Int. j. adv. multidisc. res. stud. 2026; 6(6):638-644

Received: 26-09-2026
Accepted: 06-11-2026

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

Factors Influencing Smallholder Farmers' Adoption of Mobile Apps for Market Information, Weather Forecasts, and Farm Management in FCT, Nigeria

[1] Agbonika Dora Aladi, [2] Olaiya Anuolu Queensly, [3] Okpalla Wilson Afamefuna, [4] Awatt Nsedu Kufre, [5] Obekpa Charles Usman

[1, 2, 3, 4, 5] Department of Agricultural Economics, Faculty of Agriculture, University of Abuja, Nigeria

DOI: https://doi.org/10.62225/2583049X.2026.6.6.7171
Corresponding Author: **Olaiya Anuolu Queensly**

Abstract

This study examined the factors influencing smallholder farmers' adoption of mobile applications for market information, weather forecasts, and farm management in the Federal Capital Territory (FCT), Nigeria. A multistage sampling technique was used to select 73 farmers from Gwagwalada, Kuje, and Kwali Area Councils. Primary data was collected using structured questionnaires and analyzed using descriptive statistics and a binary logistic regression model. The results showed that 68.49% of the respondents were aware of mobile agricultural applications, while 60.27% reported active usage. However, usage was largely concentrated on financial service and loan applications, with relatively low adoption of core agricultural applications such as weather forecasting and market information tools. The logit regression results revealed that awareness of mobile applications had a positive and statistically significant effect on adoption ($p < 0.01$), while annual income had a negative and significant influence ($p < 0.05$). Key constraints to adoption included the high cost of internet data, poor network coverage, and inadequate access to electricity for charging mobile devices. These challenges limit the effective utilization of mobile applications among smallholder farmers. The study concludes that although awareness of mobile agricultural applications is relatively high, adoption remains suboptimal and uneven. It recommends targeted awareness campaigns, improved digital literacy, user-friendly application design, and investments in digital infrastructure to enhance adoption. Strengthening these areas will improve farmers' access to timely information, reduce information asymmetry, and promote agricultural productivity in the FCT.

Keywords: Adoption, Constraints, Farm Management, Mobile Applications, Nigeria

Introduction

Smallholder farmers in sub-Saharan Africa, face a persistent productivity gap driven largely by information asymmetry, limited access to timely market prices, weather data, and agronomic advisory services. Mobile applications represent an increasingly accessible mechanism for addressing these information gaps and, more broadly, for strengthening the efficiency and resilience of smallholder agricultural systems. Mobile applications are self-contained software programmes designed to run on, or be accessed from portable devices such as laptops, tablets, smartphones, and various embedded devices, including handheld GPS units and smart devices in vehicles (Sturm, Pollard, and Craig, 2017) [25]. These applications have demonstrated proven utility across multiple sectors, including health, manufacturing, finance, and agriculture (Muhamad *et al*., 2021) [20]. In agriculture specifically, the use of mobile applications is known to increase productivity, enhance quality, and promote environmental sustainability (Saiz-Rubio and Rovira-Más, 2020) [24].

In Nigeria, as in many other developing countries, the adoption of mobile applications in agriculture is critical because the agricultural sector remains an indispensable component of the national economy, contributing more than a fifth of GDP and employing nearly two-thirds of the workforce (Central Bank of Nigeria [CBN], 2024) [7]. In 2023, the sector contributed 24.76% to total GDP (Food and Agriculture Organization [FAO], 2024) [11]. Despite this substantial contribution, Nigeria's agricultural sector faces several challenges that constrain its productivity, including inadequate mechanisation, limited access to financing, high post-harvest losses, and poor market access, among others (Mhlanga, 2023) [17]. The Federal Capital

Territory (FCT), Abuja, situated in the North Central geopolitical zone, is home to a significant smallholder farming community engaged in the cultivation of staple crops such as rice, maize, cassava, and yams across six area councils, namely Abaji, Kuje, Kwali, Municipal, Bwari, and Gwagwalada. Like many rural farming communities in Nigeria, FCT smallholder farmers contend with limited access to extension services, erratic rainfall patterns, and constrained market linkages (Anthony *et al*., 2021) [4]. The adoption of mobile applications therefore represents a positive development for Nigeria's agricultural growth. Although mobile applications for agricultural use are increasingly available in Nigeria, their uptake among smallholder farmers remains limited. In the context of this study, adoption is understood as the mental process an individual undergoes from initial awareness of an innovation through to its sustained integration into regular farming practice (Dissanayake *et al*., 2022) [8].

Several mobile applications are available in Nigeria that offer digital agricultural services including farm management, market access, and advisory support. For example, FarmSmarter provides AI-based crop disease detection, weather alerts, and climate-smart farming advice, while NaijaFarmers offers crop disease diagnosis, market price information, and links to buyers. AgroXchange FarmSider enables farmers to develop digital farm profiles, locate warehouses, and sell produce directly to buyers via secure digital payments. Despite the growing availability of these platforms, adoption rates among smallholder farmers for market information, weather forecasts, and farm management services remain low. Farmers are often unaware of available digital tools or remain hesitant to adopt them. Contributing factors to low adoption include educational attainment, training, internet access, smartphone ownership, willingness to pay for applications, awareness of available tools, and the cost of digital services (Abioye *et al*., 2024) [3]. Notably, female-headed farming households tend to show lower willingness to adopt mobile applications for agricultural purposes, reflecting broader gender disparities in access to productive assets and digital technologies in sub-Saharan Africa (Mhlanga, 2023) [17].

Mobile applications represent a promising instrument for addressing the challenges that limit agricultural productivity and growth among smallholder farmers. Prior studies have examined mobile technology adoption in agriculture with particular focus on weather forecasting, pest and disease information, crop nutrient advisory services, and early warning systems (Dissanayake *et al*., 2022; Mhlanga, 2023) [8, 17]. Research specifically examining the socioeconomic, technological, and institutional determinants of mobile app adoption in the context of market information, weather forecasts, and farm management services among Nigerian smallholder farmers remains limited. Furthermore, existing studies have largely neglected the specific geographical context of the FCT, a territory with a distinct smallholder farming profile and particular infrastructure constraints (Anthony *et al*., 2021) [4]. This study therefore aims to identify the socioeconomic, technological, and institutional factors affecting adoption, and to evaluate the awareness and usage patterns of mobile applications among FCT smallholder farmers. This research contributes to the growing body of literature on digital agricultural transformation in Nigeria and offers practical insights for multiple stakeholder groups. Ultimately, improving mobile application adoption among FCT smallholder farmers has the potential to empower farming households, reduce information asymmetries, and support more sustainable agricultural development in Nigeria.

Research Method

The study area

The study was conducted in the Federal Capital Territory (FCT), Abuja, Nigeria. The FCT is centrally located in Nigeria and covers a land area of approximately 7,315 km². It comprises six Area Councils: Abaji, Abuja Municipal Area Council (AMAC), Bwari, Gwagwalada, Kuje, and Kwali (National Population Commission [NPC], 2017) [22]. The FCT lies within the Guinea Savannah agro-ecological zone, characterized by moderate to high annual rainfall and an average temperature of about 30°C. The vegetation supports the cultivation of cereals, legumes, and root and tuber crops (FAO, 2020) [10].

Agriculture plays a significant role in the FCT, with a large proportion of land suitable for both rain-fed and irrigated farming. Major farming activities include crop production and livestock rearing.

Sampling Technique

The study population comprised smallholder farming households in three Area Councils: Gwagwalada, Kuje, and Kwali. These councils were selected due to their high concentration of farming activities in the FCT.

A multistage sampling technique was employed in this study. In the first stage, purposive selection of three Area Councils (Gwagwalada, Kuje, and Kwali) based on the intensity of farming activities was carried out. The second stage involved the random selection of two communities from each area council, giving a total of 6 communities. In the third stage, 12 farming households were randomly selected from each community giving a total of 72 farmers, however, 73 questionnaires were distributed and collected.

Data Collection

Primary data were collected between February and March 2026 using a structured questionnaire administered to the respondents.

Data Analysis

Both descriptive and inferential statistical tools were used to achieve the objectives. Descriptive statistics such as frequencies, percentages, means, and standard deviations were used to describe the socioeconomic characteristics of respondents and describe the level of awareness of mobile applications. Binary Logistic Regression Model was used to determine the factors influencing adoption of mobile applications among smallholder farmers. Data was analyzed using Stata.

Model Specification

Logit model is developed based on the cumulative logistic probability function. Implicitly, the model assumes that the probability is:

$$P_i = F(Z_i) \quad (1)$$

$$F(Z_i) = 1 / (1 + e^{-}Zi) \quad (2)$$

$$\text{Where } Zi = \alpha + \beta Xi \quad (3)$$

From the logit distribution function, Zi = f(Xi). Hence the logistic function can be linearised:
Log [Pi / (1−Pi)] = Zi = α + βXi — this is linearised in both variable and parameter, which is OLS compatible.
Log [Pi / (1−Pi)] is simply the odds ratio in favour of adoption. The odds ratio is the ratio of the probability that a farmer would adopt mobile apps (Pi) to the probability of not adopting (1−Pi).

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \ldots + \beta_7 X_7 + \varepsilon i \quad (4)$$

Where the explanatory variables are:

X_1= Age (years)
X_2= Gender (male = 1, female = 0)
X_3= Years of schooling (education level)
X_4= Years of farming experience
X_5= Farm size (hectares)
X_6= Annual income (₦)
X_7 = Awareness of mobile agricultural applications (aware = 1, not aware = 0)

The logit model is appropriate due to the binary nature of the dependent variable (adoption = yes/no) and its ability to model nonlinear probability relationships (Gujarati and Porter, 2009; Greene, 2018) [13, 12].

Results and Discussion

Socio-Economic Characteristics of respondents in the study area

The study involved 73 smallholder farmers in the Federal Capital Territory (FCT), Nigeria. The demographic and socioeconomic profiles of respondents are presented in Table 1. The findings revealed that male farmers constituted the majority of respondents (64.38%), while females accounted for 35.62%. This gender disparity reflects broader structural inequalities in access to land, agricultural resources, and digital technologies that have been well documented in the literature on smallholder agriculture in Sub-Saharan Africa. The underrepresentation of female farmers is not unique to this study but mirrors a consistent pattern in empirical agricultural research across the continent. This result is consistent with Kolapo and Didunyemi (2024) [14]; Abioye *et al*. (2024) [3] who in their study of agricultural smartphone app adoption among smallholder farmers in Southwest Nigeria, found that male farmers were significantly more involved with mobile phone-enabled agricultural services than their female counterparts.

With respect to educational attainment, about 89.04% of respondents held tertiary qualifications, 9.59% had secondary education, and only 1.37% had no formal education. This notably high educational profile among smallholder farmers in the FCT is somewhat atypical relative to rural farming communities elsewhere in Nigeria and West Africa, and likely reflects the peri-urban character of agriculture in Abuja, where many educated individuals engage in farming as a supplementary or entrepreneurial livelihood activity.

The significance of education in shaping agricultural technology adoption has been extensively documented. Fadeyi *et al.* (2022) [9] also identified most farmers in their study were educated noting that smallholder farmers with higher literacy levels are better equipped to comprehend and apply complex digital tools.

Farming experience among respondents ranged from less than five years to more than thirty years, with a mean of 12.7 years. The modal category was 5–10 years of experience, accounting for 46.58% of respondents, followed by those with 10–15 years (17.81%) and 15–20 years (15.07%). Farming experience is a nuanced determinant of technology adoption. Kolapo and Didunyemi (2024) [14] found that majority of farmers had farming experience of about 20 years reporting that more experienced farmers were more likely to recognize the practical value of mobile-based information tools, such as those providing agronomic advice and market prices, particularly where such tools resolved long-standing information gaps encountered in their farming practice.

More than half of the respondents (52.05%) cultivated less than 3 hectares, 39.73% farmed between 3 and 6 hectares, and only 8.22% cultivated more than 6 hectares. The mean farm size was 3.06 hectares, confirming the smallholder nature of the farming operations in the FCT, consistent with the definitional threshold of smallholder farmers generally cultivating less than 5 hectares in the Nigerian context. Farm size is consistently cited in the technology adoption literature as a significant determinant, largely because larger farms generate greater expected returns from investment in new technologies, making adoption economically more rational. This is similar to the findings of Kolapo and Didunyemi (2024) [14] who reported that most farmers had farm sizes of about 2.89 ha. Fadeyi *et al.* (2022) [9] identified farm size as the fifth most frequently cited factor influencing technology adoption in their Africa-wide systematic review, appearing in 62 of the 128 studies examined.

The age distribution of respondents was relatively young, with 45.21% falling within the 30–40 year bracket, followed by 40–50 years (24.66%), under 30 years (13.70%), 50–60 years (13.70%), and above 60 years (2.74%). The mean age was 40.6 years, suggesting a predominantly middle-aged farming population. Krell *et al*. (2021) [15], in a study of smallholder farmers' use of mobile phone services in central Kenya, found that middle-aged farmers were significant users of mobile information services for weather and market data, as they had the farming experience to contextualise and act on the information provided.

Annual income among respondents was heterogeneous. The largest proportion of farmers earned between ₦100,000 and ₦500,000 (26.03%), followed by ₦500,001–₦1,000,000 (23.29%), and ₦1,000,001–₦3,000,000 (21.92%). A notable proportion of respondents reported incomes between ₦3,000,001 and ₦7,000,000 (15.07%), while 13.70% earned above ₦7,000,000. The mean annual income was ₦2,911,643.84, indicating substantial income variation within the sample, with a segment of relatively high-earning farmers alongside a larger base of lower-income smallholders. Income is widely recognized as a critical enabling condition for agricultural technology adoption, as it determines farmers' ability to purchase smartphones, afford mobile data subscriptions, and bear any costs associated with accessing mobile app-based services.

Table 1: Socioeconomic Characteristics of Smallholder Farmers in FCT, Nigeria

Variable	Category	Frequency	Percentage (%)
Gender	Female	26	35.62
	Male	47	64.38
Highest Level of Education	No formal education	1	1.37
	Secondary education	7	9.59
	Tertiary education	65	89.04
Farming Experience (Years)	Less than 5	6	8.22
	5–10	34	46.58
	10–15	13	17.81
	15–20	11	15.07
	20–25	3	4.11
	25–30	5	6.85
	Above 30	1	1.37
	Mean		**12.7 years**
Farm Size (ha)	Less than 3 ha	38	52.05
	3–6 ha	29	39.73
	Above 6 ha	6	8.22
	Mean		**3.06 ha**
Age (Years)	Less than 30	10	13.70
	30–40	33	45.21
	40–50	18	24.66
	50–60	10	13.70
	Above 60	2	2.74
	Mean		**40.6 years**
Income(Naira)	₦100,000-500,000	19	26.03
	₦500,001-1,000,000	17	23.29
	₦1,000,001-3,000,000	16	21.92
	₦3,000,001-7,000,000	11	15.07
	Above ₦7,000,000	10	13.70
	Mean		**₦2,911,643.836**

Source: Computed from Field Survey, 2026

Level of Awareness of Mobile Agricultural Applications

The study examined the extent to which smallholder farmers in the FCT were aware of the existence of mobile applications designed for agricultural purposes. As presented in Table 2, the majority of respondents (68.49%) reported being aware of mobile agricultural applications, while 31.51% indicated no awareness. This finding suggests that awareness of mobile agricultural apps has begun to penetrate the smallholder farming population in the FCT, though a substantial proportion of farmers remain uninformed about the existence of such tools.

The awareness level of 68.49% recorded in this study is relatively encouraging within the Nigerian context. Kolapo and Didunyemi (2024) [14], in their study of smallholder farmers in Southwest Nigeria, established that awareness operationalised as prior exposure to agricultural smartphone applications was a critical and statistically significant precondition for actual adoption. Their findings demonstrated that farmers who had been exposed to agricultural smartphone apps through extension agents, peer networks, or media campaigns were significantly more likely to adopt these tools, underscoring the causal primacy of awareness in the technology diffusion pathway. Abioye *et al.* (2024) [3], in their study of farmers' willingness to adopt digital application tools in Ogun State, Nigeria, explicitly identified low awareness of specific applications. Despite the majority awareness recorded in this study, the 31.51% who reported no awareness represent a significant gap that calls for targeted awareness campaigns through agricultural extension services, radio broadcasts, community-based farmer groups, and government digital agriculture programmes in the FCT.

Table 2: Level of Awareness of Mobile Agricultural Applications

Level of Awareness	Frequency	Percentage (%)
Not Aware	23	31.51
Aware	50	68.49
Grand Total	**73**	**100.00**

Source: Computed from Field Survey, 2026

Current Usage of Mobile Agricultural Applications

Beyond awareness, the study assessed the proportion of respondents who were actively using mobile agricultural applications at the time of the survey. As shown in Fig 1, 60.27% of respondents reported currently using mobile agricultural apps, while 39.73% indicated they were not currently using any such applications.

The recorded app usage rate of 60.27% is notably higher than what has been documented in many comparable studies from sub-Saharan Africa. For instance, Abdulai *et al.* (2023) [1], in a large-scale survey of 1,565 farmers in Northern Ghana, found that while mobile phone ownership was widespread, farmers were largely confined to simple communication uses and that engagement with purposive agricultural apps or digital advisory services remained limited. The relatively high awareness (68.49%) alongside a usage rate of 60.27% in this study suggests that in the FCT, the conversion from awareness to usage is reasonably efficient, though a gap of approximately 8 percentage points between the two rates signals that some aware farmers face residual barriers likely related to digital skills, cost, or perceived utility that prevent them from becoming active users.

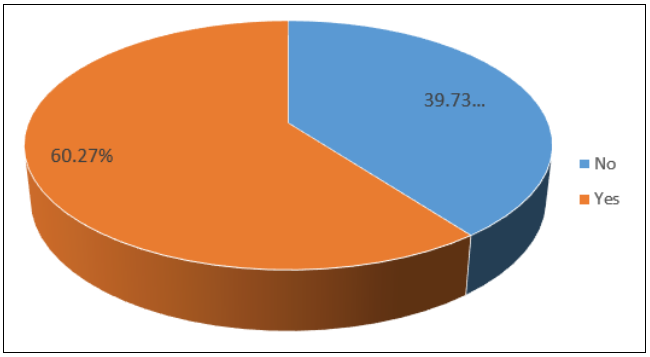


Fig 1: Current Usage of Mobile Agricultural Applications

Types of Agricultural Applications Used by Farmers

To understand the nature of farmers' mobile app engagement, the study examined the specific types of agricultural applications being used. The results, presented in Table 3, reveal important patterns in how farmers in the FCT are leveraging digital tools. Financial service and loan applications were the most frequently reported category (32.88%). The dominance of financial service and loan apps in this study is particularly noteworthy. It reflects the acute financing constraints faced by smallholder farmers in Nigeria, where limited access to formal agricultural credit from commercial banks compels farmers to seek out alternative digital financial services.

Farm management and record-keeping apps were used by 16.44% of respondents, making them the second most

commonly adopted category overall. Mdoda *et al.* (2023) [16], in a study of mobile app use among smallholder farmers in the Eastern Cape Province of South Africa, found that mobile phone applications were primarily used for farm management reminders, soil fertility management, and access to market prices, with daily and weekly usage patterns predominating among active users.

The weather forecast apps constituted about 13.70%. Krell *et al.* (2021) [15], in their study of smallholder farmers' use of mobile phone services in central Kenya, found that weather information was among the most commonly sought agricultural information through mobile platforms, as farmers used it to make planting, irrigation, and harvesting decisions.

Market price information apps (10.96%), extension advisory apps (8.22%), and input supply apps (8.22%) were the least adopted categories among the respondents. The limited uptake of market price information apps is of particular concern, given that access to accurate and timely market information is widely considered one of the most direct pathways through which mobile technology can improve smallholder welfare by reducing price information asymmetries between farmers and traders. The low uptake of input supply and extension advisory apps in this study mirrors findings by Abdulai *et al.* (2023) [1], who found that in Northern Ghana, farmers' engagement with purposive digital advisory services remained limited even where mobile phones were widely owned, largely due to the absence of locally relevant, language-appropriate, and affordable content on advisory platforms.

Table 3: Types of Agricultural Applications Used by Respondents

Agricultural App Type	Frequency	Percentage (%)
Extension advisory apps	6	8.22
Farm management/record keeping apps	12	16.44
Financial service/loan apps	23	32.88
Input supply apps	6	8.22
Market price information apps	8	10.96
None	8	10.96
Weather forecast apps	10	13.70
Grand Total	73	100.00

Source: Computed from Field Survey, 2026

Factors Influencing Adoption of Mobile Applications among Smallholder Farmers in FCT

To identify the factors that significantly influence smallholder farmers' decision to adopt mobile applications in the FCT, a binary logistic regression model was estimated with adoption of mobile apps as the dependent variable. The explanatory variables included years of farming experience, farm size (hectares), estimated annual income (Naira), age, years of schooling, awareness of mobile applications, and gender. The results, presented in Table 4, reflect four iterations of the maximum likelihood estimation procedure, converging at a final log likelihood of −34.952765. To facilitate a more intuitive and policy-relevant interpretation of the logistic regression coefficients, average marginal effects (AME) were estimated. The marginal effects express the change in the predicted probability of mobile app adoption associated with a one-unit change in each independent variable. Only two variables were found to be significant; awareness of mobile applications and annual income.

The average marginal effect of awareness of mobile applications on the probability of adoption is 0.5163072 significant at $p < 0.01$. This implies that farmers who are aware of mobile agricultural applications have on average, a 51.63 percentage point higher probability of adopting such applications compared to farmers who are unaware, holding all other variables constant. This finding is consistent with Okoroji *et al.* (2021) [23] who demonstrated through their SEM-based analysis that information awareness significantly increased both behavioral intention and actual usage of mobile apps among Nigerian farmers. Abioye *et al.* (2024) [3], in their study of Nigerian farmers, similarly demonstrated that awareness of specific digital application tools had a statistically significant and positive effect on willingness to adopt, corroborating the causal primacy of awareness-raising interventions as a cost-effective strategy for accelerating mobile agricultural app diffusion.

Annual income has a negative marginal effect and significant $p < 0.05$. This negative marginal effect implies that, on average, each additional Naira of annual income is associated with a very small reduction in the probability of mobile app adoption, that is, higher-income farmers in FCT are less likely to adopt mobile agricultural apps. This is in contrast to the findings of Mohammed *et al.* (2025) [19]; Asravor *et al.* (2022) [5] who both found positive income effects on mobile agricultural service adoption A possible explanation for this result could be that higher-income farmers in the FCT likely derive a significant portion of their income from non-agricultural sources, making farming a secondary livelihood activity for which intensive digital farm management tool adoption is less of a priority, compared to lower-income farmers who are more dependent on farming and therefore more motivated to seek out productivity and market information tools.

Table 4: Factors Influencing Adoption of Mobile Applications among Smallholder Farmers in FCT

Variable	dy/dx	Std. Err.	z	P>|z|
Years of farming experience	−0.0001541	0.0065721	−0.02	0.981
Farm size (hectares)	−0.0288613	0.0243068	−1.19	0.235
Annual income (Naira)	−2.22e−08**	1.23e−08	−1.81	0.071
Age	−0.0045048	0.0056595	−0.80	0.426
Years of schooling	0.0355653	0.0340427	1.04	0.296
Awareness of mobile apps	0.5163072***	0.0619487	8.33	0.000
Gender	0.0794039	0.1135242	0.70	0.484
Number of Observation= 73 LR chi2(7) = 28.19 Prob>chi2 = 0.0002 Log likelihood = -34.952765				

*** significant at 1%,** significant at 5%,*significant at 1%

Source: Computed from Field Survey, 2026

Constraints to the adoption of Mobile apps by smallholder farmers in FCT

The study assessed the severity of specific barriers that smallholder farmers in the FCT perceive as constraining their adoption of mobile agricultural applications. The results are summarised in Table 5, which reports the frequency distributions and mean scores for each constraint.

The cost of internet data emerged as the most severe constraint to mobile app adoption among FCT smallholder farmers, with a mean severity score of 3.91. This finding reflects the well-documented problem of data affordability in Nigeria and sub-Saharan Africa more broadly. Muromba

et al. (2025) [21], in their systematic review of Mobile Agricultural Service Application (MASA) adoption in sub-Saharan Africa, identified cost-effectiveness encompassing data usage costs, subscription fees, and device costs as a key determinant of perceived usefulness, appearing in 40% of the studies reviewed. They noted that resource-constrained farmers conduct careful cost-benefit analyses before adopting MASA, and that where data costs are perceived as high relative to the anticipated benefits, adoption intentions are significantly depressed.

Network coverage in farming areas was the second most severely rated constraint, with a mean score of 3.76. This result is particularly noteworthy because, unlike cost-related barriers that can be addressed through subsidies or pricing reforms, network coverage is fundamentally an infrastructure deficit that requires capital-intensive investment in telecommunications infrastructure to resolve. This finding is consistent with Mollel *et al*. (2025) [18], who, in a comprehensive review of digital technologies for scaling climate-smart agriculture among next-generation farmers in Africa, identified poor network connectivity as one of the most persistent and structurally entrenched barriers to digital agricultural service delivery in sub-Saharan Africa, noting that many smallholder farming communities lack effective access to the phone and internet services necessary for efficient digital agronomy delivery even where mobile phone ownership is widespread.

Electricity access for charging mobile phones was rated as the third most severe constraint, with a mean score of 3.60. The inability to consistently charge mobile phones directly limits farmers' ability to maintain the continuous device operability that regular app usage requires, creating a practical but often overlooked infrastructural barrier to sustained digital agricultural tool adoption. Mollel *et al.* (2025) [18] explicitly identified electricity access for charging as one of the key access barriers faced by smallholder farmers in sub-Saharan Africa.

The cost of a smartphone was rated as the fourth most severe barrier, with a mean score of 3.49. Abioye *et al.* (2024) [3], in their study of smallholder farmers' willingness to adopt digital application tools in Ogun State, Nigeria, identified smartphone ownership as a significant determinant of willingness to adopt, arguing that the cost of devices constitutes a direct financial barrier that limits the adoption potential of agricultural apps among lower-income farmers. Muromba *et al.* (2025) [21] similarly noted that the cost of acquiring and maintaining smartphone devices was a recurring barrier to MASA adoption across multiple studies in sub-Saharan Africa.

The presence of excessive advertising pop-ups within apps was rated as the fifth most severe barrier, with a mean score of 3.38. Reliability of information was rated as the sixth most severe constraint with a mean score of 3.21. Technical knowledge and digital skills were rated as the seventh most severe barrier, with a mean score of 3.10. Literacy level and ability to read and use apps was rated as the least severe barrier among all eight constraints, with the lowest mean score of 3.05.

Table 5: Constraints to the adoption of Mobile apps by smallholder farmers in FCT

Constraints	Very Critical (5)	Critical (4)	Neutral (3)	Less Critical (2)	Not Critical (1)	Mean
Cost of smartphone	19 (26.03%)	26 (35.62%)	8 (10.96%)	12 (16.44%)	8 (10.96%)	3.49
Cost of internet data	21 (28.77%)	33 (45.21%)	12 (16.44%)	6 (8.22%)	1 (1.37%)	3.91
Literacy level/ability to read and use apps	8 (10.96%)	21 (28.77%)	23 (31.51%)	9 (12.33%)	12 (16.44%)	3.05
Technical knowledge/digital skills	6 (8.22%)	30 (41.10%)	16 (21.92%)	8 (10.96%)	13 (17.81%)	3.10
Reliability of information	10 (13.70%)	25 (34.25%)	19 (26.03%)	9 (12.33%)	10 (13.70%)	3.21
Network coverage in farming area	26 (35.62%)	25 (34.25%)	6 (8.22%)	11 (15.07%)	5 (6.85%)	3.76
Electricity for charging phones	19 (26.03%)	26 (35.62%)	14 (19.18%)	8 (10.96%)	6 (8.22%)	3.60
Too many advert pop-ups	12 (16.44%)	25 (34.25%)	23 (31.51%)	5 (6.85%)	8 (10.96%)	3.38

Computed from Field Survey, 2026

Conclusion and Recommendation

The study showed that awareness of mobile agricultural applications was relatively high (68.49%), however, usage was concentrated mainly on financial and loan-related applications rather than core agricultural apps such as weather forecasting and market information platforms. Awareness and income significantly influenced adoption with awareness having a strong positive effect on adoption, while income showed a negative relationship with adoption, suggesting that higher-income farmers may rely on alternative sources of information or services. Major constraints identified included: High cost of internet data, Poor network coverage, and Inadequate electricity supply.

Based on these findings, the following recommendations are proposed:

1. Given that awareness significantly influences adoption, targeted awareness programs should be implemented through extension services, cooperatives, and digital campaigns.
2. Developers should design applications that are simple, visual, and tailored to farmers' literacy levels to improve usability.
3. Government and farmer organizations should collaborate to ensure that mobile applications address farmers' real needs.
4. Capacity-building programs should be introduced to train farmers on how to effectively use mobile applications.

Conflicts of Interest

The authors declare no conflicts of interest.

References

1. Abdulai AR, Duncan E, Quarshie PT, Fraser EDG. Is agricultural digitization a reality among smallholder farmers in Africa? Unpacking farmers' lived realities of engagement with digital tools and services in rural Northern Ghana. Agriculture and Food Security. 2023; 12:22. Doi: https://doi.org/10.1186/s40066-023-00416-6.
2. Abioye DO, Fadare DA, Omitoyin S, Olinya P, Shaibu A, Nwilene F, *et al*. Adoption impact and heterogeneity

of mobile agricultural advisory technologies among smallholder farmers in Nigeria. Discover Agriculture. 2025; 3:27. Doi: https://doi.org/10.1007/s44279-025-00427-w
3. Abioye DO, Popoola O, Akande A, Fadare DA, Omitoyin SA, Yinusa B, *et al*. Farmers' willingness to adopt digital application tools in Ogun State, Nigeria. Journal of Strategy and Management. Advance Online Publication, 2024. Doi: https://doi.org/10.1108/JSMA-06-2023-0135.
4. Anthony L, Alabi OO, Ebukiba ES, Gamba V. Factors influencing output of rice produced and choice of marketing outlets among smallholder farming households, Abuja, Nigeria. Sarhad Journal of Agriculture. 2021; 37(1):262-277. Doi: https://doi.org/10.17582/journal.sja/2021/37.1.262.277
5. Asravor RK, Boakye AN, Essuman J. Adoption and intensity of use of mobile money among smallholder farmers in rural Ghana. Information Development. 2022; 38(3):373-389. Doi: https://doi.org/10.1177/0266666921999089
6. Boateng R, Budu J, Mbrokoh AS, Ansong E, Boateng SL, Anderson AB. Digital enterprises in Africa: A synthesis of current evidence (DIODE Network Paper No. 2). Centre for Development Informatics, University of Manchester, 2017.
7. Central Bank of Nigeria. Agriculture, 2024. https://www.cbn.gov.ng/dfd/agriculture.html
8. Dissanayake CAK, Jayathilake W, Wickramasuriya HVA, Dissanayake U, Kopiyawattage KPP, Wasala WMCB. Theories and models of technology adoption in the agricultural sector. Human Behavior and Emerging Technologies, 2022, Article 9258317. Doi: https://doi.org/10.1155/2022/9258317
9. Fadeyi OA, Ariyawardana A, Aziz AA. Factors influencing technology adoption among smallholder farmers: A systematic review in Africa. Journal of Agriculture and Rural Development in the Tropics and Subtropics. 2022; 123(1):13-30. Doi: https://doi.org/10.17170/kobra-202201195569
10. Food and Agriculture Organization. Agro-ecological zoning and farming systems in Nigeria. FAO, 2020.
11. Food and Agriculture Organization of the United Nations. Nigeria at a glance, 2024. https://www.fao.org/nigeria/fao-in-nigeria/nigeria-at-a-glance.
12. Greene WH. Econometric analysis (8th ed.). Pearson, 2018.
13. Gujarati DN, Porter DC. Basic econometrics (5th ed.). McGraw-Hill, 2009.
14. Kolapo A, Didunyemi S. Effects of exposure on adoption of agricultural smartphone apps among smallholder farmers in Southwest, Nigeria: Implications on farm-level efficiency. Agriculture and Food Security. 2024; 13:31. Doi: https://doi.org/10.1186/s40066-024-00485-1
15. Krell NT, Giroux SA, Guido Z, Hannah C, Lopus SE, Caylor KK, *et al*. Smallholder farmers' use of mobile phone services in central Kenya. Climate and Development. 2021; 13(3):215-227. Doi: https://doi.org/10.1080/17565529.2020.1748847
16. Mdoda L, Christian M, Agbugba I. Use of information systems (mobile phone app) for enhancing smallholder farmers' productivity in Eastern Cape Province, South Africa: Implications on food security. Journal of the Knowledge Economy. 2023; 14:4318-4340. Doi: https://doi.org/10.1007/s13132-023-01212-0
17. Mhlanga D. Digital technology adoption in the agriculture sector: Challenges and complexities in Africa. Human Behavior and Emerging Technologies, 2023, Article 6951879. Doi: https://doi.org/10.1155/2023/6951879
18. Mollel M, Quiroz LF, Varley C, Firestine A, McLoughlin ME, Kafunah J, *et al*. Digital technologies to accelerate the impact of climate smart agriculture by next-generation farmers in Africa. Front. Sustain. Food Syst. 2025; 9:1462328. Doi: 10.3389/fsufs.2025.1462328
19. Mohammed OH, Belayneh FS, Tay AY. Determinants affecting smallholder farmers' use of mobile-based agricultural information via the farmer's hotline in Southern Ethiopia's Borecha District. Advances in Agriculture, 2025, 4157664. Doi: https://doi.org/10.1155/aia/4157664
20. Muhamad S, Kusairi S, Man M, Majid NFH, Kassim WZW. Digital adoption by enterprises in Malaysian industrial sectors during COVID-19 pandemic: A data article. Data in Brief. 2021; 37, Article 107256. Doi: https://doi.org/10.1016/j.dib.2021.107256
21. Muromba P, Keeni M, Fuyuki K. A systematic review of mobile agricultural service applications for smallholder farmers in sub-Saharan Africa: Perspectives from the technology acceptance model. Agriculture and Food Security. 2025; 14:34. Doi: https://doi.org/10.1186/s40066-025-00563-y
22. National Population Commission (NPC). Population distribution data for Nigeria. Abuja: NPC, 2017.
23. Okoroji V, Lees JN, Lucock X. Factors affecting the adoption of mobile applications by farmers: An empirical investigation. African Journal of Agricultural Research. 2021; 16(1):45-58. Doi: https://doi.org/10.5897/AJAR2020.14989
24. Saiz-Rubio V, Rovira-Más F. From smart farming towards agriculture 5.0: A review on crop data management. Agronomy. 2020; 10(2), Article 207. Doi: https://doi.org/10.3390/agronomy10020207
25. Sturm R, Pollard C, Craig J. Application performance management (APM) in the digital enterprise. Morgan Kaufmann, 2017, 71-82.