



FACTORS INFLUENCING THE ADOPTION OF E-EXTENSION TOOLS BY SMALLHOLDER SUGARCANE FARMERS IN KADUNA STATE, NIGERIA

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ABSTRACT

The study examined factors influencing the adoption of e-extension tools among smallholder sugarcane farmers in Kaduna State, Nigeria. A multistage sampling technique was employed to select 273 sugarcane farmers. Data were collected using structured questionnaires and analyzed using descriptive statistics and Tobit regression model. The findings revealed that the majority (79.5%) of sugarcane farmers were males, with a mean age of 37.2 years. Also 61.5% of sugarcane farmers had secondary education, with a mean of 12.1 years spent in school, and an average farming experience of 8.6 years. The average household size and farm size were 7 members and a 1.4 hectares, respectively. The findings further revealed that majority (61.5%, 71.8% and 54.6%) of sugarcane farmers had no contact with extension agents, were not members of cooperatives, and had no access to credit, respectively. The Tobit regression results showed that sex ($P<0.05$), farm size ($P<0.01$), farming experience ($P<0.10$), years spent in school ($P<0.01$), number of extension visits ($P<0.01$), and amount of credit received ($P<0.01$) were the significant factors influencing the adoption of e-extension tools in the study area. Key challenges included limited extension contact (61.5%), low cooperative participation (71.8%), and inadequate access to credit (54.6%). The study concludes that sex, farm size, farming experience, education, extension visits and access to credit were the significant factors influencing the adoption e-extension tools in the study area. The study recommends the need to enhance extension services, improving access to credit, promoting gender-inclusive strategies, and strengthening farmer cooperatives to facilitate collective access to digital resources.

Keywords: Adoption, E-extension, Smallholder, Farmers, Sugarcane.

INTRODUCTION

Nigeria's agricultural sector remains fundamental to the country's economic structure, though its contribution has faced significant challenges. Prior to the year 1970, agriculture was the main source of livelihood and backbone of the Nigerian economy until the discovery of oil drastically decelerated its potential to sustainably maintain food security and generate significant export earnings (Olugbire *et al.*, 2021). Despite its sudden fall in productivity, agriculture still remains the main sector providing the highest employment (70% of the population) for the populace. Within this broader agricultural context, sugarcane production represents a significant opportunity for economic diversification and value creation. Sugarcane's economic importance extends far beyond primary production, encompassing significant industrial applications that create substantial economic value. Biobased polyethylene (bioPE) is a key component of this transition, which is obtained from natural and renewable sources such as sugarcane (Trucillo *et al.*, 2024). The employment potential of sugarcane production is substantial, particularly for smallholder farmers who constitute the majority of Nigeria's agricultural workforce. Comparative analysis from other regions shows significant employment effects - in 1995, the industry had employed over 35,000 workers and supported over 2 million people in the region (Khaemba and Muiruri, 2022). The sector contributes about 16% to the nation's Gross Domestic Product in Kenya's sugar industry, illustrating the potential scale of employment generation that could be achieved in Nigeria.

Smallholder farming is the most prevalent form of agriculture in world, supports many planet's vulnerable populations, and coexists with some its diverse threatened landscapes (Samberg *et al.*, 2016). These smallholder-dominated systems serves as home to more than 380 million households,



make up roughly 30% produce 70% food calories produced in these regions. This global pattern emphasizes the critical role that smallholder sugarcane production could play in Nigeria's rural economy. E-extension services have emerged as a transformative approach to agricultural extension in Nigeria. These services leverage information and communication technology (ICT) to provide timely and relevant information to farmers. E-extension services leverage digital technologies to provide tailored agricultural advice and inputs to farmers. The Growth Enhancement Scheme (GES) and e-voucher program in Nigeria exemplify such initiatives, where private agro-dealers distribute subsidized fertilizers, improved seeds, and extension services through digital platforms (Benjamin *et al.*, 2020). The establishment of departments dedicated to e-extension within agricultural institutions like National Agricultural Extension and Research Liaison Services (NAERLS) to enhance service delivery by utilizing digital platforms for communication and training is a typical example (<https://naerls.gov.ng/e-extension/>). The E-extension tools include;

- i. **Radio:** This is a mass medium that can assist the agricultural extension department in transferring information to farmers. This medium has been used for the longest time and is very efficient as it is cheaper to purchase by rural farmers in Nigeria
- ii. **Phones:** These are electronic communication devices that promote the timely transfer of information between farmers and extension agents irrespective of their locations.
- iii. **Television:** This is a mass medium, with a visual capacity that enables the extension department to conduct training demonstrations via this medium for the farmers.
- iv. **National Farmers Helpline:** This serves as a medium for dissemination and delivery of improved technologies, market linkages, and other agricultural information and advisory services to farmers to complement traditional extension agents/farmers interface in Nigeria.
- v. **Websites:** Information is accessed via this medium by both farmers and extension agents when they are connected to the Internet.
- vi. **Interactive voice response:** IVR is a telephony system that interacts with callers, records information, and directs calls to an appropriate database of prerecorded information in voice form.
- vii. **Social media:** This includes WhatsApp groups, and Facebook group and page. It can be accessed via phones and computers with available internet/network. This is a very popular medium utilized especially by the youths.

The study aims to evaluate the factors influencing the adoption of e-extension tools by smallholder sugarcane farmers in Kaduna State. Specifically, the study will;

- i. describe the socio-economic and institutional characteristics of sugarcane farmers in the area; and;
- ii. determine the factors influencing the adoption of e-extension tools by sugarcane farmers in the area.

METHODOLOGY

The Study Area

The study was conducted in four (4) selected Local Government Areas of Kaduna State (Makarfi, Kudan, Kubau and Ikara). Makarfi Local Government shares boundaries with four (4) Local Governments namely; Rogo LG of Kano State to the East, Kudan LG to the South East, Ikara LG to North West and Soba LG to the South West. Makarfi with a projected population of 216,600 at 2.5% birth rate (NBS, 2022), have a landmass of 540.6 Square Kilometer (KM²) and is located on latitude 11°.332795 and longitude 7°.974132 (KDSG, 2021). The mean temperature of 34 °C is experienced between the months of March and May, while the temperature could be as low as 20 °C from December to February. This low temperature is intensified by humidity due to the dry Harmattan wind. The wet season usually begins from May to October, and the dry season lasts from November to March. Makarfi is characterized by low-lying fertile land important for farming activities (Yusuf *et al.*, 2023). The people are predominantly farmers with great potentials in livestock farming. These two activities serve



as their major sources of livelihood. Makarfi is well known for its large-scale crops production potential in rice, sorghum, millet, soybeans, cotton, chilly and most especially sugarcane (Issa *et al.*, 2020).

Kudan Local Government Area of Kaduna State, Nigeria, with its headquarters in Hunkuyi shares borders with Makarfi LGA to the East, Sabon-Gari LGA's to the West and Kano State by the North. It has a land area of approximately 345.5 Square Kilometers (KM²), with a projected population of 205,300 at 2.5% birth rate (NBS, 2022). Kudan LG has five (5) districts; Kudan, Hunkuyi, Likoro, Doka and Kauran-Wali. Administratively, Kudan LGA is divided into 10 wards namely; Kudan, Doka, Garu, Hunkuyi, Kauran Wali North, Kauran Wali South, Likoro, Sabon Garin Hunkuyi, Taban Sani and Zabi. The LGA has an average temperature of 32 °C with distinct dry and wet seasons. Agriculture is a significant economic activity, with crops like maize, millet, tomatoes and sugarcane being prominent.

Kubau Local Government Area (LGA) located in the North-Eastern part of Kaduna State and lies at longitude 8°3' North of the Greenwich Meridian and Latitude 11°06' East of the Equator. It shares boundaries with Ikara LGA to the North-East, Soba LGA to the West, Kauru LGA to the South-West and Lere LGA to the south-east. It covers an area of approximately 2,363 square kilometers (km²) (Ikpe *et al.*, 2023). Kubau LGA had a population of 282,045 people during the 2006 census (NPC, 2006) and a projected population of 414,700 in 2022 using a growth rate of 3.12% (Mohammed *et al.*, 2022). Administratively, Kubau LGA is divided into 11 wards namely; Kubau, Dutsen-Wai, Pambegua, Zuntu, Damau, Karreh, Anchau, Haskiya, Kargi, Mah and Zabi. The LGA is characterized by a well-developed grass layer, shrubs and enjoys a tropical climate with two distinct (dry and wet) seasons (Mohammed *et al.*, 2022).

Ikara Local Government Area (LGA) is located in the northern part of Kaduna State and lies approximately at Longitude 8°9' North of the Greenwich Meridian and Latitude 11°19' East of the Equator. It shares boundaries with Makarfi LGA to the west, Soba LGA to the southwest, Kubau LGA to the south, and the Kano State border to the north and east. The LGA covers an estimated land area of about 2,466 square kilometers (km²), and had a population of 194,723 people (NPC, 2006), with a projected population of 286,300 in 2022 based on an annual growth rate of 3.12% (Issa *et al.*, 2016). Administratively, Ikara LGA is divided into 11 wards namely; Ikara, Auchan, Danlawan, Janfalan, Kankanki, Malikachi, Paki, Saulawa, Rumi, Kurmin Kogi, and Furana. The LGA is characterized by a Sudan Savanna vegetation zone with a mixture of grasses and scattered trees and experiences a tropical climate with two distinct seasons: the rainy season and the dry season (Issa *et al.*, 2016).

Sampling Procedure and Sample Size

A multistage sampling procedure was employed for the study. Kaduna State has four (4) Agricultural Development Project zones namely; Maigana, Birnin-Gwari, Lere, and Samaru. In the first stage, Maigana zone which cuts across eight (8) Local Government Area's (Soba, Giwa, Kubau, Ikara, Makarfi, Kudan, Sabon-Gari and Zaria) of Kaduna State was purposively selected due to high production of sugarcane in the zone amongst the other four (4) zones in the State. In the second stage, four (4) local government area's (Makarfi, Ikara, Kudan and Kubau) were also purposively selected from the list of eight (8) Local Government Area's due to notable high production of sugarcane. In the third stage, two (2) wards were randomly selected from the four (4) LGA's to give a total of eight (8) wards. The wards are; Gubuci and Makarfi from Makarfi LGA, Kurmin Kogi and Saulawa from Ikara LGA, Kauran Wali South and Kauran Wali North from Kudan LGA, Anchau and Damau from Kubau LGA. In the final stage, the sample frame for the study was drawn from the list of 861 registered sugarcane farmers with the Kaduna State Agricultural Development Project (KADP) in the selected villages using the Slovin's formula. Thus, a sample size of two hundred and seventy-three sugarcane farmers, (31.71%) of the registered farmers were used as sample size for the study using the Slovin's formula which was given as;

$$n = \frac{N}{1+N(e^2)}$$

Where;

n = Sample size of the sugarcane farmers,

N = Population size (Total sample frame)

e² = Error term (0.05)²



Therefore,

$$n = \frac{861}{1+861(0.05^2)} = \frac{861}{3.1525} = 273. \text{ Sample ratio} = \frac{273}{861} \times 100 = 31.71 \%$$

Table 1: Sampling Procedure and Sample Size

Zones	LGAs	Wards	Sample frame	Sample size (31.71%)
Maigana	Makarfi	Gubuci	101	32
		Makarfi	117	37
	Ikara	Kurmin Kogi	98	31
		Saulawa	127	40
		Kuran Wali South	112	36
	Kubau	Kuran Wali North	89	28
		Anchau	121	38
		Damau	96	31
			861	273

Method of Data Collection

Primary data were collected using well-structured questionnaire. Questionnaires were administered on the spot by the researcher with the help of well-trained research assistants.

Analytical Techniques

Descriptive and inferential statistics was used to achieve the stated objectives and hypothesis of the study.

Descriptive statistics

The descriptive statistics used were frequencies, percentages mean and standard deviation to achieve objectives i, and iii.

Inferential statistics

Tobit regression model was used to determine the factors influencing the use of e-extension services and test the hypotheses.

Tobit regression model

The model is thus expressed as:

$$Y_i^* = \beta_0 + \beta_i X_i + U_i$$

$$Y_i^* = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + U_i \dots \dots \dots$$

Where:

Y_i = index of the E-extension tools

B_i = is the vector of unknown parameters

U_i = is the error term which is normally distributed with a mean of 0 and a variance σ^2

X_1 = Age (Years)

X_2 = Sex (Male = 1 and female = 2)

X_3 = Education level (Informal=1 Formal=2)

X_4 = Marital Status (Single = 1, married=2)

X_5 = Households size (Number of Individuals in the household)

X_6 = Farming Experience (Years in maize farming)

X_7 = Farm size (hectares)

X_8 = Membership of Association (Years spent as a member)

X_9 = Extension visits (numbers of visits)

X_{10} = Access to credit (Accessible=1, Not accessible=0),

β_0 = constant

$\beta_1 - \beta_{10}$ = coefficients of the independent variables

$X_1 - X_{10}$ = independent variables

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RESULTS AND DISCUSSIONS

Socioeconomic Characteristics of the Respondents

The results in Table 1 revealed that the majority of the sugarcane farmers (50.6%) were between the age ranges of 31-40 years. This implies that the sugarcane farmers were in their youthful productive age. This also shows that, there are enough human resources to expand the production of sugarcane in Kaduna State. Since most farmers were energetic, they could be ready to harness the potentials in sugarcane production. This is in line with the work of Aminu (2020), who also reported that majority of sugarcane farmers in Kaduna State were in their youthful age. The results further revealed that majority (79.5%) of the respondents were male. This implies that sugarcane farming is dominated by male farmers. This could be due to the fact that sugarcane farming involves a lot of physical energy and male farmers are mostly in possession of the production resources. This is in line with the work of Issa *et al.* (2020), who also reported that majority of sugarcane farmers in Kaduna State were male.

As revealed in the table, majority (79.9%) of the sugarcane farmers were married. This implies that the farmers would bear more children to form part of family labour, thereby reducing the cost of production. This also guarantees the sustainability of sugarcane farming as children take over the production from their parents. This finding is in line with the work of Aminu (2020) which revealed that most sugarcane farmers in Kaduna State were married with children that help in the provision of labour on the farm.

Furthermore, on educational background, majority of the sugarcane farmers (61.5%) had secondary education with a mean year spent in school of 12.1 years. This implies that the sugarcane farmers could understand and make use of agricultural information communicated to them as they can presumably read and write. This is an edge over those that cannot, and this signifies that sugarcane production has enormous potential in the study area, as most of the farmers are literate. This signifies that sugarcane farmers in the study area can easily make use of different e-extension tools to enhance their production with less cost. This is in line with the work of Aminu (2020), who reported that majority of sugarcane farmers in Kaduna State had secondary education. Result on household size revealed that majority of the sugarcane farmers (56.8%) had a household size ranging from 6-10 members with a mean of 7 members. This implies that they had household members that could easily contribute to labour on the farm and reduce cost of production. This is in line with the work of Sennuga *et al.* (2020), which revealed that most sugarcane farmers in Kaduna State had household size of 5-10 members that can help with the provision of family labour on the farm.

In addition, the results also revealed that 51.6% of the sugarcane farmers had experience ranging from 6-10 years, with a mean of 8.6 years. This implies that sugarcane farming has been practiced for a long time in the study area and farmers who engaged in the production had gathered many years of experience which could help them to make better farming decisions and easily access some production resources. This is in line with the work of Aminu (2020) which also revealed that most of sugarcane farmers in Kaduna State have an average of 8 years of farming experience, having been born into families into sugarcane farming as their source of livelihood. Result on farm size revealed that majority of the sugarcane farmers (73.6%) had farm size ranging from 1-2 ha with a mean of 1.4 ha. This implies that sugarcane is produced by small scale farmers at subsistence level. This could cause short supply which may trigger inflation in the cost of price of sugarcane. Despite many years of experience and education, when the most important factor of production (land) is not sufficient, the skills and knowledge will not be useful. This is an indication that the low production may be because of lack of sufficient land available for production. This is in line with the work of Issa *et al.* (2020), which also revealed that most sugarcane farmers in Kaduna State operate on small and fragmented farmlands between 1-2 ha, which hinders commercialization of sugarcane farming in Nigeria.



Table 1: Distribution of Respondents Socioeconomic Characteristics (n=273)

Socioeconomic characteristics	Frequency	Percentage	Mean	Std. Dev.
Age				
20-30	61	22.3		
31-40	138	50.6		
41-50	53	19.4		
51 and above	21	7.7		
Sex				
Male	217	79.5		
Female	56	20.5		
Marital status				
Single	44	16.1		
Married	210	76.9		
Separated	19	7.0		
Level of education				
Informal	25	9.2		
Primary	32	11.7		
Secondary	168	61.5		
Tertiary	48	17.6		
Years spent in school				
1-6	42	15.4		
7-12	138	50.6	12.1	4.03
13-16	61	22.3		
17 above	32	11.7		
Household size				
1-5	85	31.1		
6-10	155	56.8	7	1.32
11-15	24	8.8		
16 above	9	3.3		
Farming experience				
1-5	65	23.8		
6-10	141	51.6	8.6	2.75
11-15	31	11.4		
16-20	13	4.8		
21 above	23	8.4		
Farm size				
1-2	201	73.6	1.4	0.31
3-4	56	20.5		
5 above	16	5.9		

Institutional Characteristics of the Respondents

Results in Table 2 revealed that while majority of the farmers (61.5%) had no access to extension contact, the 38.5% who had access to extension contact were visited once in a month on average. This implies that most of the sugarcane farmers lack access to information and training that could boost production and enhance the adoption of e-extension tools. This is in line with Issa *et al.* (2020) who also reported that majority of sugarcane farmers in Kaduna State had no access to extension agents and when they do, it was mostly once a month. The results further revealed that majority (71.8%) of the farmers were not members of any cooperative societies while 28.2% of the farmers were members of cooperative societies, they have spent 6.1 years as members on average. This implies that most of the sugarcane farmers could be lacking farming information, access to loans and other benefits known to be provided by most cooperative societies. This may hinder the expansion of the farming enterprise or the productivity of their sugarcane farm. This is corroborated by the study of Issa *et al.* (2020) which also reported that majority of sugarcane farmers in Kaduna State were not members of cooperative societies.



On access to credit facilities, the results revealed that the majority of the sugarcane farmers (54.6%) do not have access to credit. While those with access to credit (45.4%) received on average ₦211,031.61. This implies that despite operating on a small scale, most sugarcane farmers in the study area do not have access to credit to expand their sugarcane farming. This could lead to low production across subsequent farming seasons, as cost of input rises due to inflation. This is in line with the work of Issa *et al.* (2020) who also reported while majority of sugarcane farmers in Kaduna State were not members of cooperative societies, access to credit facilities was mostly available to farmers who belonged to a cooperative society.

Table 2: Distribution of Respondents According to their Institutional Characteristics (n=273)

Institutional characteristics	Frequency	Percentage	Mean	Std. Dev.
Access to extension contact				
Had access	105	38.5		
No access	168	61.5		
Number of extension visits				
1-2	64	60.9	1.1	0.47
3-4	32	30.5		
5 above	9	8.6		
Membership of cooperatives				
Member	77	28.2		
Not a member	196	71.8		
Years spent in cooperative				
1-5	15	19.5		
6-10	47	61	6.1	1.93
11-15	10	13		
16 above	5	6.5		
Access to credit				
Had access	124	45.4		
No access	149	54.6		
Amount of credit received (₦)				
<50,000-100,000	21	16.9		
100, 001-200,000	38	30.7		
200,001-300,000	43	34.7	211,031.61	139,033.95
300,001-400,000	7	5.6		
400,001-500,000	10	8.1		
500,001 & above	5	4		

Factors Influencing the Adoption of E-extension Tools by Sugarcane Farmers

The Tobit regression results presented in Table 3 shows the socio-economic and institutional factors influencing the adoption of e-extension tools among sugarcane farmers in Kaduna State. Sex has a negative and statistically significant coefficient (-0.069 ; $p = 0.022$) at 5% probability level, implying that gender differences significantly shaping adoption outcomes, with female farmers exhibiting lower likelihood of adoption. The result gives credit to the fact that sugarcane farming is labour intensive which explains why females shying away. The coefficient for marital status was negative and statistically insignificant (-0.009 ; $p = 0.033$), indicating that marital status does not play a meaningful role in predicting e-extension adoption and suggesting that married sugarcane farmers are less likely to adopt e-extension tools compared to their unmarried counterparts.

Household size has a negative but insignificant coefficient (-0.012 ; $p = 0.515$), meaning family size does not significantly determine adoption. Farm size, although positive (0.007), is not statistically significant ($p = 0.409$), showing that landholding capacity does not necessarily translate to increased use of e-extension services.

Results further revealed that farming experience was one of the strongest predictors of adoption of e-extension tools by sugarcane farmers in Kaduna State, with a positive and highly significant coefficient (0.067 ; $p = 0.001$), indicating that farmers with more years of farming are more likely to



utilize e-extension tools. Years spent in school also positively influenced adoption (0.008) and was statistically significant at the 10% level of probability ($p = 0.076$), demonstrating that education enhances farmers' ability to understand and engage with digital extension platforms. The number of extension visits is another major determinant, with a positive and highly significant effect (0.002; $p = 0.004$), showing that frequent interactions with extension agents strongly encourage the use of e-extension tools. Conversely, years spent in cooperatives shows a positive but insignificant effect (0.004; $p = 0.154$), indicating that cooperative membership alone does not guarantee adoption. Finally, the amount of credit received significantly and positively influences adoption (0.025; $p = 0.002$), suggesting that access to financial resources improves farmers' capacity to procure digital tools or data services needed for e-extension. The significance of the overall model (LR $\chi^2 = 56.01$; $p = 0.000$) confirms that the included variables jointly influence a meaningful portion of the farmers' adoption of e-extension tools.

Table 3: Socio-economic Factors Influencing the Adoption of E-extension Tools by Sugarcane Farmers in Kaduna State

Variables	Coefficient	Std. Error	T-Value	P-Value
Age	0.001	0.001	1.52	0.130
Sex	-0.069	0.030	-2.30	0.022**
Marital status	-0.012	0.019	-0.65	0.515
Household size	0.007	0.008	0.83	0.409
Farm size	0.060	0.018	3.27	0.001***
Farming experience	0.003	0.002	1.78	0.076*
Years spent in school	0.027	0.007	3.62	0.002***
Number of extension visits	0.029	0.008	2.52	0.012***
Years spent in cooperative	0.006	0.024	1.43	0.154
Amount of credit received	0.074	0.023	3.20	0.002***
Constant	0.205	0.066	3.07	0.003***
Sigma	0.18055	0.01492		

LR $\chi^2(14) = 56.01$

Prob > $\chi^2 = 0.000$

Log likelihood = -239.194

Pseudo $R^2 = 0.1916$

***= Significant at 1%, **= significant at 5% and *= significant at 10% levels of probability.

CONCLUSION AND RECOMMENDATIONS

The study concludes that sex, farm size, farming experience, years spent in school, number of extension visits, and credit amount were the factors influencing the adoption e-extension tools in the study area. The study recommended that:

- The need for training extension agents on e-extension tool incorporating digital extension platforms into routine operations, of Kaduna State Agricultural Development Project (KADP) and other agricultural extension organizations in order to encourage farmer adoption.
- Financial organizations should create accessible credit solutions that are suited to farmers' demands in digital agriculture, especially microfinance banks and agricultural loan programs.
- To bridge the current gender gap in e-extension adoption, gender-inclusive policies and initiatives should be put into place training programs that target female farmers.
- To improve digital literacy among farmers, especially those with poor educational attainment, the government and development partners should set up training programs on using smartphones in navigating agricultural apps, and interpreting digital data.
- It is important to support and encourage farmer cooperatives to function as shared platforms for information sharing, resource aggregation, and e-extension service access in order to



- negotiate discounted data plans for their members, cooperative societies ought to collaborate with telecom companies.
- vi. Investments in rural telecommunications infrastructure, such as increasing broadband access and enhancing network coverage in rural areas, should be given top priority by the government.
 - vii. A comprehensive policy framework for digital agriculture that tackles concerns of data affordability, rural connection, and digital inclusion should be created and implemented by the government.

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