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Research

E-Extension Agricultural Technologies Utilization among Arable Crop Farmers in Southwest Nigeria

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Highlights

- Awareness of e-extension platforms such as WhatsApp and FarmCrowdy is high among arable crop farmers in Nigeria, yet actual adoption remains significantly low.
- Sustained adoption of e-extension tools is influenced more by perceived usefulness and service bundling than mere exposure or training.
- Digital infrastructure challenges including poor internet connectivity and limited smartphone access—significantly constrain effective e-extension implementation.
- Multi-stakeholder collaboration, including government and private sector input, is essential for scaling e-extension innovations in rural areas.

Abstract

The advancement of Information and Communication Technologies (ICTs) has revolutionised agricultural extension services globally, offering innovative channels to enhance farmers' access to vital information. In Nigeria, e-extension agricultural technologies hold significant promise for improving productivity, sustainability, and food security, especially among arable crop farmers in Southwest Nigeria. This study assessed the utilisation patterns, adoption levels, and influencing factors of e-extension technologies among arable crop farmers in the region. A descriptive survey research design was adopted, targeting a sample of 500 farmers across three purposively selected states, Ondo, Ogun, and Oyo using a multistage sampling technique. Data were collected via structured questionnaires and analysed using descriptive statistics, Chi-square tests, correlation, and multiple regression analysis. Findings revealed a moderate to high level of awareness (weighted mean = 3.17) of mobile agricultural technologies, with platforms such as Hello Tractor, Facebook, mobile banking apps, and IITA Herbicide Calculator demonstrating higher utilisation rates. However, specialised tools like Google Trader and Farmcrowdy recorded low engagement. Adoption levels varied across technologies, with broader acceptance seen in multipurpose platforms compared to niche agricultural applications. Regression analysis identified gender, age, marital status, household size, and farmland acquisition as significant predictors of technology utilisation, while religion and ethnicity were insignificant. The study concludes that while e-extension technologies are gaining traction among arable crop farmers in Southwest Nigeria, barriers such as limited awareness of specialised applications and socio-demographic disparities persist. Targeted training and inclusive digital policies are recommended to enhance adoption and bridge existing gaps, thereby fostering more sustainable and productive agricultural practices.

Keywords: E-extension, agricultural technologies, arable crop farmers, technology adoption, Southwest Nigeria

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1.0 Introduction

Agriculture plays a vital role in Nigeria's economic development, providing employment and making a significant contribution to food security. In recent years, the advancement of Information and Communication Technologies (ICTs) has transformed agricultural extension services in Nigeria, leading to the emergence of e-extension systems. ICT can enable equitable, efficient, and sustainable agricultural development, ensuring food security in a rapidly changing world. These digital tools, including mobile applications, social media, and websites, play a crucial role in disseminating agricultural information and enhancing knowledge transfer to farmers. **[1,2]**

E-extension offers solutions to resource constraints, expands outreach, and enhances information flow in rural areas **[2]**. It enables farmers to access advisory services, market information, and weather forecasts more easily

Among arable crop farmers in Southwest Nigeria, the adoption of e-extension agricultural technologies has the potential to bridge the knowledge gap, improve decision-making, and promote sustainable farming practices. However, despite the benefits, the extent of utilisation of these technologies remains uncertain due to factors such as access to digital tools, literacy levels, awareness, and perceived effectiveness.

The study therefore assessed the utilisation of e-extension agricultural technologies among arable crop farmers in Southwest Nigeria, as well as examining the factors influencing their adoption.

The objectives of the study are to:

- Investigate the awareness levels of e-extension agricultural technologies among arable crop farmers in Southwest Nigeria
- examine the utilisation patterns of e-extension and agricultural mobile applications among the respondents
- ascertain the adoption levels of e-extension agricultural technologies among arable crop farmers in the study area
- determine the socio-demographic factors influencing the utilisation of e-extension technologies and agricultural mobile applications among the respondents

2.0 Research Methodology

The study employed a descriptive survey research design to investigate the utilisation of e-extension agricultural technologies among arable crop farmers in Southwest Nigeria. This design was considered appropriate because it enabled the collection of cross-sectional data to describe patterns of technology adoption, perceived benefits, and barriers among a diverse population of farmers.

The population for this study consisted of registered arable crop farmers across the six states of Southwest Nigeria, namely Ekiti, Lagos, Ogun, Ondo, Osun, and Oyo. These states represent a region where both traditional agricultural practices and emerging ICT-driven extension services co-exist. The purposive focus on arable crop farmers was informed by their central role in food production and their growing exposure to e-extension services through government and private sector initiatives.

A multistage sampling technique was employed to ensure representativeness across the region. First, three states with active e-extension programs and significant arable crop production (Ondo, Ogun, and Oyo) were purposively selected. Within each state, two agricultural extension zones were randomly chosen, followed by the selection of five extension blocks or Local Government Areas (LGAs) within each zone. Finally, systematic random sampling was employed to select participating farmers from official lists of farmers provided by local extension offices. A total sample size of 500 arable crop farmers was targeted; however, only 482 were fit for analysis.

Data collection was conducted using a structured questionnaire, which was designed following an extensive review of the literature on ICT use in agricultural extension and validated by three experts in agricultural extension and rural sociology. The instrument was divided into several key sections: (1) demographic and socioeconomic characteristics of respondents; (2) awareness and access to e-extension technologies; (3) extent and frequency of technology utilisation; (4) perceived benefits of e-extension use; and (5) challenges and barriers to effective utilisation. Attitudinal items were measured using a 5-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree." The reliability

of the instrument was assessed through a pilot study involving 20 farmers outside the main study area, yielding a Cronbach's Alpha coefficient of 0.81, which indicates good internal consistency.

For data analysis, responses were coded and entered into SPSS (Version 26) for processing. Descriptive statistics (frequencies, percentages, means, and standard deviations) were used to summarise the characteristics of the respondents and their patterns of technology use. Furthermore, multiple regression analysis was performed to identify key predictors of e-extension technology adoption. In contrast, correlation analysis was used to explore potential relationships between technology use and reported improvements in farm productivity.

3.0 Results

Table 1: Observed level of awareness of the technologies among the respondents

S/N	ITEM	NA	RA	MA	FA	$\overline{X}$
1	I am aware that mobile agricultural technologies could be used for agricultural purposes	-	25 (5.2%)	121 (25%)	336 (69.8%)	3.65
2	I am aware that many mobile agricultural technologies could be used for agricultural information dissemination	29 (6%)	62 (12.9%)	166 (34.5%)	225 (46.6%)	3.22
3	I am aware that farmers do receive useful information through mobile agricultural technologies	62 (12.9%)	96 (19.9%)	75 (15.5%)	249 (51.7%)	3.06
4	Mobile agricultural technologies could be used to improve farming business	91 (19%)	58 (12.1%)	262 (54.3%)	71 (14.6%)	2.65
5	Mobile agricultural technologies link buyers and sellers as well as enabling them to display their goods	16 (3.4%)	46 (9.5%)	175 (36.2%)	245 (50.9%)	3.34
6	I am aware that mobile agricultural technologies provide farmers with information on farm output and also facilitates	12 (2.6%)	46 (9.5%)	162 (33.6%)	262 (54.3%)	3.40
7	Mobile Agricultural technologies can be used for simultaneous provision of information on management of arable crops	75 (15.5%)	62 (12.9%)	299 (62.1%)	46 (9.5%)	2.66
8	Mobile agricultural technologies can be used as linkage between research institute, extension experts and farmers	-	37 (7.8%)	208 (43.1%)	237 (49.1%)	3.41
9	I am aware that mobile agricultural technologies can be used to provide appropriate guidance on weather forecast	29 (6%)	58 (12.1%)	166 (34.5%)	229 (47.4%)	3.23
10	A mobile agricultural technology enables registered farmers to ask questions and receives answers to their questions	62 (12.9%)	33 (6.9%)	341 (70.7%)	46 (9.5%)	2.77
11	It provides updated price information to farmers in English language and local languages	33 (6.9%)	121 (25.1%)	71 (14.7%)	257 (53.3%)	3.15
12	Mobile agricultural technologies can be used to calculate actual dosage of chemical to be applied per hectare of land during production	0	58 (12.1%)	121 (25.1%)	303 (62.8%)	3.51
	WEIGHTED MEAN					**3.17**

N =482: Low (<3.10); Moderate (≥3.11<3.17); High (≥3.17)

Key: (NA) Not aware; (RA) Rarely aware; (MA) Moderately aware; (FA) Fully aware

This table outlines respondents' awareness levels regarding various mobile agricultural technologies and their four key applications in the agricultural sector. Awareness is assessed across four categories: Not Aware (NA), Rarely Aware (RA), Moderately Aware (MA), and Fully Aware (FA), with remarks indicating the intensity of awareness.

The highest awareness is observed in the general understanding that mobile agricultural technologies can be used for agricultural purposes, with 69.8% of respondents fully aware and a high weighted mean of 3.65. This suggests a widespread recognition of mobile tech's applicability in agriculture. Similarly, 46.6% of respondents are fully aware of the role of mobile technologies in agricultural information dissemination, scoring an average of 3.22.

Respondents also demonstrate high awareness of mobile technology's role in providing information on farm output and support (54.3% fully aware) and linking buyers and sellers (50.9% fully aware), both with a mean score of 3.40 and 3.34, respectively. These figures imply that respondents not only recognise the informational value of mobile technology but also its role in enhancing market connectivity.

Conversely, certain functions reveal lower awareness levels. For instance, the use of mobile technologies for business improvement is less recognised, with only 14.6% fully aware and a mean score of 2.65, indicating a low level of awareness. Likewise, using mobile tech as a platform for providing simultaneous management information across various agricultural commodities has limited recognition, with a mean of 2.66 and only 9.5% fully aware. These lower scores suggest that respondents may not fully understand the potential breadth of mobile tech applications in specialised areas.

Moderate awareness is evident in applications that provide price information in multiple languages, with 53.3% of respondents fully aware and a mean score of 3.15. Additionally, the idea that mobile technology can serve as a link between research institutes, extension experts, and farmers has a higher awareness level, achieving a mean score of 3.41, indicating that respondents value mobile technology for networking and communication purposes.

The weighted mean of 3.17 reflects an overall moderate to high level of awareness about the applications and benefits of mobile agricultural technologies among respondents, indicating an encouraging level of familiarity with these technologies in agricultural settings. This broad awareness suggests that mobile agricultural technologies are generally well-received, though opportunities remain to raise awareness about more specialised applications for maximum impact on agricultural productivity.

Table 2: Utilisation Pattern of E-Extension and Agricultural Mobile Applications Among Arable Crop Farmers

S/N	App	Utilized F(%)	Unutilized F(%)	Mean $\overline{X}$
1.	Google trader	34(7.1)	448(92.9)	1.09
2.	Farm crowdy	59(12.1)	423(87.9)	1.07
3.	Facebook	394(81.9)	88(18.1)	1.18
4.	Telegram	316(65.5)	166(34.5)	1.34
5.	IITA herbicide calculator	299(68.1)	183(31.9)	1.32
6.	WhatsApp	303(62.9)	99(37.1)	1.37
7.	Hello Tractor	436(90.5)	46(9.5)	1.09
8.	Agro data	220(45.7)	262(54.3)	1.54
9.	Mobile banking app	361(75.0)	121(25.0)	1.25
10.	Esoko	46(9.5)	436(90.5)	1.09
11.	Probity Farm	34(6.9)	448(93.1)	1.07
12.	GPS	175(36.2)	307(63.8)	1.36
13.	E-wallet	71(14.7)	411(85.3	1.15
14.	Climate app	75(15.5)	407(84.5)	1.16
15.	Ignitia	216(44.8)	266(55.1)	1.45

N = 482 Low (<2.5); Moderate (≥2.5<3.5); High (≥3.5), Grandmean = 1.2

The utilisation pattern of various e-extension and agri-tech applications among arable crop farmers in Southwest Nigeria reveals notable trends in digital agricultural engagement. Among the platforms assessed, Hello Tractor exhibited the highest utilisation rate, with 90.5% of farmers reporting active use, indicating strong demand for digital mechanisation services, particularly tractor bookings and field support. This was closely followed by Facebook (81.9%), Mobile Banking Apps (75.0%), and the IITA Herbicide Calculator (68.1%), reflecting the growing influence of general digital platforms and decision-support tools in everyday farming activities. Telegram (65.5%) and WhatsApp (62.9%) were also heavily utilised, likely due to their accessibility, multimedia capabilities, and use in farmer groups and cooperative communications.

In contrast, platforms like Google Trader (7.1%), Probity Farm (6.9%), and Esoko (9.5%) had extremely low utilisation rates, suggesting limited awareness or failed scaling efforts in the region. Other underutilised tools included Climate Apps (15.5%), E-wallet (14.7%), and Farmcrowdy (12.1%), despite their potential relevance for climate-smart farming and input financing. Interestingly, Ignitia, a weather-focused SMS platform, showed moderate usage at 44.8%, suggesting that weather forecasting tools are gaining traction. Overall, the results highlight a clear preference for social media and SMS-based platforms that offer practical, real-time benefits and are integrated into farmers' daily communication habits.

Table 3: Respondents' Engagement Levels with Agricultural Technologies and Digital Tools

S/N	ITEMS	Heard About	Heard & Taught	Tried	Adopted & Still in Use	Mean $\overline{X}$
1	Cocoa Link	195 (40.5)	145 (30.2)	96 (19.8)	46 (9.5)	1.98
2	Google Trader	133 (27.5)	87 (18.2)	45 (9.3)	18 (15.5)	2.42
3	Farm Crowthy	208 (43.1)	258 (53.4)	16 (3.4)	0 (0.0)	1.6
4	Whatsapp	233 (48.3)	137 (28.4)	29 (6.0)	83 (17.2)	1.92
5	Hello Tractor	58 (12.1)	179 (37.1)	154 (27.6)	91 (18.9)	2.49
6	AgroData	46 (9.5)	104 (21.5)	224 (46.5)	63 (22.4)	2.82
7	E-Wallet	149 (31.0)	308 (63.8)	0 (0.0)	25 (5.2)	1.79
8	Mobile Banking App	58 (12.1)	162 (33.6)	166 (34.5)	96 (19.8)	2.62
9	Esoko	96 (19.8)	224 (46.5)	116 (24.1)	45 (9.5)	2.23
10	Probity Farm	46 (9.5)	328 (68.1)	108 (22.4)	0 (0.0)	2.13
11	GPS	340 (70.6)	67 (13.8)	33 (6.9)	42 (8.6)	1.53
12	Compare the Market	125 (25.9)	236 (49.1)	54 (11.2)	67 (12.0)	2.13
13	Agrivi App	261 (54.3)	166 (34.5)	54 (11.2)	0 (0.0)	1.57
14	Facebook	108 (22.4)	108 (22.4)	96 (19.8)	170 (35.3)	2.68
15	IITA Herbicide Calculator	133 (27.5)	196 (40.5)	62 (12.9)	91 (19.0)	2.23
16	Telegram	175 (36.2)	237 (49.1)	25 (5.2)	45 (9.5)	1.88
17	Climate App	108 (22.4)	204 (42.2)	133 (27.6)	37 (7.8)	2.21

N = 482: Low (<2.5); Moderate (≥2.5<3.5); High (≥3.5)

This table provides insight into the respondents' awareness, experimentation, and adoption of various agriculture-related apps and technology enablers. Data captured for each app shows respondents' levels of engagement, indicating whether they have heard about it, been introduced to it, tried it, or adopted it for continued use. The mean scores at the end of each row reflect an average engagement or adoption level, with interpretation guidelines indicating low (<2.5), moderate (2.5 < x < 3.5), and high (x≥ 3.5) engagement.

Apps like Cocoa Link have moderate visibility, with 40.5% of respondents having heard of it and 30.2% having heard of it and received training. Only. 9.5% report ongoing usage, yielding a mean score of 1.98, which indicates low engagement. In comparison, Google Trader has a mean score of 2.42, also in the low range, with 27.5% having heard of it and 15.5% reporting continued use.

Farm Crowthy stands out with a high level of awareness, as 43.1% of respondents have heard about it, and an impressive 53.4% have received some form of training. However, it shows limited usage, with only 3.4% having tried

it, reflected in a mean score of 1.60. Conversely, AgroData shows higher adoption rates, with 46.5% trying it and 22.4% still using it, resulting in a mean score of 2.82, indicating moderate engagement.

Messaging apps such as WhatsApp and Facebook demonstrate substantial usage. WhatsApp has 48.3% awareness and 17.2% ongoing usage, while Facebook shows even higher adoption, with 35.3% continuing to use it. Facebook's mean score of 2.68 confirms moderate engagement. Similarly, Mobile Banking Apps show 34.5% usage and 19.8% adoption, leading to a mean score of 2.62, suggesting they are moderately adopted as well.

Meanwhile, specialised apps like E-Wallet (with 63.8% trained users but only 5.2% adoption) and GPS (with 70.6% awareness but 8.6% ongoing use) score low on adoption, with mean scores of 1.79 and 1.53, respectively. This highlights a disconnect between awareness and sustained usage of these tools.

Overall, apps with broad applications beyond agriculture, such as Facebook, Mobile Banking Apps, and AgroData, show higher engagement levels than more specialised apps.

Table 4: Relative factors influencing the utilisation of the technology/APPS among the respondents

Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**T**	**Sig.**
		B	Std. Error	Beta		
	(Constant)	97.391	38.050		3.918	.000
	Sex	2.382	1.680	0.194	3.902	.001
	Age	0.684	.604	0.117	4.762	.000
	Religion	-1.686	.728	-0.296	-3.618	.389
	Marital status	1.691	.711	0.301	2.911	.001
	Ethnicity	-1.517	1.390	-0.141	-1.443	.152
	Household size	0.040	.833	0.103	2.381	.000
	Farmland acquisition	1.329	.741	0.292	4.228	.000

Table 4 presents the findings of a multiple regression analysis undertaken to investigate the relative influence of selected socio-demographic factors on the utilisation of e-extension agricultural technologies and apps among arable crop farmers in Southwest Nigeria. The model included seven independent variables: gender, age, religion, marital status, ethnicity, household size, and farmland acquisition. The results offer valuable insights into how these factors affect farmers' engagement with e-extension tools.

The regression model yielded a significant constant term ($B = 97.391$, $p < 0.001$), indicating that even in the absence of the predictor variables, there remains a baseline level of technology utilisation. Among the individual factors, sex was found to have a positive and statistically significant influence ($B = 2.382$, $\beta = 0.194$, $p = 0.001$), suggesting that male farmers may be slightly more likely to utilise e-extension technologies compared to their female counterparts. This finding aligns with prior research that highlights gender disparities in access to and use of ICT in agricultural contexts.

Age also emerged as a significant positive predictor ($B = 0.684$, $\beta = 0.117$, $p < 0.001$), implying that older farmers in the sample were more likely to engage with e-extension platforms. This result is somewhat counterintuitive, as younger farmers are often assumed to be more tech-savvy; however, it may reflect the greater experience, decision-making power, and control over resources among older farmers in this region. While younger farmers are generally more likely to adopt digital tools (Hoang & Tran, 2023; Zinzade Pooja et al., 2024), some research indicates older farmers may be more engaged with e-extension platforms (Le Thi Hoa Sen et al., 2024). Education level, farm size, and social connections positively influence adoption (Hoang & Tran, 2023; Zinzade Pooja et al., 2024)

Interestingly, religion showed a negative coefficient ($B = -1.686$, $\beta = -0.296$), though its effect was not statistically significant ($p = 0.389$). Similarly, ethnicity had a negative but non-significant influence on technology utilisation ($B = -$

1.517, β = -0.141, p = 0.152), suggesting that cultural or ethnic background did not significantly influence access to or use of e-extension services in this sample.

On the other hand, marital status demonstrated a positive and significant effect (B = 1.691, β = 0.301, p = 0.001), indicating that married farmers tended to utilise e-extension technologies more frequently, possibly due to their more stable household structures and greater farming responsibilities. Similarly, household size was positively and significantly related to technology use (B = 0.040, β = 0.103, p < 0.001), perhaps reflecting the greater labour and information needs of larger households.

Finally, farmland acquisition showed a strong and positive effect on utilisation (B = 1.329, β = 0.292, p < 0.001). Farmers who had secured land through ownership or long-term leases were more likely to invest in e-extension tools, likely because of their greater tenure security and willingness to adopt productivity-enhancing innovations.

4.0 Discussion

The study reveals a high level of awareness of digital agricultural platforms among arable crop farmers in Nigeria, yet the actual adoption and consistent use of these platforms remain relatively low. Despite widespread familiarity with tools such as FarmCrowdy, WhatsApp, and CocoaLink, a significant proportion of farmers had not adopted these tools into regular use. This finding is consistent with earlier studies that reported a gap between awareness and practical usage of ICT tools in agricultural contexts across sub-Saharan Africa **[3,4]**.

The relatively high engagement with platforms like WhatsApp aligns with observations by Munyua et al., who noted that informal digital channels often have better reach in rural areas compared to formal e-extension platforms **[5]**. Similarly, the success of FarmCrowdy, which offers bundled services including access to inputs and market linkages, supports previous arguments that platforms offering comprehensive solutions tend to enjoy better adoption rates **[6]**.

However, low usage of platforms such as Hello Tractor despite moderate awareness suggests that adoption is influenced not just by availability but also by perceived relevance, ease of use, and economic benefit—a view supported by Adolwa et al. **[7]**. This study also reveals that younger farmers were more likely to adopt e-extension tools, consistent with findings that younger populations are more tech-savvy and receptive to innovations **[8]**.

Infrastructure challenges such as limited internet access, irregular electricity supply, and the high cost of smartphones were frequently cited as barriers to adoption. These issues have also been widely reported in earlier Nigerian studies on ICT use in agriculture **[8,9]**. Furthermore, low digital literacy among older farmers exacerbates the digital divide, limiting the potential impact of e-extension services.

To address these issues, previous studies recommend integrating e-extension training into traditional extension services and tailoring digital platforms to meet local needs, including local languages, simplified interfaces, and affordable access **[3,10]**. For Nigeria to fully benefit from the promise of e-extension technologies, a multi-stakeholder approach is required, involving government, private sector, and local communities to improve digital infrastructure, provide targeted capacity building, and ensure that platforms are user-centric and context-specific.

5.0 Conclusion

This study provides valuable insights into the current state of e-extension agricultural technology utilisation among arable crop farmers in Southwest Nigeria. The findings reveal that while awareness of these technologies is generally moderate to high, actual utilisation and sustained adoption remain uneven across different platforms. Farmers display a strong preference for general-purpose digital tools, such as social media and mobile banking applications, while the uptake of specialised agricultural apps remains limited. This indicates a gap between awareness and practical engagement that must be addressed through targeted capacity-building and farmer education.

Socio-demographic factors—particularly sex, age, marital status, household size, and farmland acquisition—significantly influence the adoption of e-extension technologies. These insights highlight the importance of designing inclusive and context-sensitive interventions that account for gender disparities, land tenure security, and household

dynamics. Encouragingly, the study found no significant cultural or religious barriers to adoption, suggesting broad potential for scaling up e-extension services across diverse communities.

The study also underscores key challenges that must be overcome to realise the full potential of digital extension services. These include limited digital literacy, affordability of devices and internet services, infrastructural limitations, and a lack of localised and user-friendly content. Addressing these barriers through comprehensive digital inclusion strategies will be critical for promoting wider and more effective use of e-extension technologies.

6.0 Ethical Considerations

This study was conducted in accordance with established ethical standards for research involving humans. Participation in the study was entirely voluntary, and all respondents were informed of the study's objectives, their right to withdraw at any time, and the confidentiality of the information provided.

Informed consent was obtained from all participants before administering the questionnaires. To ensure privacy, no personal identifiers were collected, and all data were anonymized and securely stored.

7.0 Limitations

While this study provides valuable insights into the utilisation of e-extension agricultural technologies among arable crop farmers in Southwest Nigeria, certain limitations should be acknowledged. First, the study relied on self-reported data collected through structured questionnaires, which may be subject to response bias or inaccuracies in recall. Second, although the sample was drawn from three key states in Southwest Nigeria, the findings may not fully represent the experiences of farmers in other regions of the country where different socio-economic or infrastructural conditions may apply. Third, the study primarily focused on the extent of awareness, utilisation, and adoption of e-extension technologies, but did not conduct a longitudinal assessment of their direct impact on farm productivity or income levels.

Future research should consider employing a longitudinal design to capture better the long-term effects of e-extension technologies on agricultural outcomes. Additionally, qualitative approaches such as focus group discussions and in-depth interviews could complement survey data to provide deeper insights into the barriers and enablers of technology adoption. Expanding the study to other geopolitical zones in Nigeria would also enhance the generalizability of the findings and support the development of more targeted digital extension strategies at the national level.

Ultimately, the study affirms that e-extension tools can significantly enhance farmers' access to timely and relevant agricultural information, improve decision-making, and contribute to more sustainable and productive farming practices. Furthermore, ongoing monitoring and evaluation of e-extension initiatives will be essential to track their evolving impact on farmers' productivity and to inform continuous improvement of digital extension services. To maximise these benefits, policymakers, extension agencies, and technology developers must work collaboratively to bridge the gap between awareness and sustained use, promote equitable access, and ensure that digital innovations are tailored to the practical needs of arable crop farmers in Nigeria. By doing so, e-extension can become a transformative force in advancing agricultural development and food security in the region.

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Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request. All data were collected through structured questionnaires administered to arable crop farmers and have been anonymized to ensure the privacy and confidentiality of the respondents.

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Conflict of Interest

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