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Knowledge and Attitude of Extension Educators Towards Digitising Agricultural Extension Services in Kwara State, Nigeria

Abstract. This study assessed the knowledge, attitudes and constraints of agricultural extension educators regarding the integration of digital tools in agricultural extension services in Kwara State, Nigeria, by examining the extent to which extension educators are knowledgeable about and favourably disposed to using digital tools in agricultural extension services, as well as ascertaining the barriers to their effective adoption. A survey design was employed using a two-stage sampling technique. Data were collected via a structured interview schedule and analysed using descriptive statistics. The results showed that 57% of respondents were male, 71% were married and 40% held PhDs – with a mean age of 45.3 years and 11.3 years of teaching experience. A significant majority (77%) demonstrated high knowledge and a favourable attitude towards digital extension services. Although 82% were aware of digital tools, only 48.2% reported high usage. The main constraints were poor orientation, high internet connectivity costs and the expense of digital equipment. Correlation analysis indicated a statistically significant relationship between digital literacy and willingness to adopt digital extension tools ($r = 0.72$, $p < 0.05$), emphasising the role of technical capacity-building in accelerating adoption. These findings underscore the need for targeted capacity-building, financial incentives and infrastructure improvements to enhance digital adoption in agricultural extension services.

Keywords: knowledge, attitude, digital extension, extension services, educators

JEL Classification: O33, Q16

Introduction

Agricultural extension services play a crucial role in improving agricultural productivity, promoting sustainable practices and ensuring food security. Traditionally delivered through face-to-face interactions and group meetings, these services have undergone significant transformations due to advancements in digitisation. The introduction of mobile-based platforms, automated technologies and information and communication

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technologies (ICTs) has enabled timelier, focused and cost-effective delivery of knowledge and advisory services to farmers (Awad, 2021). These digitised systems provide farmers with actionable information, enhancing decision-making and increasing productivity while fostering inclusivity by attracting younger generations to agriculture through technology-driven innovations. However, despite the growing adoption of digital tools, several challenges persist, including limited infrastructure, connectivity issues and varying levels of digital literacy among farmers and extension personnel. Mohammed et al. (2023) and Vincent & Iyobhebhe (2025) reinforce that the pace of digital transformation in rural African agriculture remains uneven due to infrastructural bottlenecks and capacity gaps among extension personnel.

This study is grounded in the Technology Acceptance Model (TAM) (Davis, 1989), which provides a framework for understanding how individuals perceive and adopt technological innovations. TAM suggests that perceived usefulness and perceived ease of use are critical factors influencing the acceptance of new technologies. In the context of digitising agricultural extension, educators' willingness to integrate digital tools depends on their perception of the benefits these technologies provide in enhancing extension services. Furthermore, the Diffusion of Innovation Theory (Rogers, 2003) is relevant because it explains how new technologies spread within a social system. Extension educators serve as key change agents in the diffusion process, and their ability to adopt digital platforms determines the successful transmission of agricultural knowledge.

Understanding educators' attitudes towards digital tools is essential, as their readiness to incorporate ICTs influences agricultural extension outcomes. Factors such as digital literacy, accessibility, institutional support and socio-economic challenges significantly impact their adoption rate. Kwara State presents a compelling case for studying these dynamics due to its diverse socio-economic and geographical landscape, comprising both urbanised areas with strong digital infrastructure and rural communities facing broadband limitations and socio-economic constraints. Agriculture remains a significant livelihood for many within the state, making it essential to explore how digital extension systems can bridge gaps between knowledge dissemination and field implementation. While existing studies examine digital agricultural extension across Nigeria and globally, there remains a critical gap in understanding extension educators' preparedness, attitude and adoption of digital tools specifically in Kwara State. The ability of extension educators to efficiently utilise digital platforms is fundamental in ensuring the seamless transmission of agricultural innovations to farmers; yet, their perspectives on digitisation are underexplored (Kurdyś-Kujawska et al., 2021). Additionally, Okafor & Ekong (2024) argue that digital extension success in Nigeria depends heavily on the digital competencies and behavioural orientation of educators who act as intermediaries between innovation creators and end-users.

The COVID-19 pandemic underscored the significance of digital extension tools in maintaining resilience across agricultural systems. During the crisis, digital technologies were pivotal in mitigating disruptions in agri-food supply chains, facilitating access to financial aid and agricultural inputs and ensuring continuous communication between farmers and extension agents (FAO, 2020a; FAO, 2020b). These advancements emphasise the need for scalable digital solutions that can enhance agricultural extension services and ensure food security, particularly in regions where traditional extension methods are becoming increasingly challenging (Grote et al., 2021). The development of virtual networks and digital platforms has enabled global interaction and knowledge exchange among farmers,

extension agents and agricultural stakeholders, offering smallholder farmers access to innovative techniques, market intelligence and climate adaptation strategies (Ajaegbu et al., 2019). Mulungua et al. (2025) also confirm that countries with decentralised digital networks and multi-lingual content delivery achieved better extension continuity during the pandemic. However, realising the full potential of these systems in Kwara State necessitates addressing key barriers such as limited ICT infrastructure, affordability constraints and the need for continuous capacity building among extension educators.

Extension educators serve as the backbone of digitised agricultural extension systems. As intermediaries between agricultural researchers and farmers, they disseminate knowledge, facilitate innovation adoption and respond to evolving challenges in the agricultural landscape. Over time, their roles have evolved beyond technical advisory functions to include responsibilities such as monitoring disease outbreaks, assessing climate variability and analysing market trends. Despite their importance, extension educators in Kwara State face challenges such as insufficient training in ICT usage, restricted access to digital tools and motivational setbacks due to resource constraints (Saiz-Rubio & Rovira-Más, 2020; Savary et al., 2020). Addressing these limitations is essential to ensuring that e-extension services are effectively deployed and contribute to sustainable agricultural growth. This study focuses specifically on extension educators (lecturers) within the academic community who train future field-level advisors, thus indirectly shaping how advisory services are delivered to farmers. The aims are to:

1. Assess the knowledge of extension educators in Kwara State regarding the digitisation of agricultural extension services;
2. Examine the attitudes of extension educators regarding the digitisation of agricultural extension services;
3. Examine the capabilities of extension educators in Kwara State regarding the digitisation of agricultural extension services;
4. Identify key constraints to effective e-extension systems.

This research seeks to provide actionable insights that will inform policy directions, enhance service provision and bridge the identified research gaps. Specifically, the study will evaluate extension educators' familiarity with digital tools, examine their attitudes towards adopting these technologies and explore the infrastructural and socio-economic barriers affecting digital extension services within the state. To empirically test educators' engagement with digital extension services, this study posits that there is no significant relationship between extension educators' knowledge of digital tools and their attitude towards adopting digitised agricultural extension services in Kwara State. This hypothesis enables an objective analysis of whether educators' knowledge of digital platforms affects their willingness to implement such technologies in their extension practices. Given the urban-agricultural duality of Kwara State, this research offers a valuable case study for understanding the challenges and opportunities surrounding digital agricultural extension in Nigeria. By addressing disparities in access, infrastructure and training, the study contributes to broader goals of advancing sustainable agricultural practices, strengthening food security and fostering resilience amid global agricultural uncertainties.

Methodology

This study was conducted in Kwara State, Nigeria. The region was selected due to its strategic importance in agricultural development, characterised by a diverse mix of urban and rural settings with varying levels of digital accessibility. Kwara State serves as a representative case for examining digital agricultural extension services, as its extension educators encounter challenges related to infrastructure, digital literacy and adoption readiness. A survey research design was employed to systematically assess lecturers' knowledge, attitudes and constraints regarding digital extension services. The target population comprised lecturers in the departments of Agricultural Extension across state universities, selected for their direct involvement in training extension educators who ultimately implement digital extension services. These lecturers serve as key stakeholders in shaping the digital readiness of future extension personnel, making their perspectives essential for understanding the state of digitisation within agricultural extension programmes. This focus on university lecturers underscores their indirect but influential role in shaping front-line advisory services delivered by extension practitioners who interact directly with farmers.

A two-stage sampling procedure was used. In the first stage, higher education institutions offering Agricultural Extension programmes were purposively selected based on their relevance, research reputation and contribution to extension education. The selection criteria were the accreditation status of the Agricultural Extension department, active participation in extension training and research and institutional capacity in adopting digital extension technologies. In the second stage, 42 lecturers were randomly selected from these institutions, ensuring stratification by academic rank, years of teaching experience and areas of specialisation. This approach provided diversity in expertise and minimised biases related to knowledge and experience disparities. The final sample consisted of 42 respondents, with demographic and professional characteristics detailed in Table 1, including age distribution, household size, alternative occupations, teaching experience and professional affiliations. This comprehensive profile enables a clearer understanding of the sample's representativeness within the broader academic extension educator community in Kwara State.

Data were collected using a structured interview schedule developed with validated questions addressing key study variables such as digital literacy, attitudes towards digitisation and institutional challenges. The reliability of the instrument was confirmed through a pilot test conducted with agricultural extension educators outside the study area, achieving a Cronbach's alpha of 0.85, indicating high internal consistency. The validity of the instrument was established through expert review by specialists in agricultural extension and ICT, ensuring that the questions accurately captured the intended research concepts. Descriptive statistical tools, such as percentages and charts, were employed to present demographic characteristics and insights into respondents' digital literacy and attitudes towards digitisation. Additionally, correlation analysis was conducted to examine potential relationships between lecturers' familiarity with digital tools and their attitudes towards digital extension services. This statistical approach provided empirical evidence on whether educators' exposure to technology significantly influenced their adoption of digital innovations. Correlation analysis was used to understand the relationships between demographics, knowledge, attitude, constraints and the adoption of digitalisation of

agricultural extension services, to identify patterns, validate assumptions and make informed decisions. The correlation analysis does not establish causation but explores data and uncovers potential connections between variables.

Results and Discussions

Table 1 presents the results on the demographic characteristics of the respondents, providing significant insights into their potential readiness for the digitisation of agricultural extension services. The respondents' mean age of 45 ± 11 years indicates that the majority are within their productive years, with 69% under the age of 50. Younger individuals tend to be more receptive to innovation and technological advancements, which could facilitate their willingness to integrate digital tools into extension practices. This observation is supported by Aja et al. (2024), who emphasise that agricultural extension personnel in similar age brackets exhibit higher levels of adaptability, risk tolerance and enthusiasm for technological shifts. Such attributes could significantly influence their responsiveness to digital extension services. Marital status and household size provide additional insights into the professional engagement of respondents. With 76.2% of respondents married and an average household size of 6 ± 2 persons, their socioeconomic responsibilities may incentivise them to seek professional stability and innovation. The national average household size in Nigeria is approximately five persons (Statista, 2019), suggesting that the respondents manage slightly larger households, which may necessitate financial security and career advancements. The willingness to embrace digitisation may be influenced by a need for improved productivity and income diversification. Prior studies, such as those by Mustapha et al. (2022), highlight that individuals with extensive familial responsibilities often engage more proactively with professional opportunities that promise efficiency and long-term sustainability.

Table 1. Respondents by demographic characteristics (n = 42)

Variables	Percentage	$\bar{X} \pm SD$	Variables	Percentage	$\bar{X} \pm SD$
Age Interval			**Household Size**		
<41	33.3		1-5	45.2	
41-50	35.7	45.3 ± 11	6-10	45.2	5.94 ± 2
>50	31.0		11-15	9.5	
Alternative Occupation			**Years of Teaching Experience**		
Artisan	35.7		5-10	45.2	
Trading	54.7		11-15	38.1	
Others	9.5		16-20	14.3	11.25 ± 5
Membership of Professional Association			21-30	2.4	
Yes	57.0				
Others	42.9				

Source: Authors' computation, 2024.

The educational qualification plays a significant role in shaping attitudes towards agricultural digitisation, with 57% of respondents reporting membership in professional organisations. Such affiliations create platforms for knowledge exchange, networking and exposure to technological innovations, equipping extension personnel with the skills necessary to navigate digital extension successfully. The importance of professional networking in knowledge sharing has been well documented (Aja et al., 2024), illustrating how engagement in professional communities enhances the ability of extension personnel to collaborate, learn collectively and embrace new technologies. Additionally, higher educational qualifications contribute significantly to digital readiness, with 76% of respondents holding postgraduate degrees. Advanced education provides individuals with analytical skills, problem-solving capabilities and exposure to complex technological ecosystems, making them better equipped to integrate ICTs into agricultural extension services. This finding aligns with Mustapha et al. (2022), who argue that postgraduate education enhances the cognitive ability to interpret and apply digital innovations within professional contexts.

The respondents demonstrated a high degree of multifunctionality, with 54.7% reporting engagement in trading as an alternative occupation. This entrepreneurial spirit suggests adaptability, which could extend to their willingness to adopt digital tools for agricultural extension services. A strong entrepreneurial mindset can drive digital innovation, as extension personnel who engage in multiple income streams may recognise the efficiency and financial advantages of technology in their core profession. The gender distribution from Figure 2 revealed that 57% of respondents were male, reflecting a traditional trend where men dominate leadership roles in agricultural extension. While this may indicate established gender norms, fostering a more inclusive environment for female extension personnel could introduce diverse perspectives and enrich the adoption of digital tools in agricultural extension. Gender-responsive strategies have been increasingly advocated by scholars such as Mwangi et al. (2022), who highlight the critical contributions of women in agricultural knowledge dissemination, particularly in regions where gender disparities persist. Meena & Kumar (2025) emphasise that gender-inclusive extension services, such as tailoring training schedules to women's availability and promoting female leadership, significantly improve technology adoption and agricultural productivity among rural women. Similarly, Bamanyaki (2022) advocates for a gender equality and social inclusion approach in agricultural advisory services, noting that increasing female participation in extension roles enhances the relevance and reach of agricultural innovations. The Nigeria Gender Innovation Lab (2025) of the World Bank also reports that engaging more female extension agents and designing gender-sensitive programmes can close productivity gaps and boost national GDP by billions of dollars.
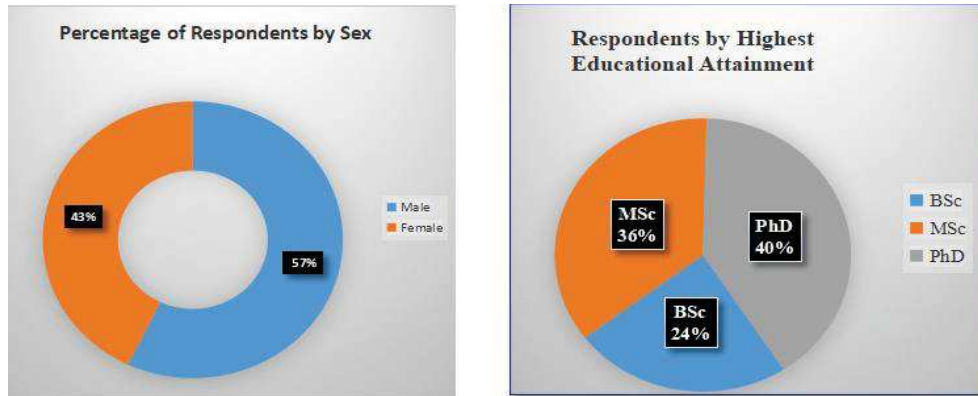
Fig. 1. Distribution of respondents by sex and highest educational attainment

Source: Authors' computation, 2024.

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A comparative analysis with international contexts highlights both shared challenges and unique opportunities in the digitisation of agricultural extension services. Studies from India (Singh et al., 2021) and Kenya (Mwangi et al., 2022) illustrate the effectiveness of structured training programmes and professional networks in enhancing digital literacy among extension personnel. However, challenges such as limited ICT infrastructure and inconsistent internet access, common in developing regions, require context-specific interventions. For instance, India has developed government-led digitisation training programmes that significantly boost technology adoption among extension personnel, whereas Kenya has implemented collaborative learning platforms that enable peer-to-peer engagement. Drawing lessons from both countries, Kwara State could benefit from a hybrid model that merges formal training programmes with collaborative, experience-based learning.

Respondents' knowledge on digital extension service delivery

The results from Table 2 demonstrate a strong awareness among respondents regarding the use of digital tools in agricultural extension services. The majority (81%, 83% and 81%) acknowledged the functionality of digital tools as websites, programs or online platforms, operating both offline and online to facilitate the dissemination of agricultural information. Their familiarity with social media platforms such as Facebook, Twitter and YouTube, as well as communication tools like Google Meet, WhatsApp and Email, alongside knowledge repositories such as Wikipedia, indicates that agricultural extension educators in Kwara State are relatively well-versed in digital technologies. This substantial level of digital awareness suggests that they possess the foundational competencies necessary for integrating digital tools into extension practices. However, the effective deployment of these tools depends on institutional support, sustained professional training and policy-driven incentives that facilitate seamless adoption.

Table 2. Respondents' knowledge on digital extension service delivery

Items	Yes (%)	No (%)
Digital tools can be programs, websites or online	81.0	19.0
They can be used online or offline	83.3	16.9
Digital tools must be downloaded before use	73.8	26.2
Digital e-extension support delivery of information in different ways?	81.0	19.0
Facebook is one of digital e-extension channels?	73.8	26.2
Twitter is one of digital e-extension channels?	78.6	21.4
YouTube is one of digital e-extension channels?	71.4	28.6
Google meet is one of e-extension channels?	83.3	16.9
Wikipedia is one of digital e-extension channels?	69.0	31.0
Email is one of digital e-extension channels?	78.6	21.4
WhatsApp is one of digital e-extension channels?	83.3	16.9
Can Radio be classified as a digital e-extension channels?	83.3	16.9
Digital tools allow for feedback	73.8	26.2
Data and information in digital tools can be edited	73.8	26.2

Source: Authors' computation, 2024.

These findings are consistent with Phillip and Ndirpaya (2020), who reported that agricultural extension agents (AEAs) in Nigeria exhibit baseline digital literacy and competency in ICT usage. Nonetheless, they cautioned that periodic training and retraining remain essential for ensuring that AEAs can fully leverage digital tools in their professional roles. Likewise, Ajah and Chigozie-Okwum (2019) highlighted that despite AEAs' knowledge of digital tools, strategic investment in capacity-building programmes is crucial to optimising their functionality in agricultural extension delivery. The convergence of findings underscores the reality that knowledge alone does not automatically translate into effective application. Without structured digital literacy programmes, educators may struggle

to adapt to rapidly evolving digital extension mechanisms, leading to suboptimal utilisation of available technological resources. The Pearson correlation analysis indicated a statistically significant positive correlation ($r = 0.72$, $p < 0.05$) between educators' knowledge of digital tools and their attitude towards digitisation. This suggests that increased exposure to technology enhances the willingness to integrate digital tools into agricultural extension services. However, several institutional barriers persist, including insufficient funding, weak ICT infrastructure and gaps in digital literacy training, which can hinder full-scale adoption. These challenges reflect broader structural limitations observed in other developing agricultural economies, where underinvestment in digital agriculture impedes the effectiveness of extension programmes. Mustapha et al. (2022) corroborate these findings, asserting that digital extension services in African agricultural systems often suffer from inadequate policy support, financial constraints and technological gaps, necessitating government-backed initiatives to bridge existing disparities. Furthermore, these findings align with Singh et al. (2021), who documented similar correlations among extension personnel in India, emphasising the necessity of capacity-building initiatives to bridge the gap between knowledge and adoption. Findings from this study also resonate with international perspectives, particularly research from India (Singh et al., 2021) and Kenya (Mwangi et al., 2022), where digital extension frameworks have been successfully integrated into agricultural advisory systems. In India, targeted government-led ICT training programs have substantially increased extension personnel's digital adoption rates, enabling more effective communication between farmers and educators. Similarly, Kenya's collaborative e-extension models have facilitated peer-to-peer learning, ensuring that extension personnel are not only digitally competent but also actively engage in knowledge-sharing networks to refine their expertise. Applying these models to Kwara State could yield similar benefits, particularly if policymakers prioritise structured capacity-building programs that blend formal digital training with hands-on experiential learning.

Respondents' attitude to digital extension service delivery

The results from Table 3 indicate that respondents generally hold a favourable attitude towards digital extension service delivery, with 73.3% expressing openness to its adoption. This suggests that extension educators recognise the value of digital tools in facilitating timely dissemination of agricultural information, enhancing extension outreach and empowering both farmers and extension agents. The increasing reliance on digital technologies in agricultural extension reflects global trends, as ICT-driven extension models have gained traction in recent years. Adebayo et al. (2023) emphasise that digital extension platforms have the potential to enhance agricultural productivity by enabling real-time knowledge transfer and decision-making support. Mukherjee et al. (2025) further confirm that e-agriculture and e-extension are dominant themes in global agricultural research, indicating a growing consensus on the transformative role of ICTs in extension services.

Despite this optimistic outlook, respondents identified specific barriers that could hinder the full-scale adoption of digital tools. Sixty-nine per cent noted that digital platforms often lack flexibility in accommodating local languages, posing a communication challenge for farmers in rural communities. Language accessibility has been a critical issue in ICT-driven extension systems, as standardised digital platforms may not always align with the linguistic diversity of farming populations. Singh et al. (2022) argue that the effectiveness of digital extension services is contingent on linguistic inclusivity, as farmers are more likely to engage with technologies that reflect their native language. Addressing this issue calls for the

localisation of digital tools, ensuring that extension resources, mobile applications and advisory services are available in multiple languages relevant to the target communities. Okolo & Tano (2024) emphasise that inclusive language technologies must go beyond translation to address power dynamics and cultural representation, advocating for participatory design in digital extension platforms to ensure equitable access for marginalised communities.

Table 3. Respondents' attitude on digital extension service delivery

Items	Yes (%)	No (%)
Digital tools are too rigid and do not allow the use of local languages	69.0	31.0
Farmers can be taught to use digital tools	83.3	16.9
Digital tools help both the farmers and extension agents to get an updated information about agriculture	83.3	16.9
They are not important in the dissemination of agricultural information	78.6	21.4
Digital tools are efficient but not consistent	83.3	16.7
They have disadvantage of data insecurity	78.6	21.4
All digital tools are complex and require special training to use	78.6	21.4
Power supply can be a major setback for the use of digital tools in rural Nigeria	64.3	35.7

Source: Authors' computation, 2024.

Additionally, 64.3% of respondents cited an unreliable power supply as a major constraint, particularly in rural areas where electricity access remains inconsistent. This finding aligns with Mwangi and Ouma (2021), who found that infrastructural deficits, including electricity and broadband limitations, negatively impact the adoption of digital agricultural extension services in sub-Saharan Africa. Extension educators in Kwara State face similar challenges, as digital tools require stable internet connectivity, adequate power infrastructure and affordable access to ICT devices to be effectively deployed. Power disruptions undermine the reliability of digital extension delivery, making it difficult for educators to maintain uninterrupted communication with farmers. Mustapha et al. (2022) advocate for hybrid ICT models, including offline-accessible digital resources and SMS-based advisory services, as viable solutions to mitigate power-related constraints. Vincent et al. (2024) and Iyobhebhe & Abiodun (2025) corroborate this, highlighting that hybrid renewable energy systems and decentralised ICT hubs can significantly improve rural electrification and digital service delivery in Nigeria, especially when integrated with solar-powered extension centres.

The findings resonate with international studies that highlight both the opportunities and challenges associated with digital agricultural extension. In India, for example, Patel et al. (2022) examined the effectiveness of mobile-based extension platforms and found that educators exhibit positive attitudes towards digital tools when institutional support is strong. This underscores the importance of policy-driven interventions that incentivise digital adoption while addressing infrastructural gaps. In Kenya, Kimani et al. (2023) identified financial limitations and inadequate ICT training as primary barriers to digital extension implementation. The study recommended structured training programmes that equip

extension educators with practical digital skills, ensuring that they can effectively navigate technological advancements. Similarly, Mulungua et al. (2025) found that ICT-based extension services significantly improve awareness, adoption and yield outcomes when tailored to local contexts and supported by capacity-building initiatives. Their review revealed that well-designed messaging and integration with complementary interventions are key to success.

Awareness and usage level of digital extension tools by the respondents

The data from Table 4 highlights a substantial gap between awareness and usage of digital extension tools among respondents. While 82% of respondents demonstrated high awareness of digital tools, only 48.2% reported actively using them. This disparity is particularly evident with tools such as USSD and interactive voice response (IVR), which had impressive awareness levels of 91%, but much lower usage rates at 55% and 45%, respectively. This suggests that while extension educators recognise the existence and potential of digital tools, various systemic challenges prevent widespread practical adoption. The findings align with prior research, notably Owolabi & Yekinni (2022), which noted that agricultural extension agents exhibit strong theoretical knowledge of ICTs but face constraints that limit their full implementation.

A closer examination of the barriers restricting digital tool adoption reveals affordability and technical constraints as dominant factors. While respondents acknowledge the effectiveness of digital tools such as short messaging services, mobile apps and video conferencing platforms, financial limitations and insufficient technical expertise appear to hinder their frequent usage. Mustapha et al. (2022) argue that the cost of acquiring digital tools, maintaining subscriptions and ensuring stable connectivity are among the primary concerns limiting agricultural extension personnel's ability to integrate ICTs into their work. Additionally, Phillip & Ndirpaya (2020) emphasise that limited training opportunities and a lack of digital proficiency create significant barriers, preventing educators from fully leveraging the available technological resources. The underutilisation of digital tools among extension educators in Kwara State reflects broader trends observed in other developing agricultural economies.

Table 4. Awareness and usage level of digital extension tools by the respondents

Items	Level of Awareness (%)		Level of Usage (%)	
	High	Low	High	Low
Short Messaging	85.5	14.3	13.9	88.1
Interactive Voice Response	90.5	9.5	44.7	45.3
Apps	85.5	14.3	45.3	54.7
USSD	90.5	9.5	54.8	45.3
Web	81.0	19.0	54.8	45.3
Video conferencing	78.6	21.4	57.2	42.8
News and discussion group	61.0	31.0	50.0	50.0
Farming Video	83.3	16.7	57.1	42.9

Source: Authors' computation, 2024.

In India, Singh et al. (2021) examined the widespread use of mobile advisory systems and found that while extension educators exhibit strong awareness of mobile-based platforms, sustained grassroots-level engagement and structured training programmes are necessary to ensure adoption. Similarly, in Kenya, Mwangi et al. (2022) highlighted the critical role of professional networks in fostering digital competence among extension personnel, emphasising that peer-driven capacity-building initiatives improve digital literacy and facilitate the practical application of ICT tools. These insights suggest that Nigeria could benefit from adapting similar frameworks, particularly by integrating structured digital training programmes within extension education curricula and fostering professional networks to encourage peer learning and digital tool adoption.

Solving these issues requires multi-pronged interventions that emphasise affordability, technical capacity-building and infrastructural support. To improve accessibility, stakeholders should reduce the costs associated with acquiring and maintaining digital tools by offering subsidies or financial grants to agricultural extension educators. This approach has proven effective in countries like India and Kenya, where government-led incentives significantly increased digital tool adoption among extension personnel (Kimani et al., 2023). Moreover, targeted training programmes are essential to equip extension educators with practical digital skills. Workshops, tutorials and online modules tailored to address specific digital literacy gaps can empower extension educators to fully engage with available technologies. Adebayo et al. (2023) advocate for hands-on digital training programmes, noting that skill acquisition directly influences the extent to which educators integrate ICT tools into their extension services. Beyond affordability and training, connectivity and infrastructure development remain key priorities. Many respondents cited unstable internet and unreliable power supply as significant limitations affecting digital tool usage. Ouma & Mwangi (2021) reported similar trends in African agricultural extension systems, where weak infrastructure hinders technology adoption in rural areas. To mitigate this, stakeholders must prioritise investments in broadband expansion, provision of off-grid power solutions and support for local ICT innovations that provide low-cost digital access for extension educators. This will bridge the gap between digital awareness and usage, ensuring that extension educators can effectively integrate digital tools into their work.

Constraints to the utilisation of digital extension tools

As shown in Table 5, the major constraints identified by respondents were poor orientation (92.8%), high internet connectivity costs (90.5%) and high equipment costs (90.6%). These challenges align with findings by Ibe et al. (2020) and Godson-Ibeji et al. (2018), who emphasised infrastructural deficits and affordability issues as significant barriers to e-extension adoption in Nigeria.

The study identified several major constraints to the utilisation of digital extension tools by agricultural extension agents, including poor orientation (92.8%), high internet connectivity costs (90.5%) and high equipment costs (90.6%). These issues highlight infrastructural deficits and affordability challenges that hinder the effective adoption of e-extension systems. This finding is consistent with observations by Ibe et al. (2020) and Godson-Ibeji et al. (2018), who noted that extension agents in Nigeria face significant barriers related to inadequate infrastructure and the prohibitive cost of digital tools. Other challenges revealed by the study include erratic power supply, limited internet coverage and unfavourable government policies, which further compound the difficulties

faced by extension personnel in utilising digital tools. These systemic issues require urgent attention, as they impede the accessibility and effectiveness of digital extension systems, particularly in underserved areas. Additionally, constraints such as high maintenance costs, poor technical know-how and the unavailability of modern gadgets reflect broader gaps in support and resource allocation, which limit the potential of extension agents to leverage digital innovations.

Table 5. Constraints to the utilisation of digital extension tools by the respondents

Constraints	Percentage	Grand Mean
Poor orientation	92.8	3.0
High cost of internet connectivity	90.5	2.9
High cost of equipment	90.6	2.9
Power instability	85.7	2.7
Poor ICT infrastructure	85.7	2.7
High cost of internet maintenance	83.4	2.7
Poor technical know-how	83.3	2.7
Unavailability of modern gadgets	83.3	2.6
Limited internet coverage	81.0	2.6
Unfavourable government policies	78.5	2.5
Poor enabling environment	78.5	2.5
High cost of tool maintenance	78.6	2.5

Source: Authors' computation, 2024.

Addressing these challenges requires a range of targeted policy-level interventions. First, infrastructure development must be prioritised by expanding internet coverage and ensuring a reliable power supply, both of which are essential for the effective use of digital tools. To reduce the financial burden associated with acquiring and maintaining ICT tools, policymakers should explore measures such as subsidies, grants and tax relief. These efforts would help extension institutions and personnel gain the necessary resources for effective e-extension service delivery. Singh et al. (2021) documented the success of mobile advisory systems in India, which were bolstered by structured training and grassroots engagement, while Mwangi et al. (2022) highlighted how professional networks in Kenya have enhanced digital knowledge among extension educators. Although developed nations like the United States benefit from robust ICT infrastructures and high digital literacy, developing regions continue to face challenges such as inconsistent connectivity and limited affordability. By adapting effective training models and collaborative frameworks from contexts like India and Kenya, Nigeria can better integrate digital tools into agricultural extension practices.

Relationship between Selected Socio-Economic Characteristics and Attitude Towards Digitising Agricultural Extension Services

The results of the correlation analysis showed that age (r = 0.191) and years of teaching (r = 0.054) had a positive and significant relationship with attitude towards digitising agricultural extension services at P ≤ 0.01. The results further show that the number of years

spent in school (r = 0.152) and knowledge of digital extension services (r = 0.720) had a positive and significant relationship with attitude towards digitising agricultural extension services at P ≤ 0.05. The results indicated that younger individuals tend to be more receptive to innovation and technological advancements, which could facilitate their willingness to integrate digital tools into extension practices. Their academic qualifications, years of teaching and knowledge of digital extension tools are major determinants of their attitude towards practising digitising agricultural extension services. These three factors provide individuals with analytical skills, problem-solving capabilities and exposure to complex technological ecosystems, making them better equipped to integrate ICTs into agricultural extension services. This finding explicitly refutes the initial hypothesis stated earlier in the paper, which posited no significant relationship between educators' knowledge of digital tools and their attitude towards adopting digital extension services. The strong positive correlation (r = 0.720) clearly demonstrates that greater knowledge among extension educators is associated with a more favourable attitude, confirming that digital literacy plays a key role in shaping their openness to ICT-based agricultural innovation.

Table 6. Relationship between selected socio-economic characteristics and attitude towards digitising agricultural extension services

Variable	R-value
Age of respondents	0.191**
Number of years spent in school	0.152*
Household size	0.147
Years of teaching	0.054**
Knowledge of digital extension services	0.720*
Usage of digital extension tools	0.699
Challenges in accessing digital extension tools	0.529

** Significant at p ≤0.01; * Significant at p ≤0.05

Source: Authors' computation, 2024.

Conclusions and recommendations

The findings of this study reveal that while agricultural extension educators in Kwara State exhibit high levels of awareness and hold favourable attitudes towards digital tools, their actual usage remains moderate due to socio-economic and infrastructural constraints. Despite being well-informed and open to adopting digital extension services, financial limitations, unreliable internet connectivity and inadequate digital infrastructure impede full-scale integration and practical utilisation. This disconnect between awareness and application underscores the need for targeted interventions that bridge technological, financial and institutional gaps to ensure extension educators can fully leverage digital innovations. Furthermore, the empirical results presented in this study explicitly refute the initial hypothesis positing no significant relationship between extension educators' knowledge of digital tools and their attitude towards digitising extension services. The strong positive correlation observed confirms that greater knowledge is indeed linked to a more

favourable attitude, thereby reinforcing the importance of digital literacy as a key enabler of technology adoption in agricultural extension. However, the scope of this study was limited to extension educators within Kwara State, and the relatively small sample size may constrain the generalisability of the findings to broader populations or other geopolitical zones. Future studies should consider expanding the sample size and incorporating comparative analyses across multiple states or regions to strengthen the robustness and applicability of the conclusions.

To address these challenges, strengthening the digital capacities of extension educators should be a top priority. This requires structured training programmes, periodic retraining sessions and hands-on workshops incorporated into conferences organised by professional extension bodies. These initiatives must focus on technical proficiency, digital literacy and ICT troubleshooting, ensuring that educators are equipped with practical knowledge to navigate digital tools effectively. Investments in digital infrastructure by universities and government agencies should prioritise robust internet services, reliable power supply and the subsidisation of digital equipment at extension offices. Addressing these foundational constraints will significantly enhance digital tool accessibility, creating an enabling environment for the seamless adoption of e-extension models. Becerra-Encinales et al. (2024) and Ojo et al. (2024) emphasise that localised extension strategies and context-aware digital platforms are essential for overcoming infrastructural and institutional limitations in developing countries. These studies also highlight the importance of participatory design and multi-directional communication between extension agents, researchers and farmers to ensure relevance and sustainability. Further institutional and policy-level interventions are necessary to sustain digital transformation in agricultural extension services. Stakeholders should establish digital inclusion policies, ensuring that rural extension educators receive targeted subsidies, financial grants or public-private partnerships aimed at reducing digital tool acquisition costs. Lessons from international contexts, such as India's grassroots training models (Singh et al., 2021) and Kenya's peer-driven capacity-building initiatives (Mwangi et al., 2022), demonstrate that structured institutional backing, consistent funding and collaborative digital extension strategies are fundamental to overcoming adoption barriers. Additionally, Sen et al. (2025) advocate for interactive digital extension systems that incorporate feedback loops and localised content to improve engagement and effectiveness among smallholder farmers. By implementing contextualised best practices and fostering cross-sector collaborations, agricultural extension systems in Kwara State can transition towards a more inclusive, efficient and technology-driven framework. These interventions will empower educators, enhance knowledge dissemination and strengthen agricultural advisory services, contributing to the broader goals of food security, agricultural productivity and sustainable rural development.

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