

Determinants and Constraints to Rice Farmers' Willingness to Use Digital Extension Tools in Lafia Local Government Area, Nasarawa State, Nigeria

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ABSTRACT

This study identified the digital extension tools available to rice farmers, the factors influencing their willingness to use these tools, and the constraints to their use in Lafia LGA, Nasarawa State, Nigeria. Primary data were collected from 100 rice farmers selected through a multi-stage sampling procedure and analysed using multiple response analysis, binary logistic regression, and Likert constraint analysis. Results showed that mobile phone voice calls (91%), SMS messages (76%), and WhatsApp (62%) were the most accessible digital extension tools. The binary logistic regression model was statistically significant ($\chi^2 = 43.82$; $p < .001$; Nagelkerke $R^2 = .547$; correct classification = 76.0%). Perceived usefulness ($\beta = 0.604$; $p = .001$) and perceived ease of use ($\beta = 0.558$; $p = .001$) were the strongest predictors of willingness, followed by access to credit ($\beta = 0.597$; $p = .005$), extension contact ($\beta = 0.496$; $p = .008$), educational level ($\beta = 0.306$; $p = .007$), and cooperative membership ($\beta = 0.472$; $p = .019$); age was not significant ($p = .074$). High cost of mobile data (mean = 4.21), poor network connectivity (mean = 4.08), and low digital literacy (mean = 3.96) were the top-ranked constraints, while inadequate awareness and low content relevance were the least binding. The study concludes that TAM constructs, reinforced by institutional support factors, are the dominant drivers of willingness, and recommends subsidised data access, local-language content, digital literacy training, and cooperative-based dissemination in Lafia LGA.

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INTRODUCTION

Conventional public agricultural extension systems in developing countries face severe structural constraints, underfunding, shortages of field personnel, and poor rural infrastructure, which limit effective advisory service delivery, even though access to extension services generates substantial welfare benefits for farming households (Anteneh & Melak, 2024; Aremu & Reynolds, 2024). Digital agricultural extension, the deployment of mobile phones, SMS, mobile applications, internet platforms, social media, and interactive voice response systems to deliver advisory services, can enhance the speed, geographic reach, cost-efficiency, and personalisation of information dissemination, and reduce the cost of advisory delivery relative to purely face-to-face approaches (Anteneh & Melak, 2024; FAO, 2022; Sen *et al.*, 2025). In Nigeria, digital platforms are increasingly being deployed to link farmers with information, services, and investors (Akinwale *et al.*, 2023; Deji *et al.*, 2023).

However, physical access to digital tools does not automatically translate into their use for agricultural purposes. Farmers' willingness, their psychological readiness, positive attitude, and behavioural intention to adopt and consistently utilise digital platforms for advisory information, is theoretically distinct from mere access or awareness (Abioye *et al.*, 2024; Sen *et al.*, 2024). The Technology Acceptance Model (TAM) posits that perceived usefulness and perceived ease of use are the primary cognitive determinants of technology acceptance (Davis *et al.*, 2023), and recent studies confirm that perceived usefulness significantly drives smallholder farmers' uptake of digital extension services

(Amoussohoui *et al.*, 2024; Sen *et al.*, 2024). Nigerian evidence further indicates that education, training, internet access, smartphone ownership, and awareness positively influence farmers' willingness to adopt digital application tools, while the cost of digital tools and services constrains it (Abioye *et al.*, 2024; Makwin *et al.*, 2024).

In Lafia LGA, a major rice-producing area of Nasarawa State where public and private digital extension initiatives, including e-extension services promoted through the Nasarawa State Agricultural Development Programme (NADP), have been deployed in recent years, field evidence suggests that many rice farmers demonstrate low or inconsistent use of digital platforms for advisory purposes. Systematic empirical evidence on which tools are actually accessible to rice farmers, what drives their willingness to use them, and what constrains that use remains limited for this context. The specific objective of this study was to assess rice farmers' willingness to use digital extension tools in Lafia LGA by identifying the tools available to them, examining the factors that significantly influence their willingness to use these tools, and identifying the constraints limiting their use. The null hypothesis tested was that selected socio-economic, institutional, and psychological factors have no significant influence on farmers' willingness to use digital extension tools.

MATERIALS AND METHODS

The Study Area

The study was conducted in Lafia LGA, the administrative headquarters of Nasarawa State, Nigeria, located between latitudes 8°20'N and 8°36'N and longitudes 8°25'E and

8°41'E, and bounded by Obi, Doma, Awe, and Kokona LGAs. The LGA has an estimated population of about 430,000, with agriculture as the primary occupation of approximately 65% of the rural population. It lies within the Guinea Savannah agro-ecological zone (annual rainfall 1,200–1,400 mm; mean temperatures 27–32°C) with significant rice farming communities in the river valleys associated with the Mada and Farin Ruwa water systems.

Sampling Technique and Data Collection

A multi-stage sampling procedure was employed. In Stage I, five rice-producing communities, Gadabuke, Sabon Tasha, Agyaragu, Shabu, and Kwandere, were randomly selected from the NADP community register. In Stage II, twenty rice farmers were selected from each community using systematic random sampling from the NADP rice farmer registers, yielding 100 respondents. Primary data were collected with a structured questionnaire covering socio-economic characteristics, access to digital tools, TAM perception items, willingness statements, and constraints.

Method of Data Analysis

Multiple response analysis (frequencies and percentages) was used to identify the digital extension tools available to rice farmers. Binary logistic regression was used to identify the factors influencing willingness, with willingness dichotomised as 1 (willing) if the mean Likert score across willingness items was ≥ 3.50 and 0 otherwise. Likert constraint analysis on a five-point scale (mean ≥ 3.50 = major constraint) was used to identify and rank constraints. Analyses were performed with IBM SPSS Statistics Version 26. The binary logistic regression model estimates the log-odds (logit) of a farmer being willing to use digital extension tools as a linear function of the explanatory variables, with the coefficients estimated by maximum likelihood; the model was specified as:

$$\text{Logit}(P) = \ln[P/(1 - P)] = \beta_0 + \beta_1 Z_1 + \beta_2 Z_2 + \beta_3 Z_3 + \beta_4 Z_4 + \beta_5 Z_5 + \beta_6 Z_6 + \beta_7 Z_7 + \beta_8 Z_8 + \beta_9 Z_9 \quad (1)$$

where P = probability that a farmer is willing to use digital extension tools ($1 - P$ = probability of unwillingness); Z_1 = age (years); Z_2 = educational level (years); Z_3 = farm size (hectares); Z_4 = farming experience (years); Z_5 = access to credit (1 = yes; 0 = no); Z_6 = extension contact (visits/year); Z_7 = cooperative membership (1 = yes; 0 = no); Z_8 = perceived usefulness (Likert score); Z_9 = perceived ease of use (Likert score); β_0 = constant (intercept); and β_1 – β_9 = the maximum-likelihood coefficients of the corresponding explanatory variables. Overall model fit was assessed using the likelihood-ratio chi-square statistic, the Nagelkerke pseudo- R^2 , the Hosmer–Lemeshow goodness-of-fit test, and the percentage of correctly classified cases.

RESULTS AND DISCUSSION

Digital Extension Tools Available to Rice Farmers

Table 1 shows the digital extension tools accessible to rice farmers in Lafia LGA. Mobile phone voice calls were the most widely accessible tool among rice farmers in Lafia LGA (91%), reflecting the near-universal ownership of basic mobile phones in the study area even where smartphone and internet access remain limited. SMS messages ranked second (76%), reflecting the utility of low-bandwidth text messaging where internet connectivity is weak, and WhatsApp ranked third (62%), consistent with the dominance of basic mobile channels over data-intensive platforms among Nigerian smallholders (Makwin *et al.*, 2024). Mobile agricultural applications (22%) and internet websites (19%) ranked lowest, reflecting limited broadband penetration in parts of the LGA. The relatively high access to radio/TV agricultural programmes (55%) suggests that broadcast-based extension remains an important supplementary channel, supporting the multi-channel approach to advisory delivery recommended in recent reviews of ICT-based extension (Anteneh & Melak, 2024; Sen *et al.*, 2025).

Table 1: Digital Extension Tools Available to Rice Farmers (Multiple Response; n = 100)

Digital extension tool	Frequency	Percent (%)	Rank
Mobile phone (voice calls)	91	91.0	1st
SMS (text messages)	76	76.0	2nd
WhatsApp	62	62.0	3rd
Radio/TV agricultural programmes	55	55.0	4th
Facebook/social media	38	38.0	5th
Mobile agricultural applications	22	22.0	6th
Internet websites	19	19.0	7th

Note: Multiple responses were permitted; frequencies represent the number of respondents with access to each tool. Source: Field Survey, 2026

Factors Influencing Farmers' Willingness to Use Digital Extension Tools

Table 2 presents the binary logistic regression results. The overall model was statistically significant ($\chi^2 = 43.82$; $p < .001$; Nagelkerke $R^2 = .547$; Hosmer–Lemeshow $p = .682$; correct classification = 76.0%), indicating good fit. Perceived usefulness was the strongest predictor of willingness ($\beta = 0.604$; Wald $\chi^2 = 11.847$; $p = .001$), followed by perceived ease of use ($\beta = 0.558$; Wald $\chi^2 = 11.414$; $p = .001$). These findings directly validate the central propositions of the Technology Acceptance Model, that farmers' cognitive evaluation of digital tools' utility and operational accessibility are the primary determinants of their willingness to engage (Davis *et al.*, 2023), and are consistent with recent structural

equation modelling evidence that perceived usefulness significantly drives smallholders' uptake of digital extension services in both Africa and Asia (Amoussouhoui *et al.*, 2024; Sen *et al.*, 2024).

Access to credit ($\beta = 0.597$; $p = .005$) was the third strongest predictor, reflecting that financial resources reduce the perceived cost burden of digital tool adoption, in line with evidence that cost considerations and readiness to pay shape Nigerian farmers' willingness to adopt digital applications (Abioye *et al.*, 2024). This finding echoes broader evidence from Nasarawa State that poor access to credit is itself a binding constraint on smallholder rice farmers' productive capacity, underscoring the interdependence between financial inclusion and technology uptake in this rice-producing zone

(Usman *et al.*, 2024). Extension contact ($\beta = 0.496$; $p = .008$) was significant, indicating that farmers with regular advisory contact develop greater receptiveness to new information channels, supporting the complementarity between conventional extension support and digital advisory services demonstrated experimentally by Karki Nepal *et al.* (2025). Cooperative membership ($\beta = 0.472$; $p = .019$) was significant, consistent with the significant role of subjective norms and social influence in shaping farmers' uptake of

digital extension services (Sen *et al.*, 2024). Educational level ($\beta = 0.306$; $p = .007$), farm size ($\beta = 0.228$; $p = .018$), and farming experience ($\beta = 0.176$; $p = .034$) were also positive and significant, in line with the education and training effects reported for Nigerian farmers (Abioye *et al.*, 2024; Makwin *et al.*, 2024), while age was not ($p = .074$), suggesting that willingness is driven more by education and institutional factors than by generational differences alone. The null hypothesis was accordingly rejected.

Table 2: Binary Logistic Regression, Factors Influencing Farmers' Willingness (n = 100)

Variable	β	Std. error	Wald χ^2	p-value	Sig.
Constant	-2.764	1.108	6.222	.013	
Age (years)	-0.038	0.021	3.274	.074	ns
Educational level (years)	0.306	0.114	7.210	.007	
Farm size (ha)	0.228	0.096	5.641	.018	
Farming experience (years)	0.176	0.083	4.490	.034	
Access to credit (1 = yes)	0.597	0.212	7.933	.005	
Extension contact (visits/yr)	0.496	0.184	7.268	.008	
Cooperative membership (1 = yes)	0.472	0.201	5.528	.019	
Perceived usefulness	0.604	0.176	11.847	.001	
Perceived ease of use	0.558	0.164	11.414	.001	

Note: $\chi^2 = 43.82$; $p < .001$. Nagelkerke $R^2 = .547$. Hosmer–Lemeshow $p = .682$. Correct classification = 76.0%. $p < .001$; $p < .01$; $p < .05$; ns = not significant. Source: Field Survey, 2026

Constraints to the Use of Digital Extension Tools

Table 3 presents the ranked constraints to the use of digital extension tools. High cost of mobile data was the most critical constraint (mean = 4.21), and poor network connectivity ranked second (mean = 4.08); the affordability of data and devices and inadequate digital infrastructure are consistently identified as leading barriers to smallholder engagement with digital extension services in developing countries (Amoussouhoui *et al.*, 2024; Sen *et al.*, 2024, 2025). Low digital literacy ranked third (mean = 3.96), underscoring the need for targeted digital skills training, which recent reviews identify as a precondition for effective digital extension scaling (Anteneh & Melak, 2024; Sen *et al.*, 2025). Language/content accessibility barriers (mean = 3.82) and low trust in digital information (mean = 3.74) ranked fourth and fifth, reflecting the importance of localised, farmer-friendly content and credible information sources highlighted in the digital extension literature (Sen *et al.*, 2025). Lack of

electricity for charging devices (3.61) and lack of affordable smartphones (3.54) were present but less pervasive, while inadequate awareness of platforms (3.47) and low relevance of available content to local conditions (3.38) fell below the major-constraint threshold, indicating that infrastructural and cost barriers weigh more heavily on rice farmers in Lafia LGA than gaps in awareness or content relevance. The prominence of connectivity-related constraints echoes the finding of Karki Nepal *et al.* (2025) that limited internet access in farming communities remains a key obstacle to realising the benefits of digital extension services. By contrast, Sen *et al.* (2024) found trust and institutional support, rather than affordability, to be the more binding constraints among smallholder farmers in South-East Asia, suggesting that the relative weight of digital extension barriers is shaped by the maturity of local digital infrastructure and market conditions rather than being uniform across contexts.

Table 3: Constraints to the Use of Digital Extension Tools (n = 100)

Constraint	Mean score	SD	Rank
High cost of mobile data/internet	4.21	0.74	1st
Poor network/internet connectivity	4.08	0.78	2nd
Low digital literacy/skills	3.96	0.82	3rd
Language/content accessibility barriers	3.82	0.84	4th
Low trust in digital agricultural information	3.74	0.87	5th
Lack of electricity for device charging	3.61	0.91	6th
Lack of affordable smartphones	3.54	0.88	7th
Inadequate awareness of digital extension platforms	3.47	0.92	8th
Low relevance of available digital content to local conditions	3.38	0.94	9th

Note: Scale: 1 = Strongly Disagree; 5 = Strongly Agree. Mean ≥ 3.50 = major constraint. Source: Field Survey, 2026

CONCLUSION

The study concludes that while basic digital connectivity, voice calls, SMS, and WhatsApp, is widespread among rice farmers in Lafia LGA, access to more sophisticated platforms remains limited, and that farmers' willingness to use digital extension tools is driven primarily by the TAM constructs of perceived usefulness and perceived ease of use, reinforced by access to credit, extension contact, education, and cooperative membership, while high data costs, poor connectivity, and low digital literacy remain the dominant constraints. It is therefore recommended that government and telecommunications providers subsidise agricultural data access and expand rural network infrastructure, that extension agencies deliver advisory content in local languages alongside targeted digital literacy training, and that credit institutions and farmer cooperatives be strengthened as channels for extending credit and digital advisory services to rice farmers in the study area.

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CONFLICT OF INTEREST STATEMENT

The authors declare that there is no conflict of interest regarding the publication of this manuscript.

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