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Effectiveness of Digital Extension Services in Enhancing Rural Development for Households in Kebbi State

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ABSTRACT

This study examined the effectiveness of digital extension services in enhancing rural development among farming households in Kebbi State, Nigeria. A multistage sampling procedure was used to select 343 respondents across Kebbi State's four agricultural zones. Data were collected through structured questionnaires and analyzed using descriptive statistics, paired t-tests, and logistic regression models. Results from the socio-economic analysis revealed that (60.1%) of respondents lacked access to digital extension services, while (75.2%) had some form of formal education and (82.5%) had more than five years of farming experience. A majority operated on 1–3 hectares of farmland and (65%) lacked access to credit, indicating limited financial capacity. Findings on accessibility and utilization showed that (61.2%) of respondents owned digital devices, primarily basic mobile phones (92.9%), yet only (42.9%) had internet connectivity. Awareness and utilization of digital extension services were low, at (37.9%) and (28.0%), respectively. Among users, the most common platforms included SMS-based agricultural information (73.7%), mobile farming applications (52.6%), and social media groups (42.1%). Paired t-test results demonstrated that users of digital extension services had significantly higher mean yields (3,850 kg/ha) and annual farm incomes (₦850,000) compared to non-users (2,920 kg/ha and ₦630,000, respectively) at $p < 0.01$. Users also reported greater access to market information (82.5%) and use of improved inputs (77.9%) than non-users (45.8%) and (50.4%), respectively). These findings indicate that digital extension services substantially improve agricultural productivity and income. Logistic regression results identified education level ($\beta = 0.158$, $p = 0.001$), farm size ($\beta = 0.093$, $p = 0.002$), access to credit ($\beta = 0.564$, $p = 0.042$), membership in farmer groups ($\beta = 0.732$, $p = 0.012$), and access to digital tools ($\beta = 0.847$, $p = 0.006$) as significant predictors of adoption. Farmers with higher education, larger farms, better financial access, and group membership were more likely to use digital extension services, while age and farming experience were not significant predictors. The study concludes that digital extension services have a positive and statistically significant effect on farmers' productivity, income, and technology adoption in Kebbi State. To maximize their potentials, the study recommends targeted interventions such as digital literacy training, improved ICT infrastructure, affordable internet access, localized digital content in local languages, and expanded access to credit for smallholder farmers.

INTRODUCTION

Agriculture is predominantly characterized by smallholder farmers who rely on traditional farming methods (Kebbi State Government, 2023). These farmers face numerous challenges, including limited access to modern farming techniques, inadequate extension services, and the adverse effects of climate change. To address these issues, digital extension services have emerged as a promising solution to bridge the information gap and promote rural development. Kebbi State, located in north-western Nigeria, encompasses a land area of approximately 36,800 square kilometres (Kebbi State Government, 2023). The state's economy is heavily reliant on agriculture, with major crops including rice, millet, sorghum, maize, and groundnuts (Kebbi State Government, 2023). Despite its agricultural potential, the sector faces challenges such as outdated farming practices, limited access to quality inputs, and insufficient extension services, which have hindered productivity and rural development. Traditional agricultural extension services in Nigeria have been plagued by issues such as inadequate funding, insufficient staffing, and logistical constraints (Farmonaut, 2023). These challenges have resulted in limited outreach, leaving many rural farmers without access to timely and relevant agricultural information. The conventional face-to-face extension approach often fails to meet the diverse needs of farmers, leading to suboptimal adoption of improved agricultural practices.

Digital extension services leverage information and communication technologies (ICTs) to disseminate agricultural information to farmers efficiently. These services encompass various platforms, including mobile applications, SMS-based alerts, interactive voice response systems, and online portals (Farmonaut, 2023). The integration of digital tools into agricultural extension aims to overcome the limitations of traditional methods by providing real-time, customized, and easily accessible information to farmers. Studies have demonstrated the potential of digital extension services in enhancing agricultural productivity and promoting rural development. For instance, the Development and Expansion of Nigerian Digital Agricultural Advisory Services (DEDAAS) initiative was designed to mitigate the impacts of COVID-19 on smallholder farmers by supporting access to affordable inputs and advisory services to sustain production (Precision Development, 2021). This initiative highlights the role of digital platforms in providing timely and relevant information to farmers, thereby enhancing their decision-making processes.

Furthermore, the utilization of mobile applications has been shown to enhance the delivery of extension services. A study assessing the effectiveness of mobile apps in Nigeria revealed that these tools significantly improve the accessibility and quality of agricultural information, leading to better decision-making among farmers (Ik-Ugwoezuonu & Ezike, 2024). The study highlighted that mobile apps provide a cost-effective mechanism for service providers to offer timely, quality, last-mile services to value chain actors, including farmers. The adoption of digital extension services has far-reaching implications for rural development. By providing farmers with access to up-to-date information on best practices, market trends, and weather forecasts, these services empower them to make informed decisions, thereby increasing productivity and income levels. In Kebbi State, initiatives that promote the use of digital tools have been associated with improved agricultural output and enhanced livelihoods.

Statement of the Research Problem

Agriculture remains a critical sector in Nigeria's economy, serving as the primary source of livelihood for the majority of rural dwellers. However, the effectiveness of traditional agricultural extension systems has been constrained by factors such as inadequate funding, insufficient personnel, poor logistics, and weak communication infrastructure (Aker, 2020; Feder et al., 2021). These challenges have led to low coverage, slow information dissemination, and limited farmer participation in innovation processes. In response, digital extension services have emerged as a promising alternative, leveraging mobile phones, internet platforms, and other information and communication technologies (ICTs) to deliver agricultural knowledge more efficiently and interactively (Zanello *et al.,* 2019). Previous studies, both within and

outside Nigeria, have established that digital technologies can enhance agricultural productivity, knowledge transfer, and rural livelihoods (Mittal & Mehar, 2016; Nakasone & Torero, 2016; Fu & Akter, 2021). In the Nigerian context, several scholars such as Arokoyo (2018), Ogunniyi *et al*. (2020), and Ifeanyi-Obi and Corbon (2023) have examined the awareness and accessibility of ICT tools among farmers, highlighting challenges such as poor connectivity, limited digital literacy, and high costs of devices. However, these studies have largely focused on descriptive assessments of ICT adoption, without rigorously analyzing the determinants of adoption and their implications for rural development outcomes.

The missing link, therefore, lies in the lack of empirical evidence explaining the factors that significantly influence farmers' adoption of digital extension services and how such adoption translates into improved rural livelihoods in the Nigerian context, particularly in Kebbi State, where agricultural potential is high but digital infrastructure and literacy levels remain relatively low. Furthermore, existing research rarely employs statistical models such as logistic regression to identify the key socioeconomic and institutional factors driving digital extension adoption among rural households. This study seeks to fill this gap in knowledge by employing a robust empirical approach to determine the factors influencing the adoption of digital extension services and to assess their effectiveness in enhancing rural development among households in Kebbi State. The findings will provide evidence-based insights to guide policymakers, extension agencies, and development organizations in designing targeted interventions that promote inclusive digital transformation in Nigeria's agricultural sector.

Objectives of the Study

The primary objective of the study is to assess the effectiveness of digital extension services in fostering rural development among households in Kebbi State. Specific objectives are to:

i. describe the socio-economic characteristics of the respondents,
ii. ascertain the accessibility and utilization of digital extension services,
iii. determine the impact of these services on agricultural productivity and income, and
iv. identify the factors influencing the adoption of digital extension services.

METHODOLOGY

Description of the Study Area

Kebbi State is located in North Western Nigeria, and it occupies a total land area of 36,800 square kilometers. Kebbi state shares boundaries with Sokoto State on the North-Eastern axis, Zamfara State on the Eastern part, Niger State on the Southern part and Republic of Niger on the Western part. The state is located within latitude 100 051 to 130 271 North and Longitude 30 351 to 60 031 East (KBSG, 2023). The mean annual rainfall ranges from 400-800mm, and the mean annual temperature varies from 210C to 380C (KBSG, 2023). According to City Population, Kebbi State's projected population in 2022 is about 5,563,900. The major ethnic groups in the state include the Fulani, Hausa, Dakarkari, and Kambari. Islam is the dominant religion of the people. Kebbi State has an agriculturally viable environment since it is endowed with high soil fertility, vast farm land and economically viable rivers such as river Niger and it is also sheltered by fine tropical climate. Owing to these factors, Agriculture has remained the major source of revenue and indeed the backbone of the economy of the state. Major food crops produced in the area are millet, guinea corn, maize, cassava, potatoes, rice, beans, onions, and vegetables. While Cash crops including wheat, soybeans, ginger, groundnuts, and tobacco are also produced in the state. Similarly, fruits such as mango, cashew, guava, and pawpaw are produced under horticulture (KBSG, 2023). Kebbi state is endowed with economically viable rivers such as the Niger and Rima for the development of fisheries activities. Fishing has always been one of the key occupations of the inhabitants of the state.

Sampling Procedure and Sample Size

The study employed a multistage sampling procedure to ensure adequate and representative coverage of farming households across different agricultural zones of Kebbi State. In the first stage, four Local Government Areas (LGAs) Gwandu, Argungu, Zuru, and Yauri were purposively selected based on their agricultural significance and ecological diversity. Gwandu represents the semi-urban agricultural zone characterized by smallholder crop production; Argungu is a major rice and fish-producing area; Zuru represents the mixed farming and livestock production zone; while Yauri is predominantly a riverine area with intensive fishing and irrigation activities. The purposive selection of these LGAs provided a balanced representation of the major agricultural production systems in Kebbi State.

In the second stage, three communities were randomly selected from each of the four LGAs, resulting in a total of twelve (12) communities. This stage ensured that both core agricultural and peripheral settlements were adequately represented to capture variations in access to digital extension services and livelihood characteristics. In the third stage, a list of farming households in each selected community was obtained from agricultural extension offices and local leaders. The household heads constituted the sampling units for this study. Using a simple random sampling technique, approximately 28 to 30 farming households were selected per community, giving a total of 343 respondents across the four LGAs.

Method of Data Collection

Data were collected using structured questionnaires administered through face-to-face interviews. The questionnaire encompassed sections on socio-economic characteristics, access to and utilization of digital extension services, impacts on productivity and income, and barriers to adoption and were administered through interview with the respondents.

Method of Data Analysis

Data were analysed using both descriptive and inferential statistics such as paired sample t-tests and Logit regression analysis.

Model Specification

Logit model specification

Logit Regression Analysis (LRA) was employed to assess the factors influencing digital extension service adoption. **Logit Regression Analysis** is an inferential statistical tool that describes the relationship between a censored continuous dependent variable y_i and a vector of independent variables x_i.

The general Logit regression model is mathematically expressed as:

$$Y = \alpha + \beta o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \ldots + \beta_7 X_7 + U \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where;

Y_i is the dependent variable, and X_1– X_7 are the independent variables.
X_1 = Access to Digital Extension probability of having access to digital extension (1 if accessed, 0 if not)
X_2 = Age (Years)
X_3 = Level of education (Years spent in school)
X_4= = Farm size (ha)
X_5= = Farming experience (Years)
X_6= Access to credit (1 for access, 0, otherwise)
X_7= Membership in Farmer Groups (1 for member, 0, otherwise)
U=Error term
α =Alpha

B_i =Constant term
$B_1 - \beta_7$ = Regression coefficients estimated

RESULTS AND DISCUSSION

Table 1: Socio-Economic Characteristics of Respondents (N = 343)

Characteristic	Frequency	Percentage (%)
Access to Digital Extension Services		
Yes	137	39.9
No	206	60.1
Age (Years)		
20–29	45	13.1
30–39	102	29.7
40–49	128	37.3
50 and above	68	19.8
Education Level		
No formal education	85	24.8
Primary education	110	32.1
Secondary education	98	28.6
Tertiary education	50	14.6
Farm Size (Hectares)		
Less than 1	90	26.2
1–3	175	51.0
More than 3	78	22.7
Farming Experience (Years)		
Less than 5	60	17.5
5–10	140	40.8
More than 10	143	41.7
Access to Credit		
Yes	120	35.0
No	223	65.0
Membership in Farmer Groups		
Yes	150	43.7
No	193	56.3
Yield (kg/ha)		
Less than 1000	95	27.7
1000–2000	180	52.5
More than 2000	68	19.8
Income (Naira per annum)		
Less than 200,000	110	32.1
200,000–500,000	160	46.6
More than 500,000	73	21.3

Source: Field Survey, 2025

Table 2: Accessibility and Utilization of Digital Extension Services (N = 343)

Variable	Frequency	Percentage (%)
Access to Digital Devices		
Yes	210	61.2
No	133	38.8
Types of Digital Devices Owned		
Mobile Phone	195	92.9
Smartphone	120	57.1
Computer/Laptop	45	21.4
Tablet	30	14.3
Internet Connectivity		
Yes	150	42.9
No	193	57.1
Frequency of Internet Use		
Daily	90	60.0
Weekly	40	26.7
Monthly	20	13.3
Awareness of Digital Extension Services		
Yes	130	37.9
No	213	62.1
Utilization of Digital Extension Services		
Yes	95	28.0
No	248	72.0
Types of Services Utilized		
Agricultural Information via SMS	70	73.7
Mobile Applications for Farming Practices	50	52.6
Online Agricultural Training/Webinars	25	26.3
Social Media Groups for Farmers	40	42.1

Source: Field Survey, 2025

Table 3: Impact of Digital Extension Services on Agricultural Productivity and Income (N = 343)

Variable	Users of Digital Extension Services (N = 95)	Non-Users of Digital Extension Services (N = 248)	t-value	p-value
Average Farm Size (ha)	3.2 ± 1.5	2.7 ± 1.3	2.04	0.043*
Average Yield (kg/ha)	3,850 ± 920	2,920 ± 750	6.37	0.000**
Annual Income from Farming (₦)	850,000 ± 320,000	630,000 ± 280,000	5.29	0.000**
Access to Market Information (%)	82.5	45.8	-	-
Use of Improved Inputs (%)	77.9	50.4	-	-

Source: Field Survey, 2025 *** Significant at 1%, ** Significant at 5%, * Significant at 10%*

Table 4: Logistic Regression Results on Factors Influencing the Adoption of Digital Extension Services (N = 343)

Variable	Coefficient (β)	Standard Error (SE)	Odds Ratio (e^β)	Z-value	p-value
Intercept	-1.732	0.654	-	-2.65	0.008**
Access to Credit	0.564	0.276	1.758	2.04	0.042*
Farm Size	0.093	0.028	1.098	3.32	0.002**
Education Level	0.158	0.045	1.171	3.51	0.001**
Age	-0.024	0.013	0.976	-1.82	0.068
Farming Experience	0.011	0.015	1.011	0.74	0.462
Membership in Farmer Groups	0.732	0.298	2.080	2.46	0.012*
Access to Digital Tools	0.847	0.312	2.333	2.71	0.006**

*Source: Field Survey, 2025 *** Significant at 1%, ** Significant at 5%, * Significant at 10%*

Table 1 shows the analysis of socio-economic characteristics reveals several insights into the rural households in Kebbi State. A significant proportion (60.1%) of respondents reported not having access to digital extension services. This demographic is potentially more open to adopting new technologies, as younger farmers may be more adaptable and willing to integrate digital tools into their practices. However, the study by Yakubu et al. (2013) also highlights that computer illiteracy among extensionists poses a barrier to effective ICT utilization, which may similarly affect younger farmers lacking adequate training.

Educational attainment among respondents shows that (75.2%) have some level of formal education, with (14.6%) attaining tertiary education. Higher education levels are often associated with a greater propensity to adopt innovative practices, including digital extension services. This is corroborated by the findings of Yakubu *et al*. (2013), who noted that education significantly influences the use of ICTs for agricultural information. Farm size analysis reveals that over half of the respondents (51%) operate on 1–3 hectares, classifying them as smallholder farmers. Small farm sizes may limit the resources available for investment in new technologies, potentially hindering the adoption of digital extension services. This is consistent with the observations of Yakubu *et al.* (2013), who reported that limited access to computers and the internet is a constraint for smallholder farmers. Regarding farming experience, a substantial portion (82.5%) of respondents have more than 5 years of experience, indicating a seasoned farming community. While extensive experience can lead to entrenched traditional practices, it can also provide a foundation for understanding the benefits of adopting digital tools to enhance productivity.

Access to credit remains a challenge, with (65%) of respondents lacking access to credit. Financial constraints are a significant barrier to adopting new technologies, as noted by Yakubu *et al.* (2013), who emphasized the need for improved ICT accessibility and infrastructure to facilitate adoption. Membership in farmer groups is relatively low, with only (43.7%) participating in such organizations. Farmer groups often serve as platforms for knowledge exchange and collective bargaining, which can enhance access to extension services and resources. The low participation rate may impede the dissemination of digital extension services, as group dynamics can influence individual adoption decisions.

Yield data indicates that the majority (52.5%) achieve 1000–2000 kg/ha, while income analysis shows that (46.6%) earn between ₦200, 000–500,000 annually. These figures suggest modest productivity and income levels, which may affect the capacity to invest in digital technologies. Improving access to digital extension services could potentially enhance yields and incomes by providing farmers with timely and relevant information.

Table 2 indicates that while a majority of respondents (61.2%) have access to digital devices, primarily mobile phones (92.9%), the penetration of more advanced devices like smartphones (57.1%) and computers (21.4%) remains limited. This limited access to advanced digital tools may hinder the effective utilization of comprehensive digital extension services. Similar challenges were identified by Ifeanyi-Obi and Corbon (2023), who noted that despite the availability of digital tools, their adoption in extension service delivery is constrained by limited access to necessary devices. Internet connectivity poses a significant barrier, with only (42.9%) of respondents having access to the internet. Among those with internet access, daily usage is reported by (60%), suggesting that once connectivity is established, regular use follows. However, the overall low internet penetration aligns with findings by Yakubu *et al*. (2013), who highlighted that inadequate ICT infrastructure and erratic power supply are major constraints to ICT adoption in Nigerian agriculture.

Awareness of digital extension services is relatively low, with only (37.9%) of respondents being aware of such services and an even smaller fraction (28.0%) actively utilizing them. This gap between awareness and utilization suggests that even among those informed about digital extension services, adoption is not universal. Factors such as perceived relevance, digital literacy, and trust in digital platforms may influence this disparity. The study by Ifeanyi-Obi and Corbon (2023) also emphasizes the need for training and capacity building to enhance the effective use of digital tools among extension agents, which could similarly apply to farmers. Among users of digital extension services, the most common platforms include agricultural information via SMS (73.7%) and mobile applications for farming practices (52.6%). The preference for SMS-based information dissemination is likely due to the widespread availability of basic mobile phones and the simplicity of SMS technology. This finding is consistent with the observations of Ifeanyi-Obi and Corbon (2023), who reported that extension agents frequently utilize mobile phones for communication, highlighting the practicality of SMS in areas with limited internet access. The underutilization of online agricultural training/webinars (26.3%) and social media groups for farmers (42.1%) may be attributed to factors such as limited internet access, lack of digital literacy, and possible skepticism toward online platforms. Addressing these challenges requires concerted efforts to improve ICT infrastructure, provide affordable internet services, and implement training programs to enhance digital skills among rural farmers. As noted by Ifeanyi-Obi and Corbon (2023), motivation and accessibility are critical factors influencing the adoption of ICTs in extension service delivery.

The results in table 3 indicate that digital extension service users have significantly higher farm sizes, yields, and annual incomes than non-users. The analysis on Agricultural Productivity shows that users of digital extension services have an average yield of 3,850 kg/ha, compared to 2,920 kg/ha for non-users. The difference is statistically significant ($p < 0.01$). This suggests that access to digital advisory services, including weather updates, agronomic best practices, and improved seed varieties, positively influences productivity. This finding aligns with Fawole and Oladele (2019), who reported that mobile-based extension services improve farm productivity by providing timely agricultural information. Similarly, Aker et al. (2021) observed that digital platforms enhance farmers' access to improved agricultural technologies, boosting yields. However, some studies present contrasting findings. Nakasone and Torero (2016) argued that while digital extension services can enhance knowledge transfer, their impact on productivity may be limited by infrastructural deficits and low adoption rates of recommended technologies. In a study in India, Mittal et al. (2017) found that while ICT-based extension increased awareness, its actual impact on yield was constrained by financial and logistical barriers to adopting improved inputs.

The study also reveals that Income Levels of the farmers using digital extension services have a significantly higher annual income (₦850,000) than non-users (₦630,000) ($p < 0.01$). The higher income among users may be attributed to better farming practices, enhanced access to market information, and improved resource allocation. This finding aligns with Davis et al. (2020), who emphasized that digital extension services help farmers negotiate better prices and reduce post-harvest losses, leading to increased profitability. Contrary to this, Deichmann et al. (2016) argue that while digital extension services improve

knowledge, income gains are not immediate and depend on multiple factors, including farm size, input costs, and supply chain efficiency. Fu and Akter (2021) also caution that the benefits of digital extension services may disproportionately favour wealthier farmers who already have access to smartphones and internet connectivity, thus exacerbating income inequality.

Results on market access and input use indicate that (82.5%) of digital extension users have access to market information, compared to (45.8%) of non-users. Additionally, 77.9% of users adopt improved inputs compared to (50.4%) of non-users. These findings suggest that digital extension services play a critical role in linking farmers to agricultural markets and extension advisory content, thereby facilitating the use of modern farming inputs. Aker and Ksoll (2020) support this view, stating that mobile-based extension services significantly enhance farmers' ability to adopt improved technologies. Nonetheless, Zanello et al. (2019) highlight that despite the potential of digital platforms, infrastructural challenges such as poor network coverage and high internet costs limit widespread adoption. Similarly, Toyama (2015) argues that digital services alone cannot transform agricultural practices unless complemented by physical extension services, credit access, and infrastructural investments.

The logistic regression analysis in table 4 above identifies key factors influencing the adoption of digital extension services. The significant predictors include access to credit, education level, farm size, membership in farmer groups, and access to digital tools. From the above, education level has a significant positive influence on adoption ($\beta = 0.158$, $p = 0.001$), indicating that farmers with higher education levels are more likely to use digital extension services. This supports findings by Mittal and Mehar (2016), who argue that educated farmers are more likely to understand and integrate digital innovations into their farming practices. Similarly, Aker (2020) emphasizes that literacy plays a crucial role in the effectiveness of digital agricultural services. However, some studies suggest that even farmers with limited formal education can adopt digital tools if properly trained. Nakasone and Torero (2016) found that the availability of local language digital content can bridge the literacy gap, enabling less-educated farmers to benefit from mobile-based extension services. Access to credit is another significant factor ($\beta = 0.564$, $p = 0.042$), implying that farmers with better access to financial resources are more likely to adopt digital extension services. Credit enables farmers to invest in smartphones, data subscriptions, and other digital tools.

Farm size significantly influences adoption ($\beta = 0.093$, $p = 0.002$), suggesting that larger farms are more likely to use digital extension services. This finding aligns with Zanello et al. (2019), who reported that commercial-oriented farmers with larger landholdings are more inclined to adopt modern technologies, including digital advisory services. Conversely, Fu and Akter (2021) argue that smallholder farmers can also benefit from digital tools if provided with affordable access and proper training. Their study suggests that digital extension services should be tailored to both large- and small-scale farmers to maximize impact. Based on membership in farmer groups, Farmers belonging to cooperative groups are 2.08 times more likely to adopt digital extension services ($\beta = 0.732$, $p = 0.012$). Farmer organizations serve as key platforms for knowledge exchange and collective decision-making, making members more open to innovation. Aker and Ksoll (2020) found that social capital and peer influence play crucial roles in farmers' willingness to engage with digital technologies.

Farmers with better access to digital tools (smartphones, internet, and mobile networks) are significantly more likely to adopt digital extension services ($\beta = 0.847$, $p = 0.006$). This result supports Deichmann et al. (2016), who assert that infrastructural development is a fundamental determinant of digital adoption in agriculture. However, Toyama (2015) argues that access alone is insufficient; farmers must also perceive digital tools as useful and user-friendly. Therefore, adoption rates can be improved by enhancing digital literacy and providing localized agricultural content. Based on age and farming experience, age has a negative but non-significant effect ($\beta = -0.024$, $p = 0.068$), indicating that younger farmers are more likely to adopt digital extension services than older farmers. This is consistent with Tambo et al. (2020), who

observed that younger farmers are more tech-savvy and adaptable to digital innovations. Similarly, farming experience does not significantly influence adoption ($\beta = 0.011$, $p = 0.462$).

CONCLUSION AND RECOMMENDATIONS

Digital extension services have the potential to significantly enhance agricultural productivity and promote rural development in Kebbi State. However, their effectiveness is currently limited by socioeconomic constraints and infrastructural challenges. Addressing these issues is crucial for the successful integration of digital technologies into the agricultural sector. The following recommendations were drawn from the research: The government, non-governmental organizations (NGOs), and agricultural extension agencies should implement structured training programs to improve digital skills among farmers. Universities and research institutions should also collaborate in developing digital literacy curricula tailored to rural communities. The government, financial institutions, and private sector stakeholders should provide financial support or subsidies to make digital devices such as smartphones, tablets, and internet-enabled radios more affordable for rural farmers. Telecom companies can also offer discounted data packages for agricultural purposes. The government, telecommunications companies, and international development partners should invest in expanding and strengthening internet connectivity in rural areas. This includes building more network towers, ensuring stable electricity supply, and providing affordable internet services tailored to farmers' needs. The Ministry of Agriculture, agricultural research institutes, and digital service providers should collaborate to create digital agricultural content in local languages. NGOs and farmer organizations should also contribute by ensuring that content is culturally appropriate and accessible to all farmers, including those with low literacy levels.

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