



EFFECTS OF E-EXTENSION TOOLS ADOPTION ON PRODUCTIVITY OF MAIZE FARMERS IN MAIGANA AGRICULTURAL ZONE OF KADUNA STATE, NIGERIA

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ABSTRACT

The study examined the effects of adoption of e-extension tools on productivity of maize farmers in Maigana agricultural zone of Kaduna State, Nigeria. A multi-stage sampling technique was used to select 305 respondents, with data primarily collected through a structured questionnaire. Both descriptive and inferential statistical methods were applied to achieve the study's objectives. The findings showed that farmers who adopted E-extension tools were relatively young, with an average age of 36.8 years. Majority (73.95%) of the respondents had been members of cooperative societies for 6 to 10 years. The study also revealed a high adoption rate of E-extension tools (70.5%). In terms of impact, the results indicated a significant increase in farmers' productivity, as yield (54.142), income (21.819), and living standards (19.377) showed statistically significant improvements at a 1% probability level after adopting E-extension tools. However, the major challenges identified were the high cost of internet data (75.7%), poor network coverage in rural areas (83.3%), inadequate or unreliable information (60.3%).

Keywords: Adoption, E-extension, Maize, Productivity, Kaduna

INTRODUCTION

Change and progress in the agriculture sector are fueled by farmers' access to pertinent knowledge on innovative farming techniques (Bonephace *et al.*, 2022). The farmers' community must be informed in a timely, relevant, and current manner for sustainable agricultural growth to occur through the use of information and communication technologies. (Partap and Manju, 2021). E-extension uses electronic technologies to enhance traditional extension approaches (written and face-to-face) to enable change (Global forum for rural advisory services, 2024). E-extension refers to the use of information and communication technologies (ICTs) to improve agricultural extension services. It helps farmers make informed decisions, boost their productivity, and increase their income. These services are provided through different channels, such as mobile apps, videos, audio content, and social media platforms (Haggag, 2021). The majority of farmers in developing nations, like Nigeria, reside in rural areas, Smallholder farmers in these areas who remain the bedrock of the agricultural and food supply chains in Nigeria needs to improved their productivity through the adoption of E-extension tool for easy access to relevant agricultural information, practices and technology. Adoption of E-extension in agriculture refers to the process that includes transferring information on adopting modern practices, new crop varieties with agronomic practices, and response to supply and demand on local and international markets. (Partap and Manju, 2021).

The agricultural sector in Nigeria, particularly in Kaduna State, faces significant productivity challenges due to the inadequate dissemination of agricultural information and innovations. Zone. Reliance on traditional face-to-face extension interaction strategies and agricultural information exchange with clients has worsened the situation (Aminou *et al.*, 2020). The E-electronic extension tools have emerged as a promising solution to address the information gap and improve agricultural productivity. E-extension tools also aim to reduce inefficiencies coming from grossly simplified recommendations from traditional extension, thereby raising the productivity and profitability from adopting improved inputs (Rico *et al.*, 2024). Despite their potential, the adoption of these tools among maize farmers in Maigana is low, and their effects on maize productivity is not well understood.



Despite numerous studies that have been carried out by different scholars on E-e-extension; (Usman, *et al.*, 2020), (Etuk, *et al.*, 2023). Usman, *et al.*, (2020) Experiential Analysis of Awareness and Adoption of E-Extension among Poultry Farmers in Gombe State, Nigeria the focus of their study was to assess E-extension awareness and adoption among poultry farmers in Gombe State. Their main focus, their focus was on how to assess the factors influencing the use of E-extension tools among commercial layer farmers, (Etuk, *et al.*, 2023) their study was on the review of E- agricultural extension services in Nigeria. What is almost lacking in their studies, however, is assessing the effect of E-extension on improving productivity among maize farmers. Therefore their studies have left a gap in assessing the effects of E-extension on maize production. It is on this basis that this study attempts to provide an empirical analysis of the effects of E-extension on improving productivity maize production in Kaduna State. Thus the pertinent research objectives that were addressed are to: (i) describe the socio-economic characteristics of maize farmers, (ii) determine the level of adoption of E-extension tools among maize farmers in the area, (iii) assess the effect of E-extension tools on improving the productivity of maize farmers and (iv) describe the constraints associated with the adoption of E-extension tools by maize farmers in the study area.

METHODOLOGY

The Study Area

The study was carried out in the Maigana Zone of the Kaduna State Agricultural Development Project (KADP). Kaduna State is situated in the northern region of Nigeria, between latitudes 9°10'N and 11°30'N and longitudes 6°05'E and 8°38'E (Kaduna State Ministry of Agriculture, 2014). The state, with Kaduna as its capital, occupies a central position in northern Nigeria. It shares borders with Zamfara, Katsina, Niger, Kano, Bauchi, Plateau, and Nasarawa states. Additionally, to the southwest, it borders the Federal Capital Territory, Abuja. Kaduna State covers an area of approximately 48,473.2 square kilometers and had a recorded population of 6,113,503 in the 2006 National Population Census (NPC). Based on an annual growth rate of 3.18% estimated by the NPC, the population was projected to reach around 10.4 million by 2024. The state experiences two distinct seasons: the rainy season, which lasts from May to September, with an average annual rainfall of 600mm to 1000mm, and the dry season. Temperatures are generally high between April and September, with daily minimum and maximum temperatures averaging 15°C and 35°C, respectively. The vegetation consists of Sudan Savanna, characterized by scattered short trees, shrubs, and grasses. The soil is predominantly loamy to sandy, with some areas containing significant amounts of clay. The favorable climate and soil conditions support the cultivation of various crops, including maize, beans, groundnuts, guinea corn, millet, cotton, yam, carrots, sugarcane, tomatoes, peppers, onions, garden eggplants, lettuce, amaranthus, and tobacco. Additionally, the state is well-known for livestock farming.

Sampling Techniques and Sample Size

A multi-stage sampling approach was used to collect data for this study. Kaduna State is divided into four agricultural zones: Maigana, Birnin-Gwari, Lere, and Samaru. In the first stage, the Maigana zone was purposively chosen due to its easy accessibility and security stability, as it is free from banditry activities. Maigana zone consists of eight Local Government Areas (LGAs): Soba, Giwa, Kubau, Ikara, Makarfi, Kudan, Sabon Gari, and Zaria.

In the second stage, three LGAs, Kudan, Makarfi, and Soba were randomly selected. The third stage involved the random selection of four communities from each of these LGAs. Finally, in the fourth stage, 306 maize farmers were randomly selected from a total of 1,302 registered farmers, as obtained from the Kaduna State Agricultural Development Agency (KADP). The sample size was determined using Yamane's (1967) formula, as applied by Olademeji and Ibrahim (2017), with a 5% margin of error and a 95% confidence level. Additionally, a finite correction factor was applied, based on a list of rural farmers obtained from the Kaduna State Agricultural Development Programme (KADP) during a reconnaissance survey conducted in 2018.

The Solvian formula is given as:

$$n = N/(1+N(e)^2).$$



Where n = sample size,

e = the assumed error of margin or level of significance which is taken as 0.05 i.e 95% confidence level on the assumption (population of farmers),

N = total number of respondents

1 = statistical constant.

Therefore: $n = N/1 + N(e)^2$

Methods of Data Collection

This study relied on primary data, which was collected using a well-structured questionnaire. Trained enumerators assisted in administering the questionnaires to maize farmers in the Maigana Zone of Kaduna State.

Methods of Data Analysis

To analyze the data, descriptive statistics such as frequency distribution tables, percentages, means, and standard deviations were used to organize and summarize information for objectives (i), (ii), and (iv). For objective (iii), a Z-test analytical tool was applied to assess the impact of e-extension practices on maize farmers' productivity. The Z-test was chosen because it is suitable for sample sizes greater than 30 and helps determine significant differences in outcomes before and after adopting e-extension tools. The Z-test formula is as follows:

$$Z = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

Where Z = the calculated Z value

X_1 = mean output/ income after adoption of E-extension tools

X_2 = mean output/ income before the adoption of E-extension tools

S_1 = Standard deviation after the adoption of E-extension tools

S_2 = Standard deviation before the adoption of E-extension tools

n_1 = number of respondents before the adoption of E-extension tools

n_2 = number of respondents after adoption of E-extension tools

RESULTS AND DISCUSSION

Socioeconomic and Institutional Characteristics of the Respondents

The results in Table 1 show that a significant proportion (29.2%) of the respondents were between the ages of 31 and 40, with an average age of 37 years. This suggests that maize farmers in the study area are in their productive years and are likely to take advantage of opportunities provided by e-extension tools. Farmers in this age group are also more likely to handle the physical demands of farming, which can impact productivity and the adoption of new innovations. These findings are consistent with the study by Tukura *et al.* (2021) in Taraba State, which found that most maize farmers were in their active working years.

The table also indicates that the majority (78.0%) of the respondents were male, suggesting that men dominate maize farming in the area. This could be because maize cultivation requires significant physical effort and time, which may be more challenging for women, who often take on household responsibilities and engage in small-scale businesses. As a result, men are more involved in farming activities in this region. These findings align with the research by Oke *et al.* (2022), which also found that most maize farmers were male.

Education plays a crucial role in helping farmers make informed and effective management decisions. The educational level of a household head is believed to influence their willingness and ability to adopt E-extension tools. The results in Table 1 show that most (33.4%) of the respondents had completed secondary education. This suggests that the majority of maize farmers in the study area have a moderate level of education, which is beneficial for understanding and applying agricultural information. A good education helps farmers make better decisions, ultimately leading to higher



productivity. These findings align with the study by Samuel *et al.* (2023), which highlighted the importance of education in effectively utilizing ICT tools.

Having more farming experience often leads to better farm performance. Farmers who have spent more years in agriculture tend to make more informed decisions compared to those with less experience. The results in Table 1 indicate that most (48.2%) respondents had between 6 and 10 years of farming experience, with an average of 6.7 years. This suggests that the majority of maize farmers in the study area have significant experience, which can be beneficial in making strategic decisions and effectively utilizing resources to boost productivity. These findings are consistent with the study by Eweoya *et al.* (2021), which found that many farmers had above-average experience, contributing to their higher adoption of e-agricultural practices. This highlights the likelihood that experienced farmers are more open to adopting innovative techniques that can improve agricultural productivity. The results in Table 1 show that most (55.7%) respondents had farm sizes between 2 and 3 hectares, with an average of 2.4 hectares. This indicates that maize farming in the study area is primarily carried out on a small scale. Smaller farm sizes may encourage the adoption of new technologies, as farmers with limited land are more likely to embrace innovative methods to maximize productivity rather than risk their land on untested practices. These findings align with the study by Danjuma (2024), which also highlighted that most farmers operate on a small scale.

The results in Table 1 indicate that the majority (73.9%) of respondents had been members of cooperative societies for about 6 to 10 years, with an average membership duration of 7.9 years. This suggests that many maize farmers in the study area may have limited access to essential farming information, agricultural loans, and other benefits typically provided by cooperative societies. These findings contrast with the study by Ebisike *et al.* (2021), which found that most farmers in their study area were actively involved in associations.

The results in Table 1 show that the majority (98.8%) of respondents received only one or two visits from extension agents per month, with an average of just one visit. This suggests that most maize farmers have limited access to information on improved farming practices and other agricultural resources provided by extension agents. These findings are consistent with the study by Sennuga *et al.* (2023), which reported that most farmers acknowledged having little to no contact with extension services.

The results in Table 1 indicate that most respondents (67.8%) received credit between ₦20,000 and ₦100,000, with an average of ₦63,406.8. This suggests that, despite being small-scale farmers, many maize farmers in the study area lack sufficient access to credit to expand their production. Limited financial support may result in lower yields each farming season, as farmers may struggle to implement beneficial maize farming practices learned through e-extension tools. These findings align with the study by Mani *et al.* (2021), which also found that most farmers did not have access to credit for maize production.



Table 1: Distribution of Respondents according to their Socioeconomic and Institutional Characteristics (n=305)

Variable	Frequency	Percentage	Mean	Std. dev.
Age				
21-30	73	24.0	36.8	12.45
31-40	89	29.2		
41-50	84	27.5		
50 above	59	19.3		
Sex				
Male	238	78.0		
Female	67	22.0		
Education level				
Non-formal	76	25.0		
Primary	47	15.4		
Secondary	102	33.4		
Tertiary	80	26.2		
Farming experience				
1-5	7	2.3	6.7	4.05
6-10	147	48.2		
11-15	68	22.3		
16 above	83	27.2		
Farm size				
<1-1.9	110	36.1	2.4	1.76
2-3	170	55.7		
4-5	15	4.9		
6 above	10	3.3		
Years of Membership				
1-5	23	25	7.9	2.05
6-10	68	73.9		
11 above	1	1.1		
Extension visits				
1-2	82	98.8	1.3	0.48
3 above	1	1.2		
Amount of credit received.				
20000-100000	40	67.8	63406.8	38339.3
100001-150000	16	27.1		
1500001 above	3	5.1		

Level of Adoption of E-Extension Tools by Maize Farmers

Table 2 presents the level of adoption of e-extension tools among maize farmers in the study area. The findings show that a significant majority (70.5%) of the respondents actively use these tools. This indicates that with widespread adoption, many maize farmers can access valuable information on improved farming techniques, which can enhance their productivity. These results are consistent with the study by Fetagn *et al.* (2024), which found that most urban farmers in FCT Abuja utilize ICT for their agricultural activities.



Table 2: Distribution of Respondent according to their Level of Adoption of E-extension Tools

E-extension tools	Weighted score	Mean score	Remark
Phones	779	1.56	Sometimes
Social media	582	2.09	Sometimes
Radio	1106	1.10	Always
Television	417	2.93	Rarely
National Farmers Helpline	396	3.08	Rarely
Animations	691	1.77	Sometimes
Interactive voice response	405	2.87	Rarely
Internet websites	962	1.26	Always
Level of adoption	Adoption index	Frequency	Percentage
Low	0.00-0.20	20	6.6
Moderate	0.21-0.50	70	23
High	0.51-1.00	215	70.5

Note: Always=1, Sometimes=2, Rarely=3, Never=4

Effect of E-extension Tools Adoption on Productivity of Maize Farmers

The Z-test results in Table 3 highlight the impact of adopting e-extension tools on maize farmers' productivity. The findings reveal that the average yield before adoption was 1,523.5 kg/ha, while after adoption, it increased significantly to 2,789.3 kg/ha. This increase was statistically significant (Z-value = 54.142) at a 1% probability level. This suggests that using e-extension tools can significantly boost maize yield, as farmers produced more after adopting these digital resources. These findings align with the study by Sennuga and Fadiji (2020), which also reported that e-extension adoption led to a considerable increase in farmers' yields.

The results in Table 3 also show the impact of e-extension tool adoption on farmers' income. Before adoption, the average income was ₦240,724.6, but after adoption, it significantly increased to ₦779,304.9. This increase was statistically significant (Z-value = 21.819) at a 1% probability level. The findings suggest that as e-extension tools contribute to higher yields, they also lead to a substantial rise in farmers' income, highlighting their importance in maize production. However, these results contrast with the study by Sennuga and Fadiji (2020), which found that mobile phone ownership, rather than e-extension tools, had a significant impact on farmers' productivity in Sub-Saharan Africa.

Additionally, the results in Table 3 indicate that the average standard of living among maize farmers improved significantly after adopting e-extension tools. Before adoption, the mean level of living was ₦110,419.6, which increased to ₦324,849.2 after adoption. This increase was statistically significant at a 1% probability level, with a Z-value of 19.377. This suggests that farmers were able to spend more on household and livestock assets after using e-extension tools compared to before. These findings align with the study by Gajek *et al.* (2022), which reported that ICT usage among farmers enhances productivity and overall well-being.



Table 3: Effect of E-extension Tools Adoption on the Productivity of Maize Farmers

Variables	Before adoption		Mean	After adoption		Mean	Z-value
	Freq	%		Freq.	%		
Yield (kg)							
500-1000	9	2.9		3	0.9		
1001-2000	262	85.9		42	13.8		
2001-3000	15	4.9	1523.5	198	65	2789.3	54.142***
3001-4000	11	3.7		37	12.1		
4000 above	8	2.6		25	8.2		
Income (₦)							
<100000-400000	142	46.6		37	12.1		
4000001-700000	98	32.1	240724.6	42	13.8	779304.9	21.819***
700001-1000000	55	18		165	54.1		
1000000 above	10	3.3		61	20		
Level of living (₦)							
<100000-300000	91	30		12	3.9		
300001-400000	52	17	110419.6	21	6.9	324849.2	19.377***
400001-500000	87	28.5		221	72.5		
500000 above	75	24.5		51	16.7		

Household and Livestock Assets Owned by Maize Farmers in the Study Area

The result in Table 4 revealed that the percentage differences in household assets owned before and after the adoption of e-extension tools were 40%, 61%, 56.2%, 35%, 45.4%, and 4.4% for furniture, cars, motorcycle/tricycles/bicycle, cell phones, television, and radio respectively. Other include; sprayers, grinding machines, land, hoes, cutlass/ axes, and wheel wheelbarrows. This implies that, after the adoption of the e-extension tool, maize farmers spent more money on household assets. Also, results in Table 4 revealed that the percentage differences in livestock assets owned before and after the adoption of the e-extension tool were 21%, 17.2%, 7.2%, and 24.4% for bull, cows, goats, and sheep respectively. Other include; ducks, chickens, turkeys, rabbits, donkeys, and horses. This implies that the money that maize farmers spent on livestock assets was higher than before the adoption of e-extension tools.



Table 4: Distribution of Respondents according to Household and Livestock Assets Owned before and after Adoption of E-extension Tools

Assets	Before adoption Freq.*	%	After adoption Freq.*	%	% difference
Furniture	162	30	370	70	40
Cars	13	19.4	54	80.6	61.2
Motorcycle/tricycle/bicycle	70	21.9	250	78.1	56.2
Cell phones	179	32.5	372	67.5	35
Television	74	27.3	197	72.7	45.4
Radio	199	47.8	217	52.2	4.4
Sprayers	215	44.3	270	56.7	12.4
Grinding machines	38	27.1	102	72.9	45.8
Land	179	37.4	300	62.6	25.2
Hoes	502	45.9	592	54.1	8.2
Cutlass/axes	324	46.2	378	53.8	7.6
Wheelbarrow	201	32.5	417	67.5	35
Bull	352	39.5	539	60.5	21
Cows	402	41.4	570	58.6	17.2
Goats	303	46.4	350	53.6	7.2
Sheep	85	37.8	140	62.2	24.4
Ducks	82	21.5	299	78.5	57
Chickens	194	59.3	133	40.7	18.6
Turkey	78	22.9	263	77.1	54.2
Rabbits	179	41.1	256	58.9	17.8
Donkey	84	27.5	221	72.5	45
Horses	77	27.4	204	72.6	45.2

*Multiple responses allowed

Constraints Associated with the Adoption of E-extension Tools by Maize Farmers in the Study Area

The findings in Table 5 show that maize farmers face several challenges in adopting e-extension tools. The most common issues were poor network coverage, high mobile data costs, and inaccurate or unreliable information, ranking as the top three constraints. Other difficulties include limited access to smartphones or computers, reluctance to embrace new technologies, inconsistent power supply, low digital literacy, and language barriers, ranking 4th to 8th, respectively. This suggests that the challenges farmers encounter stem from various factors, including financial, social, cultural, and technological barriers. These findings align with the study by Idris *et al.* (2024), which highlighted that poor infrastructure in rural areas hinders the adoption of ICT tools among farmers.

Table 5: Distribution of Respondents according to Constraints Associated with the Adoption of E-extension Tools in the Study Area

Constraints	Frequency*	Percentage	Rank
Poor network coverage	254	83.3	1 st
High cost of mobile data/internet	231	75.7	2 nd
Inadequate or unreliable information	184	60.3	3 rd
Lack of access to smartphones/computers	174	57.1	4 th
Resistance to new technology	160	52.5	5 th
Erratic power supply	110	36.1	6 th
Low digital literacy	102	33.4	7 th
Language barriers	101	33.1	8 th

*Multiple responses allowed



CONCLUSION AND RECOMMENDATION

The study concluded that e-extension tools play a vital role in improving maize productivity among farmers due to their high adoption rate. The significant rise in yield, income, and overall standard of living among those who adopted these tools highlights their positive impact. However, challenges such as poor network connectivity, high mobile data costs, and unreliable information must be addressed to ensure long-term and effective use of e-extension tools.

Based on the findings it was recommended that

- i. The high cost of mobile data for farmers should be reduced by promoting subsidized data plans to make e-extension tools more affordable.
- ii. Since many maize farmers reported poor network coverage in the study area, it is recommended that network providers enhance connectivity in rural regions.
- iii. The study identified a lack of awareness about the importance of e-extension tools. Therefore, efforts should be made to educate farmers through sensitization campaigns on the benefits of using these tools.
- iv. Some maize farmers expressed concerns about unreliable information shared through e-extension services. To address this, organizations should ensure that all information comes from credible and trustworthy sources, with regular updates and corrections. Additionally, agricultural extension agencies should create targeted programs to meet the specific needs of farmers.

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