	-	-
	No	73	73.0	-	-
Access to Extension	Yes	25	25.0	-	-
	No	75	75.0	-	-

Source: Field Survey Data, 2025

Awareness and Adoption of Improved Plantain Technologies Used by Plantain Farmers

Awareness of various improved technologies was generally high. Awareness of technologies like mulching, spacing, and fertilizer use is high (>85%). However, adoption is highest for low-cost, low-risk practices like mulching (81%) and spacing (76%), and lowest for capital or skill-intensive technologies like tissue culture (12%) and post-harvest processing (32%).

Over 85% of farmers were aware of mulching, proper spacing, and the use of organic and inorganic fertilizers. However, awareness dropped for more modern technologies like tissue culture plantlets (45%). A clear disparity between awareness and adoption was observed. Low-cost, less complex practices like mulching (81% adoption) and proper spacing (76% adoption) saw the highest uptake. In contrast, technologies requiring significant capital or technical knowledge, such as tissue culture plantlets (12%) and post-harvest processing techniques (32%), had the lowest adoption rates.

The high awareness levels for certain technologies suggest that previous extension efforts and farmer-to-farmer knowledge transfer have been somewhat successful. However, the stark gap between awareness and adoption, particularly for capital-intensive technologies, underscores the influence of economic and technical barriers. This pattern is consistent with the findings of Mwangi and Kariuki (2019), who noted that in sub-Saharan Africa, the adoption of complex or expensive innovations often lags behind awareness due to financial constraints and perceived risks. The high adoption of mulching and spacing reflects their compatibility with existing practices and low initial cost, making them more accessible to resource-constrained smallholders.

Table 4 Awareness and Adoption of Improved Plantain Technologies (n=100)

Technology	*Awareness* Frequency (%)*	*Adoption* Frequency (%)*
Improved plantain varieties (e.g., PITA)	68	45
Treated suckers	75	38
Organic manure/compost	88	72
NPK/Inorganic fertilizers	85	55
Mulching techniques	92	81
Proper spacing	89	76
Pest and disease control measures	79	49
Post-harvest processing techniques	71	32
Tissue culture plantlets	45	12

Source: Field Survey Data, 2025 *multiple responses observed

Examined levels of adoption of improved agricultural technologies among Plantain farmers

According to the results presented in Table 5, the study classified farmers into four adoption categories. Only 11% were non-adopters, while 29% were low adopters (using 1-2 technologies). The largest group was medium adopters (42%), who used 3-5 technologies. A notable 18% of farmers were high adopters, having integrated more than five improved technologies into their farming systems.

This distribution indicates a promising trend where the majority of farmers (59%) are medium to high adopters. This suggests a general willingness to innovate within the farming community. However, the fact that 40% of farmers are low or non-adopters highlights a significant segment that remains underserved or faces persistent barriers. This heterogeneity in adoption levels necessitates targeted, rather than blanket, intervention strategies to move low adopters up the ladder and support high adopters as potential community champions (Rogers, 2003).

Table 5 Level of Adoption of Improved Technologies

Adoption Category	*Frequency*	*Percentage (%)*
Non-Adopter (Adopted none)	11	11.0
Low Adopter (Adopted 1-2 technologies)	29	29.0
Medium Adopter (Adopted 3-5 technologies)	42	42.0
High Adopter (Adopted >5 technologies)	18	18.0
Total	100	100.0

Source: Field Survey Data, 2025

Factors Influencing the Adoption of Improved Technologies

A logistic regression model was used to determine the factors influencing adoption. The regression model is highly significant. Education, farm Size, access to credit, and access to extension services are strong positive drivers of adoption. Perceived high cost and complexity are significant negative barriers. Age has a small but significant negative effect, suggesting younger farmers are slightly more likely to adopt. The model was statistically significant ($\chi^2 = 68.32$, $p < 0.001$), correctly classifying 82% of cases and explaining 52.4% (Nagelkerke R^2) of the variance. The results identified several significant factors:

Positive Drivers: Education level, farm size, access to credit, and access to extension services significantly increased the likelihood of adoption. Farmers with extension access were over 8 times more likely to adopt. **Negative Barriers:** Older age, high perceived cost, and perceived complexity significantly reduced adoption. Farmers who perceived technologies as costly were 79% less likely to adopt them.

These findings robustly refute the null hypothesis that socioeconomic characteristics do not significantly influence adoption. The positive role of education and farm size is well-documented, as they enhance financial capacity and risk-bearing ability (Ayinde et al., 2021). The profound impact of access to extension and credit underscores the critical role of institutional support in facilitating adoption, a finding consistent with the results of Jimmy et al., 2026; Kumari & Adekunle, 2022; Okoroafor & Akpan, 2021, that access to credit and extension service play a critical role in the adoption of technologies among crop farmers in Nigeria. The negative influence of age suggests that younger farmers are more receptive to change, a trend noted by Jimmy Furthermore, the significance of perceptual factors (cost, complexity, relative advantage) validates the relevance of Rogers' (2003) Diffusion of Innovations theory, confirming that a technology's characteristics are as crucial as the farmer's profile in determining its uptake.

Table 6: Logistic Regression Analysis of Factors Influencing Adoption of Improved Technologies

Independent Variable	*Coefficient (β)*	*Std. Error*	*p-value*	*Odds Ratio [Exp(β)]*
Constant	-4.225	1.812	0.020**	0.015
Age (X_1)	-0.045	0.022	0.041**	0.956
Gender (X_2: 1=Male)	0.512	0.589	0.384	1.668
Education Level (X_4)	0.321	0.151	0.033**	1.379
Farming Experience (X_5)	0.018	0.025	0.470	1.018
Farm Size (X_7)	0.654	0.245	0.008***	1.923
Access to Credit (X_8: 1=Yes)	1.842	0.701	0.009***	6.312
Access to Extension (X_9: 1=Yes)	2.105	0.744	0.005***	8.205
Membership in Cooperative (X_{10}: 1=Yes)	1.224	0.662	0.065	3.400
Perceived Cost (X_{11}: 1=High)	-1.551	0.612	0.011**	0.212
Compatibility (X_{12}: 1=Compatible)	1.887	0.688	0.006***	6.598
Relative Advantage (X_{13}: 1=Better)	2.431	0.795	0.002***	11.370
Complexity (X_{14}: 1=Complex)	-1.298	0.599	0.030**	0.273

Log-Likelihood: -42.15; Chi-Square (χ^2): 68.32 ($p < 0.001$); Pseudo R^2 (Nagelkerke): 0.524; Percentage Correct Prediction: 82.0%; ***Significant at 1% (p<0.01), ***Significant at 5% (p<0.05)*

Constraints to Adoption of Improved Technologies

Results displayed in Table 7 shows that farmers faced multiple, overlapping constraints. The top three barriers are economic and institutional. High cost of inputs, inadequate extension support, and lack of access to credit. The most severe was the high cost of inputs (85%), followed by institutional failures such as inadequate extension support (75%) and lack of access to credit (73%). Other significant barriers included the unavailability of inputs (62%), a lack of awareness or training (58%), and the perceived complexity of technologies (45%).

The constraints identified are both economic and institutional, forming a vicious cycle that hinders technology adoption. The high cost of inputs, consistently reported as the primary barrier, reflects the financial vulnerability of smallholder farmers and aligns with the findings of Adeyeye et al. (2022). The prominence of inadequate extension and credit access directly mirrors the institutional determinants found significant in the regression analysis, highlighting a critical area for policy intervention. These barriers have been previously reported in the region, suggesting that past interventions have not sufficiently addressed these core challenges (Chukwu et al., 2020). Addressing these foundational issues is a prerequisite for widespread and sustainable adoption of improved plantain technologies in Bayelsa State.

Table 7 Constraints Hindering the Adoption of Improved Technologies (n=100)

Constraint	*Frequency*	*Percentage (%)*	*Rank*
High cost of inputs	85	85.0	1st
Inadequate extension support	75	75.0	2nd
Lack of access to credit	73	73.0	3rd
Unavailability of inputs	62	62.0	4th
Lack of awareness/training	58	58.0	5th
Complexity of technologies	45	45.0	6th
Poor market for produce	40	40.0	7th
Cultural/Traditional beliefs	18	18.0	8th

Source: Field Survey Data, 2025; *Note: Multiple Responses Recorded constraints.*

Conclusion

This study provides critical empirical evidence on the determinants of technology adoption among plantain farmers in the Niger Delta region. It conclusively demonstrates that the socio-economic characteristics of farmers significantly influence their decision to adopt improved technologies, thereby rejecting the stated null hypothesis. The findings underscore that while farmers are generally aware of innovations, the transition to sustained adoption is hampered by a triad of critical barriers: economic limitations, institutional failures, and negative perceptions.

The prominence of financial constraints as the primary barrier highlights the economic vulnerability of smallholder plantain farmers in Bayelsa State, who lack the capital to invest in improved inputs. Furthermore, the crippling lack of access to extension services and credit facilities points to a systemic institutional failure that stifles agricultural innovation and productivity. The significant influence of farmers' perceptions regarding cost, complexity, and relative advantage emphasizes that technology design and promotion must be farmer-centric and context-specific.

Ultimately, the potential of improved agricultural technologies to enhance plantain productivity, increase farmers' incomes, and contribute to food security in Bayelsa State remains largely untapped. Achieving widespread adoption requires moving beyond mere dissemination of technologies to addressing the underlying economic and institutional bottlenecks that disempower farmers. A holistic approach that simultaneously strengthens support systems, improves financial access, and builds farmers' capacity through targeted training is essential to unlock this potential and foster a sustainable agricultural transformation in the region.

Recommendations and Policy Implication

Based on the findings of this study, the following recommendations were proposed:

a) **Implement Input Subsidy Programs:** Develop and faithfully execute targeted subsidy programs to reduce the upfront cost of critical inputs like hybrid plantain suckers, fertilizers, and simple post-harvest equipment for genuine smallholder farmers.
b) **Strengthen Rural Financial Systems:** Partner with microfinance banks and develop innovative, low-collateral credit schemes specifically tailored for smallholder farmers to improve their access to finance for technological investments.
c) **Revitalize Extension Services:** Increase the number, funding, and mobility of extension agents to ensure regular and effective contact with farmers in remote communities. The focus should be on practical, hands-on training and demonstrations.
d) **Promote Farmer-Centric Technologies:** Prioritize the promotion of technologies that are low-cost, less complex, and easily compatible with existing farming systems, such as mulching and improved spacing, to ensure higher uptake.
e) **Utilize Lead Farmers:** Identify and train high-adopter farmers to serve as demonstration hosts and peer educators within their communities, leveraging social networks for technology diffusion.
f) **Strengthen Farmer Groups:** Farmers should be encouraged to form or join active cooperatives to benefit from economies of scale, collective bargaining for inputs, and better access to government support and training programs

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