Proceedings of the Annual Conference of the Agricultural Extension Society of Nigeria
Number: Thirty-First Annual Conference
Theme: Strengthening the Agricultural Extension Innovation Systems for Greater Development Impacts
Date: 12th to 15th April 2026
Venue: Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria
ISSN: 1595 – 1421.
Website: https://info@ajol.org,
Email: agricultural.extension.nigeria@gmail.com; editorinchief@aesonnigeria.org

Adoption of E-Extension Strategies among Arable Crop Farmers in Osun State, Nigeria

https://dx.doi.org/10.4314/jae.v31i1.8S

Ogunniyi, Gbadebo[1*], Binuomote, Oluwamayowa K.[2], Oladepo, Damilare[3], and Aruleba, Sunday Adegbenga[4]

[1,2,3,4] Department of Agriculture, University of Ilesa, Osun State, Nigeria
*Correspondence and presenting author: gbadebo_ogunniyi@unilesa.edu.ng; +2348060949676
[2] binuomotemayowa21@gmail.com, +2348060174782;
[3] Dreybabaui@gmail.com, +2347033552124
[4] samuel_aruleba@unilesa.edu.ng, +2349011595559

Abstract
This study investigates adoption electronic extension (e-extension) strategies among arable crop farmers in Osun State, Nigeria, with a particular focus on the role of digital literacy A multistage sampling procedure was employed to select 420 arable crop farmers across six local government areas. Primary data were collected through structured questionnaires and analyzed using percentage, mean, standard deviation, and multiple regression analysis to examined the relationship between digital literacy and the adoption of e-extension technologies. Findings revealed that although a high proportion of farmers (78%) were aware of e-extension tools, but only 46% actively used these tools. Low level of Digital literacy with only 35% of respondents able to effectively navigate digital platforms. Regression analysis revealed a significant positive relationship between digital literacy and e-extension tool usage ($p < 0.01$). Based on these findings, the study concludes that while awareness of e-extension strategies is relatively high among arable farmers in Osun State, low digital literacy impedes effective utilization, thus, digital literacy is a crucial factor for successful adoption of e-extension strategies. policy interventions aimed at improving rural digital infrastructure, subsidizing access to smart devices, and conducting widespread digital literacy training for farmers.

Keywords: Digital literacy, digital access, digital tool.

Introduction

Agriculture remains the backbone of many economies in Sub-Saharan Africa, including Nigeria, where it employs over 60% of the rural population and contributes significantly to GDP and food security (FAO, 2022). In particular, the cultivation of food crops such as maize, cassava, yam, and vegetables, which is known as arable farming, plays a critical role in sustaining livelihoods and enhancing food self-sufficiency in Nigeria's southwest region, including Osun State. However, the sector continues to face persistent challenges, including low productivity, limited access to modern farming techniques, and limited dissemination of agricultural innovations (Akinwale et al*.,* 2023).

Traditional agricultural extension systems in Nigeria, largely based on physical interactions between farmers and extension agents, have been criticized for being underfunded, inefficient, and unable to meet the information needs of a rapidly growing and diverse farming population (Abdulai, 2022). According to Danladi et al. (2023), the ratio of extension agents to farmers in Nigeria is as low as 1:3,000, far below the FAO-recommended ratio of 1:800. This service delivery gap has necessitated the exploration of innovative mechanisms to improve knowledge dissemination and agricultural extension services.

One of the most promising approaches is electronic extension (e-extension), which refers to the use of Information and Communication Technologies (ICTs) such as mobile phones, radio, television, internet platforms, mobile apps, and social media to deliver extension services to farmers (Abdulai, 2022). E-extension strategies are not only scalable and cost-effective but also enable timely, location-specific information delivery, especially in rural communities where physical access to extension agents is limited. Several studies have highlighted how e-extension tools can enhance farmers' knowledge, promote adoption of improved practices, and ultimately improve productivity (World Bank, 2022). Despite these potentials, the impact of e-extension is not evenly distributed across farming communities, particularly in developing regions where digital literacy remains low (Akinwale, et al., 2023), Digital literacy, defined as the ability to effectively and critically navigate, evaluate, and create information using a range of digital technologies is a crucial prerequisite for maximizing the benefits of e-extension tools. In many parts of rural Nigeria, farmers face constraints such as limited access to smartphones, poor internet connectivity, low levels of education, and lack of technical know-how, all of which hinder the effective use of digital platforms (Iwuchukwu, et al., 2023; FMAFS, 2025).

In Osun State, there has been a growing interest in integrating digital solutions into agricultural extension services, particularly through partnerships between government agencies, NGOs, and private ICT providers. However, empirical data on the extent to which arable farmers in the state are accessing, using, and benefiting from e-extension services remains sparse. Similarly, the level of digital literacy among these farmers, and how it influences their engagement with such services is not well understood.

Also, despite the growing investment in digital extension platforms across Nigeria, a significant gap exists between the availability of these technologies and their actual usage by smallholder farmers. In Osun State, where arable crop farming sustains the majority of the rural population, the low adoption rate of e-extension tools raises questions about farmers' readiness and capacity to leverage digital innovations. Previous studies have established that access to information is a key driver of agricultural productivity; yet, the potential of e-extension remains underutilized, largely due to digital illiteracy and infrastructural limitations. While mobile phone ownership is increasing, many farmers lack the technical know-how to navigate mobile applications, access internet-based extension platforms, or engage with virtual training sessions. extension

Objectives of the study

The objectives of the study are to;

i. identify the level of digital literacy of arable crop farmers in Osun state,

ii. assess the level of awareness and use of E-extension,

iii. identify constraint to adoption of E-extension, and

Methodology

The study was conducted in Osun State, located in the southwestern region of Nigeria. Osun state is geographically located at the heart of the south west of Nigeria. It is situated in the tropical rain forest and thus is bounded by five states Kwara State to the North, Ogun State in the South, Oyo state in the west, Ondo and Ekiti states in the south and North East. The State covers the area of South Western Nigeria with a total area of 14,875 square kilometres. It lies between longitude 04 00E and 05 05”1. The state has 30 Local Government Areas (LGAs) and is predominantly agrarian, with a large proportion of its rural population engaged in arable crop farming. Major arable crops include cassava, maize, yam, and vegetables. Osun State also has access to various agricultural extension programs, both traditional and ICT-based, making it suitable for this investigation.

The target population includes all arable farmers in Osun State who are engaged in crop production and have access to extension services, particularly those who may have interacted with digital or electronic extension (e-extension) strategies such as SMS advisory services, mobile apps, online training, radio/TV programs, and social media platforms.

A multistage sampling procedure was employed to determine a suitable sample size for the study. Firstly, the state was stratified into its three agricultural zones which include; Osun Central, Osun East, and Osun West, and two LGAs were randomly selected from each zone to have a total of 6 LGAs. Followed by purposive selection of two farming communities from each LGA based on known farming activity and presence of extension services. From each community, a list of active arable farmers was obtained from local agricultural extension offices or farmers’ cooperatives. Stratified random sampling was used to ensure diversity in age, gender, education level, and farm size.

The sample size was determined using Yamane's formula:

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

where n is the sample size, N is the total population of arable farmers in the study area, and e is the level of precision (0.05). Based on the population of 10,267 registered arable farmers. This yields a base sample size of 385. Given the rural and field-based nature of the study, a 10% non-response rate was anticipated, increasing the target to approximately 424 respondents.

Percentages, means, and standard deviations were used to analyse, access to tools, and usage patterns, while multiple regression analysis was used to examine the relationship between digital literacy and the adoption of e-extension technologies.

Results and Discussion

Level of Digital Literacy of Arable Crop Farmers

The analysis of digital literacy reveals a clear disparity between basic and advanced digital competencies among the respondents. The results show that farmers had a high mean score for basic mobile phone use (4.6 ± 0.6) and relatively high proficiency in messaging applications such as WhatsApp (4.0 ± 0.8), indicating strong familiarity with basic communication technologies. However, digital literacy declines significantly for more advanced skills, such as the use of agricultural applications (2.6 ± 1.1), troubleshooting digital devices (2.7 ± 1.1), and using social media for agricultural purposes (2.9 ± 1.2). This pattern suggests that while farmers are digitally connected, their ability to effectively utilize digital tools for agricultural productivity remains limited. This implies that digital literacy among farmers is largely functional rather than transformative, as it does not extend to the use of specialized agricultural technologies. This gap between basic and advanced skills explains the low adoption of sophisticated e-extension platforms. This finding supports the argument of Pradhan et al (2025), who identified the "second-level digital divide" as disparities in skills and usage rather than access. Similarly, Sa'adu et al., (2022) found that Nigerian farmers often possess basic ICT knowledge but lack the competencies required for effective utilization of digital agricultural tools.

Table 2: Digital literacy skills

Digital Skill	Mean	SD	
Use of basic mobile phone features	4.6	0.6	High
Sending/receiving emails	3.3	1.0	Moderate
Using messaging apps	4.0	0.8	Moderate-High
Browsing the internet	3.1	1.1	Moderate
Using agricultural apps	2.6	1.1	Low
Accessing weather forecasts/market prices	3.2	1.0	Moderate
Using social media for agricultural info	2.9	1.2	Low-Moderate
Troubleshooting basic digital problems	2.7	1.1	Low

Source: Field Survey 2025

Level of Awareness of E-Extension

The result in table 2 shows that arable farmers are aware of SMS-based services (80.0%) and Radio/TV digital programs (61.9%). This show that there is high level of awareness of SMS-based services among arable farmers, with 80% knowing about these services, indicates a strong potential for utilizing SMS as an effective channel for delivering e-extension messages. Since farmers already recognize and

understand this mode of communication, extension agencies can leverage SMS platforms to disseminate critical agricultural information, advice, and updates. This familiarity provides a solid foundation for increasing the adoption of SMS-based e-extension strategies, making it easier to reach a large portion of the farming community. In contrast, awareness of agricultural applications was 170 respondents (40.5%), while social media platforms (35.7%), IVR (31.0%), and online forums (26.2%) recorded low awareness levels. These findings suggest that awareness is highest for technologies that are simple, accessible, and widely disseminated through traditional extension systems.

These findings are consistent with the observations of Ifeanyi-obi & Corbon (2023) who noted that farmers in developing countries tend to adopt ICT tools that are familiar, affordable, and easy to use, while more sophisticated digital platforms often experience lower uptake due to technological and infrastructural barriers. Likewise, FAO (2022) has emphasized that the successful adoption of digital agricultural technologies depends not only on availability but also on awareness, digital skills, and access to supporting infrastructure

Table 3: Awareness of e-extension strategies

E-extension Service	%	
SMS alerts	81.0%	High
Radio/TV digital programs	61.9%	Moderate
Agricultural apps	40.5%	Moderate
Social media platforms	35.7%	Low
Interactive voice response (IVR)	31.0%	Low
Online forums/websites	26.2%	Low

Source: Field Survey 2025

Use of E-Extension

Table 4 shows the level of use of e-extension strategies. The results show that SMS services recorded a high usage level of (2.19 $\pm$ 0.88), while radio/TV programs had moderate usage at (1.86 $\pm$ 0.91). In contrast, agricultural applications and social media platforms recorded very low usage levels of (1.12 $\pm$ 0.51) and (1.24 $\pm$ 0.54) respectively. This indicates that although some farmers are aware of advanced digital tools, they do not actively use them. The discrepancy between awareness and usage suggests the presence of barriers such as limited digital skills, high cost of internet access, poor network infrastructure, and lack of localized content.

These findings imply that farmers tend to adopt technologies that are perceived as easy to use, affordable, and reliable, which explains the dominance of SMS-based services. This is consistent with the Technology Acceptance Model proposed by Ifeanyi-obi & Corbon. (2023), which emphasizes perceived ease of use and

usefulness as key determinants of technology adoption. The results also align with the findings of Sa'adu et al., (2022) who reported that mobile phone-based services are the most widely adopted ICT tools among rural farmers in developing countries.

Table 4: Use of e-extension strategies

E-extension Service	Mean	SD	Category
SMS alerts	2.19	0.88	High
Agricultural apps	1.12	0.51	Low
Social media platforms	1.24	0.54	Low
Radio/TV programs	1.86	0.91	Moderate

Source: Field Survey 2025

Constraints to Adoption of E-Extension

The results in Table 5 show that lack of digital skills was the most significant constraint to the adoption of e-extension services, as reported by 68% of the respondents. This suggests that many farmers lack the necessary knowledge and competencies required to effectively utilize digital technologies for accessing agricultural information. Poor internet connectivity was identified by 55% of the respondents, indicating that inadequate network infrastructure continues to limit access to online extension services. High cost of smartphones (47%) and poor electricity supply (45%) were also major barriers, suggesting that affordability and infrastructural challenges hinder the effective use of digital agricultural technologies. Additionally, 38% of the respondents reported the high cost of data plans as a constraint, highlighting the financial burden associated with accessing internet-based extension platforms.

These findings imply that the successful adoption of e-extension services depends not only on the availability of digital technologies but also on farmers' capacity to use them, reliable internet access, affordable digital devices, stable electricity supply, and reduced internet costs. Therefore, efforts to promote e-extension should focus on improving digital literacy among farmers, expanding rural internet infrastructure, enhancing electricity supply, and making smartphones and data services more affordable.

The findings are consistent with Abdulai, (2022) and Taruna et al., (2024), who reported that limited digital skills and inadequate infrastructure are major barriers to the adoption of digital agricultural services among smallholder farmers. Similarly, Pradhan, et al., (2025) found that poor internet connectivity and the high cost of digital technologies significantly constrain the use of ICT-based agricultural information services. Furthermore, Gow et al. (2023) observed that inadequate digital literacy, limited access to smartphones, and high internet costs remain key challenges affecting the uptake of digital extension services in developing countries.

Table 5: Constraints to adoption of e-extension

Constraint	Percentage (%)
Lack of digital skills	68
Poor internet connectivity	55
High cost of smartphones	47
Poor electricity	45
High cost of data plan	38

Source: Field survey, 2025.

Determinants of E-Extension Adoption

Table 6 provides empirical evidence on the determinants of e-extension adoption. The multiple regression analysis strengthens this conclusion, as the model explains 54% of the variation in e-extension adoption ($R^2 = 0.54$, $F(4,415) = 123.6$). Among the predictors, digital literacy has the strongest influence ($\beta = 0.56$), followed by education ($\beta = 0.28$) and farm size ($\beta = 0.13$), while age has a negative effect ($\beta = -0.10$). These results indicate that increasing digital literacy significantly enhances adoption, while younger, more educated farmers with larger farm sizes are more likely to embrace e-extension technologies. The findings strongly supported by existing literature. The positive relationship between knowledge and innovation adoption is central to the theory of Eta et al., (2023), while) emphasized the role of education in ICT adoption. Similarly, Izuogu et al. (2023) highlighted the importance of resource availability, and van Danladi et al., (2023) linked digital inequality to socio-economic factors.

Table 6: Determinants of e-extension adoption

Predictor	B	SE B	B	T
Age	-0.04	0.01	-0.10	-2.70
Education	0.18	0.03	0.28	6.00
Farm size	0.07	0.02	0.13	2.90
Digital literacy	0.47	0.05	0.56	9.40

$R^2 = 0.54$

$F(4, 415) = 123.6$

***P≤ 0.5**

Source: Field Survey 2025

Conclusion and Recommendations

Based on the findings of this study, it can be concluded that while arable crop farmers in Osun State have embraced basic digital communication tools, the adoption of advanced e-extension strategies remains limited. Digital literacy emerges as the most significant determinant of adoption, surpassing socio-demographic factors such as age, education, and farm size. The study also concludes that awareness alone does not guarantee utilization, as farmers tend to adopt technologies that are simple, affordable, and compatible with their existing skills and resources.

The persistence of low adoption rates for advanced digital platforms highlights the need for a more holistic approach to digital agricultural development, one that integrates capacity building, infrastructure development, and content localization. Without addressing these underlying constraints, the potential of e-extension strategies to improve agricultural productivity and livelihoods will remain underutilized. In light of these, this study recommends that

- The Ministry of Agriculture and Rural Development and other relevant stakeholders should prioritize the development and implementation of comprehensive digital literacy programs tailored to the needs of rural farmers. Such programs should focus on practical, hands-on training that enables farmers to use agricultural applications, access online information, and troubleshoot basic digital problems. Strengthening the capacity of extension agents to deliver digital advisory services is also essential, as they can serve as intermediaries between technology providers and farmers.

- There is a need for increased investment in rural digital infrastructure, particularly in improving internet connectivity and reducing the cost of data services. Additionally, e-extension platforms should be designed with user-friendly interfaces and localized content, including the use of indigenous languages such as Yoruba, to enhance accessibility and relevance.

References

Abdulai A-R (2022) Toward digitalization futures in smallholder farming systems in Sub-Sahara Africa: A social practice proposal. Frontiers in Sustainable Food Systems. 6: 1-15. https://doi.org/10.3389/fsufs.2022.866331

Akinwale, J. A., Wole-Alo, F. I., & Oluwole, B. O. (2023). Digital platforms for linking agriculture investors with smallholder farmers in Nigeria. *Journal of Agricultural Extension*, 27(2). https://aesonnigeria.org/ajm/index.php/jae/article/view/3418

Danladi, E. B.,1 Burabe, B. I.,2 Manga, T. A.1 and Bako, H. (2023). Assessment of training needs among agricultural extension agents on information and communication technologies in Kaduna state agricultural development programme, Nigeria. *Journal of Agricultural Economics, Environment and Social Science 9(2):*147-154. https://doi.org/10.56160/JAEESS202392014

Eta, C. H., Idiku, F. O., Elemi, G. F., & Eremi, E. O. (2023). Crop farmers' access to e-information for climate-smart agriculture production in Cross River State, Nigeria. *Journal of Agricultural Extension*, 27(3), 26–34. https://journal.aesonnigeria.org/index.php/jae/article/view/3421

Food and Agriculture organisation (FAO). (2022). *Digital agriculture: Farmers in the digital era*. Food and Agriculture Organization of the United Nations. https://www.fao.org/digital-agriculture/en/

Federal Ministry of Agriculture and Food Security. (2025, March 4). FG launches NEEP to enhance extension service delivery. https://agriculture.gov.ng

Gow, G.A., Dissanayeke, U., Chowdhury, A., Ramjattan, J. (2023). Digital Literacy and Agricultural Extension in the Global South. In: Radovanović, D. (eds) Digital Literacy and Inclusion. Springer, Cham. 129-144. https://doi.org/10.1007/978-3-031-30808-6_9

Ifeanyi-obi, C. C., & Corbon, B. (2023). Utilization of digital tools in extension service delivery among extension agents in AkwaIbom State, Nigeria. *Journal of Agricultural Extension*, 27(2). https://www.aesonnigeria.org/ajm/index.php/jae/article/view/3865

Iwuchukwu, J. C., Eke, O. G., Arigbo, P. O., & Chukwudum, E. O. (2023). Challenges and training needs for integrating social media into agricultural extension services in Enugu State, Nigeria. *Journal of Agricultural Extension*, 27(2). https://www.aesonnigeria.org/ajm/index.php/jae/article/view/3469

Izuogu, C. U., Olaolu, M. O., Azuamairo, G. C., Njoku, L. C., & Ibrahim-Olesin, S. (2023). A review of the digitalization of agriculture in Nigeria. *Journal of Agricultural Extension*, 27(2). https://aesonnigeria.org/ajm/index.php/jae/article/view/3408

Pradhan, S. K., Prusty, A. K., Das, S., Ghosh, M., Chandra, Y. B., & Nayak, S. (2025). Empowering small-scale agriculture: Effective strategies for technology transfer. International *Journal of Advance Biochemistry Research, 9(3), 118–125.* https://doi.org/10.33545/26180723.2024.v7.i5a.597

Sa'adu, M., Norsida, M., & Jasmin, A. S. (2022) Factors affecting use of information communication technologies among extension agents in North-East, Nigeria. Journal of Agricultural Extension 26(1), 36-43. https://dx.doi.org/10.4314/jae.v26i1.5

Taruna, D., Komal, S., Nandita, S (2024). Role of ICT in bridging the knowledge gap in rural agriculture Nigeria: International *Journal of Agriculture Extension and social development*, 8(1), 20-24. https://doi.org/10.4314/njae.v23i2.5