



THE IMPACT OF THE ADOPTION OF DIXON CASSAVA VARIETY ON THE POVERTY STATUS AND SUSTAINABLE WELFARE OF SMALLHOLDER FARMERS IN OYO STATE, NIGERIA

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Abstract: This study evaluates the impact of the adoption of the Dixon cassava variety on the poverty status and sustainable welfare of smallholder farmers in Oyo State, Nigeria. Using the multi-stage sampling procedure, a total of 240 respondents were selected, and responses were collected in 2024 using primary data. The descriptive statistics, Probit regression, Foster-Greer-Thorbecke (FGT), and the Endogenous Switching Regression (ESR) models were used in the analytical stage. Determinants such as contact with extension agents, cost of planting, household size, and years of education positively influence the adoption of the Dixon cassava variety, while farm size and farm experience negatively influence its adoption. Results of the Endogenous Switching Regression model at a significant level of 1% show that the Dixon cassava variety reduces poverty by a 10.72% point in adopters compared to non-adopters. To improve cassava farmers' welfare, the study recommends enhancing extension services, providing subsidies for planting materials, and implementing education and awareness programs to promote adoption benefits.

Keywords: TMS-9800581 (Dixon) cassava, Adoption, Welfare, Endogenous switching regression

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Received: September 04, 2025

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Published: November 15, 2025

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Cite as: Taiwo OJ, Olasupo OA, Akindele EE, Igbatayo S, Dayo-Olagbende OG. 2025. The impact of the adoption of Dixon cassava variety on the poverty status and sustainable welfare of smallholder farmers in Oyo State, Nigeria. *BSJ Agri*, 8(6): 861-867.

1. Introduction

Cassava, a perennial woody shrub with edible roots, was introduced to Africa by Portuguese explorers in the 16th century and remains vital for food security, poverty reduction, and environmental sustainability (Köcke, 2019). In Nigeria, cassava's growing importance stems from its role as both a staple food and a food security crop (Onyediako and Adiele, 2022). It is processed into various products (e.g. gari, pupuru, lafun, tapioca, fufu) that serve over 600 million people globally (Eze et al., 2023). In 2023, global cassava production reached 334 million tonnes, with Africa contributing 193.62 million tonnes (FAO, 2024). Nigeria, producing about 60 million tonnes annually, is the world's top producer, yet over 90% is consumed locally (FAO, 2022). Meanwhile, Thailand leads in cassava exports, accounting for 70% of global trade (World Population Review, 2024).

Technological advancements have led to fortified cassava varieties with added micronutrients like vitamin A (Lawal, 2022). Enhanced processing techniques have

broadened cassava's acceptance across income groups transforming its image from a poor man's crop to a widely accepted staple. However, growing demand, especially from feed and starch industries, and rising prices of substitutes like rice and maize, may destabilize market equilibrium if supply lags behind. Cassava's adaptability allows it to thrive where other crops may fail, supporting food security for millions and providing livelihoods to farmers, processors, and traders worldwide. Understanding cassava adoption patterns is crucial for policy and development. Definitions of "adoption" vary some use a binary classification (e.g., adopters vs. non-adopters of improved varieties), while others prefer continuous measures, such as land proportion allocated to improved varieties (Sanya et al., 2020). The drivers of adoption vary widely across contexts and technologies (Sinyolo, 2020).

Although existing literature (Adewole et al., 2019; Adetula et al., 2020) addresses cassava adoption broadly, empirical evidence on the specific impact of adopting the



TMS-9800581 (Dixon) cassava variety remains limited. This gap hinders understanding of its effect on poverty and welfare among smallholder farmers. This study aims to fill that gap by assessing the impact of TMS-9800581 adoption on the poverty status and welfare of smallholder farmers in Oyo State, Nigeria.

2. Materyals and Methods

2.1. Data and Sampling Technique

Primary data was collected in 2024 using semi-structured questionnaires administered to respondents to obtain relevant information for the study. A four-stage multistage sampling procedure was adopted. Three Agricultural Development Programme (ADP) zones (Ibadan, Saki, and Oyo) were randomly selected. Six cassava-producing Local Government Areas (LGAs) were purposively chosen across these zones. Two wards were randomly selected from each LGA, totalling 12 wards. From each ward, 20 smallholder cassava farmers were randomly selected, resulting in 240 respondents. The sampling unit was smallholder cassava farmers.

2.2. Analytical Techniques

2.2.1. Descriptive analysis

Descriptive analysis was used to describe the socio-economic characteristics of the farming households, adoption status and expenditure in the study area. The analyses were presented in frequencies, percentages, means and standard deviation.

2.2.2. Probit regression

Probit regression method was used to analyze the factors affecting the adoption of improved varieties of cassava among the respondents. This method is expressed in equation 1 and equation 2 below.

$$Y^* = \beta_i X_i + e_i \tag{1}$$

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + e_i \tag{2}$$

Y= Dependent variable (adoption status). (adopters=1, non-adopters=0)

X_i= Independent variables such as;

X₁ = Age in years; X₂ = Years of formal education ; X₃= Marital status (single = 0, married = 1, widowed = 2, divorced = 3); X₄ = Gender (male=1 female=0); X₅ = Household size (number); X₆ = Farming experience (years); X₇ = Farm size (hectares); X₈= Membership of farmers association (member =1, non-members =0); X₉ = Contact with extension agents (Yes =1, No= 0); X₁₀= Access to credit (Yes =1, No =0); X₁₁ = Cost of planting materials- cassava stem (N).

2.2.3. Foster-Greer-Thorbecke (FGT) measurement of poverty

To determine household poverty status, a poverty line was constructed using per-capita monthly expenditure: total household expenditure divided by household size. The mean per capita expenditure was then calculated across all households. The poverty line was set at two-thirds of this mean, classifying households as poor or non-poor. The Foster-Greer-Thorbecke (FGT) index

measured poverty levels using incidence (P₀), depth (P₁), and severity (P₂), based on the formula given in equation 3:

$$FGT_\alpha = \frac{1}{N} \sum_{i=1}^H \left(\frac{z-y_i}{z} \right)^\alpha \tag{3}$$

Where z = poverty threshold (line); N= number of people in the economy; H = number of poor (those with income at or below z); y_i = income of each individual i; α = poverty aversion parameter.

2.2.4. Endogenous switching regression model (ESR)

The ESR model was utilized for impact analysis. In modelling the welfare impact of adopting the TMS-9800581 (Dixon) cassava variety among smallholder farmers using the ESR framework, a two-stage estimation procedure was applied simultaneously. In the first stage, the adoption decision was estimated to identify the factors influencing adoption. The second stage involved estimating the relationship between outcome variables and a set of explanatory variables, with separate specifications for two regimes: adopters and non-adopters of improved cassava varieties. The specifications for these two regimes are as follows in equation 4 and equation 5.

$$\text{Regime 1 (Adopters): } Y_{iA} \beta + u_{iA} \text{ if } S_i = 0 \tag{4}$$

$$\text{Regime 2 (Non- Adopters): } Y_{iN} \beta + u_{iN} \text{ if } S_i = 1 \tag{5}$$

Where Y_{iA} and Y_{iN} are outcome variables for adopters and non-adopters, respectively; K is a vector of respondents and demographic/socio-economic characteristics such; X₁ = Household size (number); X₂ = Farming experience (years); X₃= Farm size (hectares) X₄ = Years of education (years); X₅ = Marital status (married =1, otherwise=0) ; X₆ = Gender (male=1 female=0); β is a vector of parameters to be estimated and μ is the error term.

3. Results and Discussion

3.1. Discussion of Socioeconomic Characteristics

The socio-economic characteristics of the respondents in table 1, reveal several factors influencing the adoption of improved cassava varieties. Most farmers (80.42%) are within the 31–50 age group, with a higher proportion of adopters (48%) than non-adopters (45%), supporting (Kolapo et al., 2024) view that middle-aged farmers are more inclined to adopt innovations. Education is a notable factor, as 11% of adopters have more than ten years of schooling compared to only 0.71% of non-adopters, consistent with (Sasa et al., 2022), who emphasize the role of education in technology adoption. While males dominate cassava farming (72.5%), female participation (27.5%) remains significant. The majority of respondents are married (91.25%), highlighting the continued importance of family labour in farming (De Rosa et al., 2020). Household sizes ranging from 6 to 15 persons (67.08%) provide a strong labour base for cultivation, and 60.41% of respondents have over ten years of farming experience, which, as (Lawal, 2023)

suggests, can positively influence the adoption of new practices.

Farm size, group membership, and access to support services also play critical roles. While smallholder farming dominates, adopters are more likely to own larger farms (>2.0 ha: 14%) than non-adopters (0.71%), aligning with (Ogunleye et al., 2024) findings on the influence of landholding on adoption. Additionally, 57.92% of respondents belong to farmer associations, highlighting the importance of peer influence and information exchange. Access to extension services is

significantly higher among adopters (96%) compared to non-adopters (30.71%), reflecting (Ojoko, 2021) view of extension services as crucial to spreading innovation. Similarly, access to credit is more common among adopters (48%) than non-adopters (37.14%), supporting (Bello et al., 2021) findings on financial barriers to adoption. Interestingly, non-adopters report higher fertilizer use (65%) compared to adopters (22%), possibly indicating that the Dixon cassava variety is better suited for low-input systems, as noted by (Peprah, 2020).

Table 1. Sample statistics of the socio-economic characteristics of the respondents

Variable	Adopters N = 100	Non-adopters N = 140	Pooled N = 240	t-statistics
Age (Mean)	43.85	43.46	43.62	0.3461
Years of education (Mean)	7.29	7.03	7.14	0.8126
Marital status				
Married (%)	90	92.14	91.25	
Single (%)	10	7.86	8.75	
Gender:				
Male (%)	74	71.43	72.5	
Female (%)	26	28.57	27.5	
Household size (mean)	10.28	9.9	10.06	0.4628
Farm experience (mean)	15.25	16.25	15.83	0.9065
Farm size (mean)	1.35	1.1	1.20	3.0180***
Membership of the farmers' association:				
Yes (%)	59	57.14	57.92	
No (%)	41	42.86	42.08	
Contact with extension agent				
Yes (%)	96	30.71	57.92	
No (%)	4	69.29	42.08	
Access to credit				
Yes (%)	48	37.14	41.67	
No (%)	52	62.86	58.33	

Source= Field Survey Data, 2024.

3.2. Determinants of Adoption of Dixon Cassava Variety

Numerous socioeconomic and institutional factors impact the adoption of improved agricultural technologies, including the Dixon cassava cultivar. Adoption decisions are highly impacted by years of education, household size, agricultural experience, farm size, interaction with an extension agent, and planting cost, according to the results of the probit regression study in Table 2.

3.2.1. Years of education

Adoption of enhanced agricultural technologies is significantly influenced by education. The findings show that adopting the Dixon cassava variety is more likely after one more year of education (coef. = 0.283, P<0.01). This result is in line with research showing that education improves farmers' comprehension and use of new farming methods, such as that conducted by (Fadeyi et al., 2022). Farmers with higher levels of education are more likely to get and analyse data from agricultural markets, financial institutions, and extension agencies,

which helps to lower the uncertainty surrounding new technology.

3.2.2. Household size

Another important factor that influences adoption favourably is household size (coef. = 0.125, P<0.01). More labour is frequently available in larger households, which facilitates labour-intensive cassava farming. This is consistent with the findings of (Bakker et al., 2021), who contended that because of fewer labour limitations, larger families are better equipped to embrace new farming practices. For smallholder farmers, who might otherwise find it difficult to pay for hired labour, the availability of domestic labour is especially important.

3.2.3. Farm experience

Adoption is significantly and negatively impacted by farm experience (coef. = -0.137, P<0.01). This implies that more experienced farmers are unlikely to use the Dixon cassava variety, maybe as a result of their comfort with conventional practices and resistance to using new technologies. This is consistent with the findings of (Adesina and Baidu-Forson, 1995), who discovered that

long-term farmers are typically less receptive to new agricultural technologies and more risk-averse. The new variety may be viewed by seasoned farmers as unproven or needing extra inputs, which could raise production costs.

3.2.4. Farm size

Farm size negatively influences adoption (coef. = -1.258, P<0.01), indicating that farmers with larger landholdings are less likely to adopt the Dixon cassava variety. This contradicts the common assumption that larger farms are more innovative. One possible explanation is that smallholder farmers, who often face pressure to maximize yields per hectare, may be more willing to adopt improved varieties that promise higher productivity (Akintayo et al., 2024). Conversely, large-scale farmers may have diversified cropping systems and may not perceive cassava as a primary income-generating crop, reducing their incentive to adopt new varieties.

3.2.5. Extension agent contact

Adoption is most positively impacted by access to extension services (coef. = 2.709, P<0.01). The Dixon cassava variety is much more likely to be adopted by farmers who have engaged with extension agents, highlighting the crucial role that agricultural extension plays in the spread of technology. According to studies by (Bakker et al., 2021; Uzochukwu et al., 2021), extension services help farmers adopt technology by giving them vital information about better agricultural methods, input availability, and market connections.

3.2.6. Cost of planting

Planting costs positively influence adoption (coef. = 2.621, P<0.01), indicating that farmers who invest more in planting supplies are more likely to adopt the Dixon cassava variety. This could be because farmers who are financially committed to planting see enhanced varieties as a worthwhile investment. According to (Massresha, 2021), the willingness to invest in high-quality planting supplies demonstrates faith in the benefits of better cultivars.

Table 2. Factors influencing the adoption of TMS-9800581 (Dixon) cassava variety among the respondents

Variables	Coefficient	Standard Error	T-value	P-value
Age	0.0072074	0.0261151	0.28	0.783
Years of education	0.2831591	0.0744593	3.80	0.000***
Marital status	-0.0691257	0.6975855	-0.10	0.921
Gender	-0.6247656	0.3676259	-1.70	0.089
Household size	0.1254985	0.0335128	3.74	0.000***
Farm experience	-0.1368813	0.0330119	-4.15	0.000***
Farm size	-1.258475	0.3387552	-3.71	0.000***
Membership of farmers association	-0.4565473	0.3602051	-1.27	0.205
Contact with extension agent	2.70875	0.4778476	5.67	0.000***
Access to credit	-0.6057553	0.4217891	-1.44	0.151
Cost of planting materials (cassava stem)	2.620727	0.4327297	6.06	0.000***
Constant	-28.77047	4.872415	-5.90	0.000
Log Likelihood Function	-52.003103			
LR Chi-square	222.01			
Pseudo R ²	0.6810			

Source= Field Survey Data, 2024, ***=Sig at 1.

3.3. Poverty Status

Table 3 shows a significant difference in poverty levels between adopters and non-adopters of the TMS-9800581 (Dixon) cassava variety. Only 9% of adopters are poor compared to 21% of non-adopters, indicating adopters are less likely to be poor. This supports findings by (Olusayo et al., 2019; Wordofa et al., 2021) that agricultural technology adoption boosts production, income, and food security, thereby reducing poverty. Table 4 further shows poverty incidence (P0) is higher among non-adopters (21.43%) than adopters (9.00%). Poverty depth (P1) is also greater for non-adopters (4.35%) than adopters (2.60%), meaning non-adopters need more resources to escape poverty. Similarly, poverty severity is higher among non-adopters (1.47%) compared to adopters (0.70%). These findings align with (Zegeye et al., 2022), who observed a higher proportion

of non-poor farmers among adopters, while non-adopters experienced more severe poverty in terms of incidence, depth, and severity.

Table 3. Poverty status

Poverty status	Adopters N= 100		Non adopters N = 140	
	Freq.	Percentage	Freq.	Percentage
Poor	9	9	30	21.43
Non-poor	91	91	110	78.57
Total	100	100	140	100.00

Source: Field Survey Data, 2024.

Table 4. Foster-Greer-Thorbeck (FGT) measures showing poverty levels among adopters and non-adopters in the study area

Variables	Non adopters	Adopters	Pooled
Poverty incidence (P ₀)	0.2143	0.090	0.1625
Poverty depth (P ₁)	0.0435	0.026	0.0354
Poverty severity (P ₂)	0.0147	0.007	0.0110

Source= Field Survey Data, 2024.

3.4. The Impact of Cassava Dixon Adoption on Welfare (Poverty Status)

The results from the Endogenous Switching Regression (ESR) model as shown in Table 5, indicate that adopters of Cassava Dixon experience a 10.71 percentage point reduction in poverty compared to non-adopters. This finding is statistically significant at the 1% level, confirming that adoption of the improved cassava variety substantially enhances household welfare (Adjognon et al., 2017). The reduction in poverty among adopters can be attributed to several mechanisms. Firstly, increased agricultural productivity and income generation play a central role. Cassava Dixon is known for its higher yield potential, disease resistance, and drought tolerance. These characteristics enable farmers to achieve better harvests, translating into increased marketable surplus and higher revenues (Reddy, 2022). As farm income rises, households can afford better nutrition, healthcare, and education, thereby improving their overall welfare. Higher earnings also allow farmers to invest in other income-generating activities, creating additional pathways out of poverty (Mutungi et al., 2023).

Table 5. Average treatment effect and sensitivity analysis (Endogenous switching regression results)

Variables	Adopters	Non-adopters	ATT	T-statistics
Poverty status	0.1000	0.2071	0.1071	-6.4952***

Source= Field Survey Data, 2024.

Secondly, adoption facilitates better market access and economic opportunities. Improved cassava varieties often meet the quality standards required by industries and export markets, ensuring stable demand and better prices (Ojeniyi et al., 2024). Adopters of Cassava Dixon may benefit from improved bargaining power in the market, reducing the risk of exploitative pricing. Additionally, participation in structured markets, such as contract farming and commodity exchanges, can enhance price stability and income predictability, further strengthening the welfare of farming households (Akintayo et al., 2024). Another important consideration is food security and household resilience. The high yield of Cassava Dixon assures that households have enough food, decreasing their reliance on market purchases (Ojo et al., 2021). This improved food security protects households from seasonal price changes and economic

shocks, reducing their vulnerability to poverty. A food-secure household is more likely to invest in long-term goals like education and health, which promotes long-term poverty alleviation (Reddy, 2022).

5. Conclusion

A review of socioeconomic parameters reveals key factors impacting Dixon cassava adoption. Middle-aged farmers, particularly those aged 41 to 50, have greater adoption rates, indicating active participation in agriculture and a willingness to accept risks. Education appears as a major driver, with higher levels of schooling being connected with increased adoption. Gender distribution confirms male dominance in cassava farming, although women's large engagement highlights their importance in agricultural operations. Household size and farming experience can influence adoption trends, with larger households providing more labour resources and experienced farmers being hesitant to change.

Institutional factors like access to extension services and finance facilities have a significant impact on technology adoption. Adopters gain greatly from extension assistance, emphasising its relevance in distributing agricultural advances. Similarly, having access to financial resources increases the opportunity to invest in better types. Notably, the negative association between fertiliser use and adoption shows that the Dixon cassava variety may be well-suited to low-input farming systems, making it a viable option for farmers with limited resources. Ultimately, the socioeconomic landscape influences adoption decisions, which has a favourable impact on poverty reduction. Farmers that use the Dixon cassava variety are less likely to be considered poor, implying that technology adoption can boost productivity and improve livelihoods. Based on these findings, the study recommends strengthening extension services, providing subsidies for planting materials, and implementing education and awareness programs to promote adoption benefits.

Author Contributions

The percentages of the authors' contributions are presented below. All authors reviewed and approved the final version of the manuscript.

	O.J.T.	O.A.O.	E.E.A.	S.I.	O.G.D.O.
C	20	20	20	20	20
D	20	20	20	20	20
S				50	50
DCP	20	20	20	20	20
DAI	20	20	20	20	20
L	20	20	20	20	20
W	20	20	20	20	20
CR	20	20	20	20	20
SR	20	20	20	20	20
PM	20	20	20	20	20

C= concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision, PM= project management, FA= funding acquisition.

Conflict of Interest

The authors declared that there is no conflict of interest.

Ethical Consideration

Ethics committee approval was not required for this study because there was no study on animals or humans.

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