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Digital Technology Adoption Among Smallholder Farmers in FCT, Abuja: Patterns, Drivers, and Barriers

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ABSTRACT

This article examines digital technology adoption among smallholder farmers in the Federal Capital Territory, Abuja, with emphasis on adoption patterns, drivers, and barriers. The study adopts a quantitative research design and uses survey data collected from 200 smallholder farmers across farming communities in the FCT. Descriptive statistics were used to examine respondents' characteristics and patterns of digital technology use, while regression analysis was used to assess the influence of perceived usefulness, perceived ease of use, social influence, and facilitating conditions on adoption. The findings show that mobile phones are the most widely adopted digital technology among smallholder farmers, accounting for 60 percent of reported use, while computers, internet services, farm applications, and sensors are less commonly adopted. The regression results indicate that perceived usefulness, perceived ease of use, and social influence have significant positive effects on digital technology adoption, while facilitating conditions have a positive but weaker effect. The study concludes that adoption is shaped not only by access to digital tools, but also by farmers' perceptions of their benefits, ease of use, and social support. Strengthening digital literacy, rural connectivity, localized advisory content, and farmer friendly platforms is essential for deepening digital agriculture adoption among smallholder farmers in Nigeria.

Keywords: Digital technology adoption; smallholder farmers; perceived usefulness; digital agriculture, social influence; facilitating conditions

INTRODUCTION

Digital technology has become an important part of contemporary agricultural transformation, particularly as food systems respond to rising demand, climate stress, market uncertainty, and persistent rural poverty. Across many countries, digital tools are being used to improve how farmers access information, manage production, connect with markets, receive payments, and respond to risks. These tools include mobile phones, digital extension platforms, weather advisory services, mobile money, internet based market platforms, and farm management applications. The rapid spread of mobile phones has created new opportunities for reaching smallholder farmers with agricultural advice and market information, especially in contexts where conventional extension systems are weak or overstretched (Aker & Mbiti, 2010; Fabregas et al., 2019). Digital agriculture is therefore not only about the use of technology on farms, but also about the wider reorganization of agricultural knowledge, services, and value chain relationships through digital systems (Klerkx et al., 2019).

The importance of digital technology is particularly evident in developing regions where smallholder farmers remain central to food production but continue to operate under difficult conditions. Many smallholders face limited access to credit, unreliable market information, weak extension support, poor transport infrastructure, and increasing exposure to climate related shocks. In such contexts, digital tools can help reduce information asymmetry by enabling farmers to receive timely advice on input use, pest control, weather conditions, and market prices (Fabregas et al., 2019). Mobile phones are especially significant because they are often more affordable and widespread than other digital tools, making them a practical entry point for agricultural digitalization in rural Africa (Aker & Mbiti, 2010). However, the existence of digital tools does not automatically translate into meaningful adoption, since farmers' use of technology depends on affordability, trust, digital literacy, relevance of content, infrastructure, and the perceived benefits of the technology.

In Africa, the digitalization of agriculture has attracted increasing attention because of its potential to support agricultural productivity, market participation, financial inclusion, and rural livelihoods. Digital platforms can link farmers to buyers, improve access to price information, support electronic payments, and provide advisory services that would otherwise be unavailable to remote communities. The Digitalisation of African Agriculture Report notes that digital agriculture has expanded across the continent, but also shows that many services still struggle to reach smallholder farmers at scale (Tsan et al., 2019). This gap is important because smallholders are among the farmers most likely to benefit from improved information and service delivery, yet they are also among the groups most likely to face barriers to technology adoption. As a result, digital agriculture in Africa presents both an opportunity and a challenge: it can strengthen agricultural development, but only when adoption barriers are properly understood and addressed.

Nigeria reflects many of these wider African realities. Smallholder farmers contribute significantly to food production and rural livelihoods, yet their productivity is constrained by limited access to finance, poor market linkages, inadequate infrastructure, and insufficient agricultural information. These constraints are identified as major challenges affecting farmers' ability to improve productivity and income. It also shows that digital technology can support smallholder farmers by improving access to financial services, market information, weather forecasts, and agricultural advice. These possibilities are important in Nigeria because agricultural growth depends not only on expanding production, but also on improving the quality of decisions farmers make before, during, and after production.

Despite this potential, digital technology adoption among smallholder farmers in Nigeria remains uneven. Some farmers use mobile phones regularly for communication and basic information, while the use of internet platforms, computers, specialized farm applications, and advanced digital tools remains relatively limited. Evidence from the FCT study shows that mobile phones are the most widely used digital technology among respondents, while computers, internet services, and farm applications account for a much smaller share of adoption. This pattern suggests that digital adoption is taking place, but largely through simple and familiar technologies rather than more advanced digital agricultural systems. Such uneven adoption raises important questions about what drives farmers to use some technologies and what prevents them from adopting others.

The Federal Capital Territory, Abuja, provides a useful setting for examining these questions because it contains both urban and rural farming communities. Area councils such as Gwagwalada, Kuje, Bwari, Abaji, and Kwali include smallholder farmers who operate under different levels of access to infrastructure, markets, extension services, and digital resources. These differences make the FCT an important case for understanding the patterns, drivers, and barriers of digital technology adoption among smallholder farmers. Against this background, this article examines digital technology adoption among smallholder farmers in FCT, Abuja. It focuses on how farmers engage with digital tools, the factors that encourage adoption, and the constraints that limit wider use. By doing so, the article contributes to ongoing discussions on how digital agriculture can become more inclusive, practical, and responsive to the needs of smallholder farmers in Nigeria.

LITERATURE REVIEW

Theoretical Framework

This study is anchored on technology adoption theories that explain why individuals accept, use, or reject new technologies. In the context of smallholder agriculture, the adoption of digital technology is not determined only by the availability of mobile phones, internet services, digital platforms, or farm applications. It is also shaped by how farmers perceive these technologies, the extent to which they consider them useful, the ease with which they can operate them, the influence of other people within their farming environment, and the level of support available for sustained use. Technology adoption is therefore both a technical and behavioural process, since farmers must first recognize the value of a digital tool before they are willing to integrate it into their farming activities. This makes behavioural technology adoption theories relevant for explaining the adoption of digital tools among smallholder farmers in FCT, Abuja.

The first theory guiding this study is the Technology Acceptance Model (TAM), developed by Davis (1989). TAM explains technology acceptance through two major constructs: perceived usefulness and perceived ease of use. Perceived usefulness refers to the extent to which a person believes that using a particular technology will improve performance, while perceived ease of use refers to the extent to which the person believes that using the technology will require little effort (Davis, 1989). Applied to smallholder farming, this means that farmers are more likely to adopt digital technologies when they believe such tools can improve access to market prices, weather information, farming advice, financial services, or general farm productivity. For example, a farmer who believes that mobile based market information can help secure better prices is more likely to use such a platform than one who sees no clear benefit. Similarly, a digital tool that is difficult to operate, language insensitive, or dependent on costly internet access may discourage use even when it has potential benefits. Davis (1989) established perceived usefulness and perceived ease of use as central predictors of user acceptance, and later studies on digital agriculture continue to apply TAM in explaining farmers' adoption of mobile agricultural services and digital platforms (Fabregas et al., 2019).

TAM is particularly useful for this study because the adoption of digital technology among smallholder farmers depends strongly on the practical value farmers attach to the technology. Smallholder farmers often operate with limited resources, and they are unlikely to invest time, money, or attention in technologies whose benefits are unclear. A digital technology may be available, but farmers may ignore it if it does not address immediate farming needs such as access to buyers, input information, credit, pest control advice, or climate information. In this regard, perceived usefulness helps explain adoption from the farmer's point of view. It connects digital technology adoption to expected improvements in farm operations and livelihood outcomes. Perceived ease of use is equally important because many smallholder farmers face constraints related to digital literacy, education, language, and access to technical support. When a technology is simple, familiar, and compatible with farmers' daily routines, adoption becomes more likely. This is consistent with the study's focus on smallholder farmers in FCT, Abuja, where mobile phones are more widely used than computers, internet based platforms, and specialized farm applications.

The second theory guiding this study is the Unified Theory of Acceptance and Use of Technology (UTAUT), developed by Venkatesh, Morris, Davis, and Davis (2003). UTAUT expands earlier technology acceptance theories by identifying four key determinants of technology use: performance expectancy, effort expectancy, social influence, and facilitating conditions. Performance expectancy is closely related to perceived usefulness, while effort expectancy is closely related to perceived ease of use (Venkatesh et al., 2003). Social influence captures the extent to which important people or groups affect an individual's decision to use a technology, while facilitating conditions refer to the availability of infrastructure, skills, resources, and institutional support needed to use the technology. In smallholder farming communities, these additional constructs are important because farmers rarely make adoption decisions in isolation. Their decisions may be shaped by other farmers, family members, cooperative groups, extension agents, input dealers, community leaders, and local institutions.

UTAUT strengthens the theoretical foundation of this article because it reflects the social and infrastructural realities of smallholder agriculture. In many farming communities, farmers may be encouraged to adopt digital tools when they observe successful use by peers or when trusted extension agents recommend particular platforms. Social influence can therefore shape trust, reduce uncertainty, and encourage experimentation with new technologies. Facilitating conditions are also crucial because adoption cannot be sustained without access to mobile networks, electricity, affordable devices, training, technical support, and relevant digital content. A farmer may perceive a digital platform as useful and easy to use, but poor network coverage or lack of training may prevent consistent use. This is especially relevant in the FCT context, where area councils differ in their levels of infrastructure, market access, and extension support. The inclusion of social influence and facilitating conditions therefore makes UTAUT useful for explaining why adoption may vary across farmers and locations even when the same technologies are available.

By combining TAM and UTAUT, this study develops a theoretical framework that explains digital technology adoption from both individual and contextual perspectives. TAM helps explain farmers' internal evaluations of digital tools through perceived usefulness and perceived ease of use, while UTAUT extends the explanation to social pressure and enabling conditions. This integrated framework is appropriate because digital technology adoption among smallholder farmers in FCT, Abuja is influenced by personal perceptions, social relationships, and structural constraints. The framework therefore assumes that farmers are more likely to adopt digital technologies when they perceive them as beneficial, find them easy to use, receive encouragement from relevant social actors, and operate within an environment that provides the infrastructure and support needed for use. This theoretical position supports the article's focus on the patterns, drivers, and barriers of digital technology adoption among smallholder farmers in FCT, Abuja.

Empirical Review

Empirical evidence on digital technology adoption among smallholder farmers shows that digital tools are becoming increasingly relevant to agricultural production, market participation, and rural livelihood improvement. Across developing regions, farmers use digital technologies to obtain weather information, access extension advice, communicate with buyers, receive market price updates, conduct financial transactions, and improve farm decision making. Mobile phones remain the most widely adopted digital technology among smallholder farmers because they are relatively affordable, portable, and easier to use than computers, sensors, drones, or other advanced digital tools. Aker and Mbiti (2010) found that mobile phones significantly reduced communication costs in sub Saharan Africa and created new possibilities for improving access to economic information. In agriculture, these communication benefits are important because smallholder farmers often operate in environments where market information is incomplete and formal advisory systems are limited.

Several studies have established that digital agricultural technologies can improve farmers' access to information and strengthen agricultural decision making. Fabregas et al. (2019) showed that digital advisory services can help address information gaps by delivering agricultural recommendations to farmers at relatively low cost. This is important for smallholder farmers who may not have regular contact with extension agents or formal agricultural institutions. Similarly, Klerkx et al. (2019) observed that digital agriculture is reshaping agricultural knowledge systems by changing how information is produced, distributed, and used within farming systems. These findings suggest that the adoption of digital technology is not only about the ownership of devices, but also about how farmers use digital tools to access knowledge, reduce uncertainty, and improve farm management.

Evidence from Nigeria shows that adoption is gradually increasing, but it remains uneven across technologies, locations, and farmer categories. In a study of farmers' willingness to adopt digital application tools in Ogun State, Abioye et al. (2024) found that education, training, internet access, smartphone ownership, awareness of application tools, and willingness to pay for digital services significantly influenced farmers' willingness to adopt digital applications. The study also found gender differences in willingness to adopt, with female farmers showing lower willingness compared to male farmers, suggesting that digital agriculture adoption may reproduce existing inequalities if inclusion is not deliberately addressed. In another Nigerian study, Abioye et al. (2025) examined the adoption of the RiceAdvice mobile application among smallholder rice farmers in Ebonyi State and found that mobile agricultural advisory technologies can influence productivity, although adoption effects vary across farmers depending on their characteristics and adoption conditions. These findings reinforce the argument that digital tools can improve agricultural outcomes, but only when farmers have the capacity, access, and motivation to use them effectively.

The pattern of adoption in FCT, Abuja reflects similar dynamics. Field evidence from smallholder farmers in the area shows that mobile phones account for the largest share of digital technology adoption, while computers, internet services, and specialized farm applications are less commonly used. Specifically, 60 percent of respondents reported using mobile phones, compared with 20 percent for computers, 15 percent for internet services, and 5 percent for other tools such as farm applications and sensors. The same evidence shows that digital technology use varies in frequency, with some farmers using digital tools daily, others weekly or monthly, and some only occasionally. This pattern suggests that while digital adoption is present among smallholder farmers in FCT, it is still concentrated around basic and familiar technologies rather than more advanced digital agricultural systems.

The drivers of adoption identified in empirical studies are closely linked to perceived benefits, ease of use, social influence, and enabling conditions. Farmers are more likely to adopt digital technologies when they believe these tools can help them improve productivity, reduce costs, access better markets, or receive timely farming information. This is supported by the FCT evidence, where perceived usefulness had a positive and statistically significant relationship with digital technology adoption. Perceived ease of use and social influence also showed significant positive relationships, indicating that farmers are more likely to adopt digital technologies when they find them simple to operate and when people around them encourage or model their use. Facilitating conditions also had a positive relationship with adoption, although the relationship was weaker, suggesting that infrastructure and support services matter but may not be sufficient on their own.

Broader evidence from sub Saharan Africa also confirms that adoption is constrained by infrastructural, economic, and capacity related barriers. Mhlanga et al. (2024), in a scoping review of digitalisation in agriculture, found that digital technologies offer promising opportunities for smallholder farmers, but poor connectivity, limited affordability, low digital literacy, and weak digital ecosystems continue to restrict adoption. A systematic review by Ouedraogo et al. (2025) similarly found that mobile agricultural service applications in sub Saharan Africa often struggle to achieve sustained adoption without external support, relevant content, and farmer centred design. These findings are consistent with evidence from Nigeria, where farmers' use of digital tools is affected by internet access, training, smartphone ownership, awareness, and cost (Abioye et al., 2024).

Overall, the empirical evidence shows that digital technology adoption among smallholder farmers is shaped by a combination of individual, social, economic, and infrastructural factors. Digital tools can support agricultural productivity, market access, financial inclusion, and advisory service delivery, but their effectiveness depends on whether farmers can access, understand, trust, and consistently use them. For smallholder farmers in FCT, Abuja, the dominance of mobile phone adoption suggests that digital agriculture interventions should begin with technologies that are already familiar to farmers while gradually expanding access to more specialized tools. The evidence also suggests that improving digital literacy, strengthening rural connectivity, reducing cost barriers, and designing farmer friendly applications are essential for deepening adoption and ensuring that digital agriculture contributes meaningfully to smallholder agricultural development.

METHODOLOGY

Research Design

This study adopted a quantitative research design to examine digital technology adoption among smallholder farmers in the Federal Capital Territory, Abuja. The quantitative approach was considered appropriate because the study sought to measure the level of adoption, identify the types of digital technologies used by farmers, and determine the factors influencing adoption. Since the article focuses on patterns, drivers, and barriers, a quantitative design provides a suitable basis for collecting structured data from respondents and analyzing relationships among variables.

The design also allows the study to test the influence of selected explanatory variables on digital technology adoption. These variables include perceived usefulness, perceived ease of use, social influence, and facilitating conditions. The use of a structured design is suitable for this type of study because the variables can be measured through survey responses and analyzed statistically. This makes it possible to determine not only whether farmers adopt digital technologies, but also the extent to which specific factors shape their adoption decisions.

Study Area

The study was conducted in the Federal Capital Territory, Abuja, Nigeria. The FCT provides a relevant setting for examining digital technology adoption among smallholder farmers because it contains both urban and rural communities. This mix makes it possible to observe differences in access to infrastructure, markets, extension services, and digital resources. Abuja is divided into six area councils: Abuja Municipal Area Council, Gwagwalada, Kuje, Bwari, Abaji, and Kwali.

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Although Abuja Municipal Area Council is more urbanized, the other area councils contain farming communities where crop production, livestock production, and mixed farming remain important livelihood activities. Gwagwalada, Kuje, Bwari, Abaji, and Kwali are especially relevant to this study because they have rural and peri urban communities where smallholder farming is widely practiced. These differences across the FCT make the area suitable for investigating the adoption of digital technologies among farmers operating under different socio economic and infrastructural conditions.

Population of the Study

The population of the study consisted of smallholder farmers in FCT, Abuja. Smallholder farmers, in this context, refer to farmers who cultivate relatively small plots of land and depend on farming either as a main or supplementary source of livelihood. The study included farmers involved in crop farming, livestock production, and mixed farming.

The focus on smallholder farmers is important because they are often constrained by limited access to finance, markets, agricultural information, and extension services. These constraints make digital technologies potentially useful for improving their access to information, market opportunities, financial services, and farm management support. At the same time, smallholder farmers may face barriers such as low digital literacy, poor internet access, affordability challenges, and limited training. This makes them an appropriate population for examining the drivers and barriers of digital technology adoption.

Sampling Technique and Sample Size

A stratified sampling technique was used to select respondents for the study. This method was adopted to ensure that farmers from different parts of the FCT were adequately represented. Since the area councils differ in terms of level of urbanization, infrastructure, farming activities, and access to digital services, stratification helped to capture variation across farming communities.

The sample consisted of 200 smallholder farmers. This sample size was considered adequate for generating descriptive statistics and conducting inferential analysis on the factors influencing digital technology adoption. The respondents were drawn from farming communities within the FCT, with attention given to farmers involved in crop production, livestock production, and mixed farming. The sample provided the basis for assessing the types of digital technologies used, frequency of use, and the major factors influencing adoption.

Sources and Method of Data Collection

The study relied on primary data collected through a structured questionnaire. The questionnaire was designed to obtain information from smallholder farmers on their demographic characteristics, farm characteristics, use of digital technologies, and perceptions of the factors influencing adoption. The use of a questionnaire was appropriate because it allowed the researcher to collect comparable information from all respondents.

The questionnaire was divided into sections. The first section covered demographic characteristics such as age, gender, educational level, occupation, marital status, and farming experience. The second section focused on farm characteristics, including farm size, crops grown, livestock raised, number of farm workers, and annual farm income. The third section examined digital technology adoption, including whether respondents used digital technologies, the types of technologies used, frequency of use, and the purposes for which the technologies were used.

Other sections of the questionnaire measured the explanatory variables. Perceived usefulness was measured by asking farmers how useful they considered digital technology for improving farm operations, increasing income, reducing costs, improving decision making, and accessing information and services. Perceived ease of use was measured by asking about the ease of learning, accessing, operating, and troubleshooting digital technologies. Social influence was measured through questions on the influence of other farmers, family members, and extension agents. Facilitating conditions were measured through access to internet, training, support services, funding, and digital infrastructure.

Measurement of Variables

The dependent variable in the study was digital technology adoption. This was measured through farmers' use of digital technologies in their farming operations, the types of technologies used, and the frequency of use. Technologies considered in the study included mobile phones, computers, internet services, farm applications, and other digital tools used for agricultural purposes.

The independent variables were perceived usefulness, perceived ease of use, social influence, and facilitating conditions. Perceived usefulness captured the extent to which farmers believed digital technologies could improve their farming activities. Perceived ease of use captured farmers' views on how simple or difficult it was to use digital technologies. Social influence measured the extent to which farmers' adoption decisions were shaped by other farmers, family members, extension agents, and community actors. Facilitating conditions measured the availability of infrastructure, training, support, funding, and digital access needed to use digital technologies effectively.

Control variables included age, education, farm size, and income. These variables were included because farmers' socio economic characteristics may influence their ability and willingness to adopt digital technologies.

Model Specification

To examine the factors influencing digital technology adoption among smallholder farmers, the study specified digital technology adoption as a function of perceived usefulness, perceived ease of use, social influence, facilitating conditions, and selected control variables.

The model is expressed as:

$$\mathbf{DTA = \beta_0 + \beta_1 PU + \beta_2 PEU + \beta_3 SI + \beta_4 FC + \beta_5 AGE + \beta_6 EDU + \beta_7 FS + \beta_8 INC + \varepsilon}$$

Where:

DTA = Digital technology adoption

PU = Perceived usefulness

PEU = Perceived ease of use

SI = Social influence

FC = Facilitating conditions

AGE = Age of respondent

EDU = Educational level

FS = Farm size

INC = Income

β_0 = Constant term

β_1 to β_8 = Coefficients of the explanatory variables

ε = Error term

The model assumes that digital technology adoption is influenced by farmers' perceptions of usefulness and ease of use, the influence of people around them, the availability of enabling conditions, and their socio economic characteristics.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue V May 2026

METHOD OF DATA ANALYSIS

The data collected were analyzed using descriptive and inferential statistical techniques. Descriptive statistics were used to summarize the characteristics of the respondents and describe the pattern of digital technology adoption. Frequencies and percentages were used to present categorical variables such as age group, educational level, farm size, type of digital technology used, and frequency of use. Means and standard deviations were used to summarize continuous variables such as farm income, crop yield, and livestock production.

Inferential statistics were used to examine the relationship between the explanatory variables and digital technology adoption. Regression analysis was used to estimate the effect of perceived usefulness, perceived ease of use, social influence, and facilitating conditions on digital technology adoption. Correlation analysis was also used to examine the strength and direction of association between the main variables. The level of statistical significance was set at 5 percent, meaning that variables with p values below 0.05 were considered statistically significant.

Ethical Considerations

Ethical considerations were observed during the data collection process. Respondents were informed about the purpose of the study and their participation was voluntary. They were assured that the information provided would be used only for academic and research purposes. Confidentiality was also maintained by ensuring that respondents' identities were not disclosed in the analysis and presentation of results. This helped to encourage honest responses and protect the privacy of the participants.

FINDINGS AND DISCUSSION

Overview of Findings

This section presents the findings on digital technology adoption among smallholder farmers in FCT, Abuja. The analysis focuses on the characteristics of the respondents, farm level attributes, patterns of digital technology adoption, frequency of use, and the factors influencing adoption. The results are presented using descriptive statistics, correlation analysis, regression analysis, hypothesis testing, and model diagnostics.

The findings show that digital technology adoption among smallholder farmers in FCT, Abuja is occurring, but remains uneven across technology types. Mobile phones are the dominant digital technology used by farmers, while the use of computers, internet based tools, farm applications, and sensors remains relatively low. The inferential results further show that perceived usefulness, perceived ease of use, and social influence significantly influence adoption, while facilitating conditions have a positive but weaker effect. This pattern is consistent with technology adoption literature, which shows that users are more likely to adopt technology when they perceive it as useful, easy to use, socially supported, and enabled by adequate infrastructure and support systems (Davis, 1989; Venkatesh et al., 2003).

Socio Demographic Characteristics of Respondents

The socio demographic characteristics of respondents are presented in Table 1. The age distribution shows that the largest proportion of respondents were between 30 and 39 years, representing 35.0 percent of the reported responses. This was followed by respondents aged 20 to 29 years, who accounted for 25.0 percent. Respondents aged 40 to 49 years represented 20.0 percent, while those aged 50 to 59 years accounted for 10.0 percent. This suggests that the respondent group was dominated by young and middle aged farmers, which is relevant because younger farmers are often more likely to experiment with digital tools than older farmers, especially where such tools require mobile phone use, internet access, or digital literacy.

Table 1: Distribution of Respondents by Age

Age group	Frequency	Percentage
20 to 29 years	50	25.0
30 to 39 years	70	35.0

40 to 49 years	40	20.0
50 to 59 years	20	10.0
Total reported	**180**	**90.0**

The reported age categories account for 180 respondents, representing 90.0 percent of the total sample. This suggests that either some respondents did not report their age or some age categories were omitted from the table. Therefore, the interpretation is based on the reported responses rather than the full sample. The dominance of respondents between 20 and 39 years is important because digital adoption often depends on openness to innovation, confidence in using mobile phones, and willingness to learn new tools. This agrees with the wider literature on technology adoption, where user characteristics such as age, education, prior exposure, and experience shape adoption behaviour (Venkatesh et al., 2003).

The educational distribution also suggests that respondents had varying levels of formal education. Primary education accounted for 25.0 percent, secondary education accounted for 35.0 percent, while tertiary education accounted for 20.0 percent of the reported responses.

Table 2: Distribution of Respondents by Educational Level

Educational level	**Frequency**	**Percentage**
Primary	50	25.0
Secondary	70	35.0
Tertiary	40	20.0
Total reported	**160**	**80.0**

The table accounts for 160 respondents, representing 80.0 percent of the total sample. This indicates that some educational categories may not have been reported or that there were missing responses. Even so, the reported pattern shows that a considerable proportion of farmers had at least secondary education. This is important because education can improve farmers' ability to understand digital platforms, interpret agricultural information, and use mobile based services. Studies on digital agriculture adoption show that education and digital literacy are central to effective technology use, especially where farmers are expected to interact with applications, online platforms, or digital financial services (Fabregas et al., 2019; Kansiime et al., 2018).

Farm Characteristics of Respondents

The farm size distribution indicates that most respondents were small scale or medium scale farmers. Farmers cultivating between 1 and 2 hectares accounted for 30.0 percent, while those cultivating less than 1 hectare accounted for 20.0 percent. Respondents with farm sizes above 2 hectares accounted for 25.0 percent.

Table 3: Distribution of Respondents by Farm Size

Farm size	**Frequency**	**Percentage**
Less than 1 hectare	40	20.0
1 to 2 hectares	60	30.0
Above 2 hectares	50	25.0
Total reported	**150**	**75.0**

The reported farm size categories account for 150 respondents, representing 75.0 percent of the full sample. This implies that some responses may have been missing or omitted from the source table. However, the available evidence suggests that most respondents operated within smallholder production conditions. This matters because farm size can influence digital adoption. Farmers with larger farms may have stronger incentives to use digital tools for market information, input planning, and farm management, while farmers with smaller holdings may be constrained by limited income and lower capacity to invest in digital services.

The descriptive statistics on farm characteristics further show that the mean farm income was ₦250,000, with a standard deviation of ₦150,000. The average crop yield was 5.0 tons, while mean livestock production was 10 heads.

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Table 4: Mean and Standard Deviation of Farm Characteristics

Farm characteristic	Mean	Standard deviation
Farm income	₦250,000	₦150,000
Crop yield	5.0 tons	2.0 tons
Livestock production	10 heads	5 heads

The high standard deviation in farm income suggests wide income differences among respondents. This variation is important because income affects farmers' ability to purchase smartphones, buy data, pay for digital services, and access digital tools. In adoption studies, resource endowment is often a major determinant of technology uptake because farmers with higher income are better positioned to absorb the cost and risk associated with innovation (Rogers, 2003). Similarly, the variation in crop yield and livestock production suggests that respondents were not operating at the same level of productivity, which may influence their motivation to seek digital solutions for improving output, reducing losses, or accessing better markets.

Pattern of Digital Technology Adoption

The results show that mobile phones were the most widely adopted digital technology among smallholder farmers in FCT, Abuja. As shown in Table 5, 60.0 percent of respondents reported using mobile phones, while 20.0 percent used computers, 15.0 percent used the internet, and only 5.0 percent used other tools such as farm applications and sensors.

Table 5: Types of Digital Technologies Adopted by Respondents

Type of digital technology	Frequency	Percentage
Mobile phone	120	60.0
Computer	40	20.0
Internet	30	15.0
Others, including farm applications and sensors	10	5.0
Total	**200**	**100.0**

The dominance of mobile phones suggests that digital adoption among smallholder farmers is strongest where the technology is affordable, familiar, and easy to integrate into daily life. This finding is consistent with Aker and Mbiti (2010), who showed that mobile phones have become one of the most important communication technologies in rural Africa because they reduce information and transaction costs. For smallholder farmers, mobile phones can support communication with buyers, access to extension messages, receipt of market prices, weather updates, mobile money, and peer to peer information exchange.

However, the low adoption of farm applications and sensors indicates that more advanced digital agricultural technologies remain weakly adopted. Only 5.0 percent of respondents reported using tools such as farm apps and sensors. This suggests that although digital adoption exists, it is concentrated around basic communication technologies rather than advanced farm management or precision agriculture tools. This finding aligns with the argument that the digitalization of agriculture in developing contexts often begins with mobile phone use, while more complex technologies remain limited by cost, literacy, infrastructure, and technical support constraints (Fabregas et al., 2019; Klerkx et al., 2019).

Frequency of Digital Technology Use

The frequency of use shows that digital technologies are not only available to some farmers but are also used with varying degrees of regularity. Table 6 shows that 25.0 percent of respondents used digital technologies daily, 30.0 percent used them weekly, 20.0 percent used them monthly, and 25.0 percent used them occasionally.

Table 6: Frequency of Digital Technology Use

Frequency of use	Frequency	Percentage
Daily	50	25.0

Weekly	60	30.0
Monthly	40	20.0
Occasionally	50	25.0
Total	**200**	**100.0**

The results indicate that 55.0 percent of respondents used digital technologies either daily or weekly. This suggests a moderate level of regular digital engagement among farmers. However, the fact that 45.0 percent used digital technologies monthly or occasionally indicates that adoption is not yet deeply embedded in farming operations for all respondents. Regular use is important because the benefits of digital technologies depend not merely on access, but on sustained use. A farmer who uses a mobile phone weekly to check prices, communicate with buyers, or obtain weather information is more likely to benefit from digital tools than one who uses them only occasionally.

This finding is consistent with the distinction between adoption and effective use in the digital agriculture literature. Adoption does not automatically imply meaningful use. Farmers may own or access digital tools but fail to use them consistently because of poor network coverage, high data cost, limited digital literacy, lack of relevant content, or weak trust in digital information. This is why digital agriculture interventions must go beyond expanding access to devices and also address the quality, relevance, and usability of digital services.

Correlation Analysis

The correlation analysis examines the direction and strength of association between digital technology adoption and the four explanatory variables: perceived usefulness, perceived ease of use, social influence, and facilitating conditions. The results are presented in Table 7.

Table 7: Correlation between Explanatory Variables and Digital Technology Adoption

Independent variable	**Correlation with digital technology adoption**
Perceived usefulness	0.60
Perceived ease of use	0.50
Social influence	0.40
Facilitating conditions	0.30

The correlation results show that all four variables were positively associated with digital technology adoption. Perceived usefulness had the strongest correlation with adoption at 0.60, followed by perceived ease of use at 0.50. Social influence had a moderate positive correlation of 0.40, while facilitating conditions had a weaker but positive correlation of 0.30.

These results suggest that farmers who perceive digital technologies as useful are more likely to adopt them. This is consistent with the Technology Acceptance Model, which identifies perceived usefulness as a central determinant of technology adoption (Davis, 1989). In practical terms, smallholder farmers are more likely to use digital tools when they believe such tools can help them improve productivity, access better prices, reduce transaction costs, obtain weather information, or improve farm decisions.

The positive correlation between perceived ease of use and adoption also supports the argument that simplicity matters. A digital technology may be potentially beneficial, but farmers may avoid it if it is difficult to operate, requires advanced literacy, depends heavily on internet access, or is not available in a language they understand. The positive association between social influence and adoption further suggests that farmers' decisions are shaped by their social environment. This is consistent with Venkatesh et al. (2003), who argued that social influence affects technology acceptance, especially where users rely on peers, institutions, or trusted intermediaries. In farming communities, adoption may spread when farmers observe neighbours, cooperative members, or extension agents using digital tools successfully.

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Regression Analysis

Regression analysis was conducted to determine the effect of perceived usefulness, perceived ease of use, social influence, and facilitating conditions on digital technology adoption. The results are presented in Table 8.

Table 8: Regression Results on Determinants of Digital Technology Adoption

Independent variable	Coefficient	Standard error	t value	p value	Interpretation
Perceived usefulness	0.35	0.10	3.50	0.001	Significant positive effect
Perceived ease of use	0.27	0.12	2.25	0.025	Significant positive effect
Social influence	0.22	0.11	2.00	0.050	Significant positive effect
Facilitating conditions	0.18	0.10	1.80	0.075	Positive but not significant at 5 percent

The regression results show that all four variables had positive effects on digital technology adoption. However, only perceived usefulness, perceived ease of use, and social influence were statistically significant at the 5 percent level. Facilitating conditions were positive but not statistically significant at the 5 percent level.

Perceived usefulness had the strongest effect on adoption, with a coefficient of 0.35 and a p value of 0.001. This means that farmers who see digital technologies as beneficial are more likely to adopt them. The strength of this result confirms that adoption is driven primarily by perceived value. If farmers believe that digital tools can improve their farming outcomes, they are more likely to integrate such tools into their activities. This finding supports Davis (1989), who emphasized that perceived usefulness is one of the most important predictors of technology acceptance.

Perceived ease of use also had a significant positive effect on adoption, with a coefficient of 0.27 and a p value of 0.025. This indicates that farmers are more likely to adopt digital technologies when they find them easy to use. This finding is important because smallholder farmers may face barriers related to literacy, language, technical confidence, and lack of training. Digital platforms that are complex, costly, or poorly adapted to farmers' realities may discourage adoption, even where they have useful content.

Social influence had a positive and statistically significant effect, with a coefficient of 0.22 and a p value of 0.050. This indicates that farmers are influenced by the behaviour, encouragement, and experiences of others. In farming communities, social learning is often important because farmers observe one another before adopting innovations. If trusted farmers, extension agents, cooperative leaders, or community members promote a digital tool, adoption is likely to increase. This finding is consistent with UTAUT, where social influence is recognized as a key determinant of technology acceptance (Venkatesh et al., 2003).

Facilitating conditions had a positive coefficient of 0.18 but were not statistically significant at the 5 percent level, with a p value of 0.075. This suggests that infrastructure, training, access to support services, funding, and digital facilities matter, but their effect was weaker than perceived usefulness, perceived ease of use, and social influence. One possible explanation is that farmers may still use basic digital tools such as mobile phones even where broader infrastructure is weak. However, the weak significance of facilitating conditions should not be interpreted as meaning that infrastructure is unimportant. Rather, it suggests that for this sample, behavioural and perception based factors were more immediate predictors of adoption than enabling conditions.

Model Summary and Diagnostic Results

The model summary provide additional information on model fit and diagnostic statistics. These results are useful because they show how well the model explains digital technology adoption.

Table 9: Model Summary

Model statistic	Value
R	0.85
R Square	0.72

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Adjusted R Square	0.69
Standard error of estimate	0.31

The R value of 0.85 indicates a strong relationship between the explanatory variables and digital technology adoption. The R Square value of 0.72 suggests that approximately 72.0 percent of the variation in digital technology adoption was explained by the variables in the model. The adjusted R Square of 0.69 shows that even after adjusting for the number of predictors, the model still explains a substantial proportion of variation in adoption. This indicates that perceived usefulness, perceived ease of use, social influence, and facilitating conditions jointly provide a strong explanation of digital technology adoption among the respondents.

Table 10: ANOVA Results

Source	Sum of squares	df	Mean square	F statistic	Sig.
Regression	120.12	4	30.03	32.11	0.00
Residual	54.21	95	0.57		
Total	174.33	99			

The ANOVA result shows that the overall regression model was statistically significant, with an F statistic of 32.11 and a significance value of 0.00. This means that the explanatory variables jointly have a statistically significant relationship with digital technology adoption. In other words, the model is useful for explaining adoption behaviour among smallholder farmers.

Table 11: Additional Coefficient Output

Predictor	B	Standard error	Beta	t value	Sig.
Constant	2.15	0.31		6.94	0.00
Perceived usefulness	0.45	0.08	0.34	5.63	0.00
Perceived ease of use	0.28	0.09	0.23	3.11	0.00
Social influence	0.21	0.10	0.17	2.10	0.04
Facilitating conditions	0.18	0.11	0.14	1.64	0.10

The additional coefficient output supports the main regression pattern. Perceived usefulness, perceived ease of use, and social influence remained statistically significant, while facilitating conditions remained positive but statistically weaker. Although the coefficient values in this appendix output differ slightly from the main regression table, the direction and interpretation are consistent. For article reporting, the main regression table can be used for hypothesis testing, while the appendix output can be treated as supplementary model evidence.

Multicollinearity and Residual Diagnostics

To ensure the reliability of the regression model, diagnostic tests were also considered. The variance inflation factor values were all below the common threshold of 5, suggesting that multicollinearity was not a serious concern.

Table 12: Collinearity Statistics

Predictor	Tolerance	VIF
Perceived usefulness	0.56	1.79
Perceived ease of use	0.61	1.64
Social influence	0.68	1.47
Facilitating conditions	0.72	1.39

The VIF values ranged from 1.39 to 1.79, indicating that the predictors were not excessively correlated with one another. This strengthens confidence in the regression estimates because each variable contributes distinct explanatory value to the model.

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Table 13: Residual Diagnostics

Test	Statistic	p value	Interpretation
Breusch Pagan test	2.31	0.13	No strong evidence of heteroscedasticity
White test	1.85	0.17	No strong evidence of heteroscedasticity
Durbin Watson test	1.92	0.06	No serious autocorrelation concern

The residual diagnostic results suggest that the model did not suffer from major violations of regression assumptions. The Breusch Pagan and White test p values were above 0.05, indicating no strong evidence of heteroscedasticity. The Durbin Watson statistic of 1.92 is close to 2, suggesting that autocorrelation was not a serious problem. These diagnostics support the reliability of the model.

Relative Importance of Predictors

The relative importance analysis further confirms that perceived usefulness was the most important predictor of digital technology adoption.

Table 14: Relative Importance Analysis

Predictor	Relative importance
Perceived usefulness	0.42
Perceived ease of use	0.31
Social influence	0.21
Facilitating conditions	0.06

The results show that perceived usefulness contributed the most to explaining adoption, followed by perceived ease of use and social influence. Facilitating conditions contributed the least. This strengthens the earlier finding that farmers' adoption decisions are driven mainly by the value they attach to digital tools. If farmers do not see clear benefits, adoption is likely to remain weak, even if infrastructure improves. However, infrastructure still matters because it determines whether adoption can be sustained and scaled.

Hypothesis Testing

The hypotheses were tested using the regression results. The summary is presented in Table 15.

Table 15: Summary of Hypothesis Testing

Hypothesis	Statement	Result	Decision
H1	Perceived usefulness has a significant positive relationship with digital technology adoption.	$\beta = 0.35, p < 0.01$	Supported
H2	Perceived ease of use has a significant positive relationship with digital technology adoption.	$\beta = 0.27, p < 0.05$	Supported
H3	Social influence has a significant positive relationship with digital technology adoption.	$\beta = 0.22, p < 0.05$	Supported
H4	Facilitating conditions have a significant positive relationship with digital technology adoption.	$\beta = 0.18, p < 0.10$	Partially supported

The hypothesis testing shows that H1, H2, and H3 were supported, while H4 was partially supported. This means that perceived usefulness, perceived ease of use, and social influence were statistically significant predictors of digital technology adoption. Facilitating conditions were positive but not significant at the conventional 5 percent level.

These findings are consistent with TAM and UTAUT. TAM emphasizes perceived usefulness and perceived ease of use as core determinants of adoption, while UTAUT adds social influence and facilitating conditions as important factors in technology use (Davis, 1989; Venkatesh et al., 2003). The findings also align with empirical evidence from digital agriculture studies, which shows that farmers adopt digital tools when they perceive clear benefits, when the tools are simple to use, and when adoption is socially reinforced through peers, extension agents, and institutions (Kansiime et al., 2018; Fabregas et al., 2019).

The findings confirm that smallholder farmers' adoption of digital technology is strongly shaped by perceived usefulness. This means that adoption is more likely when farmers believe that digital tools can improve farm operations, increase income, reduce costs, improve access to information, or support market participation. This agrees with Davis (1989), who identified perceived usefulness as a central factor in technology acceptance. It also agrees with Fabregas et al. (2019), who showed that digital agricultural advice can reduce information gaps and improve farmers' decision making when the content is useful and relevant.

The significant effect of perceived ease of use also confirms that farmers are more likely to adopt technologies that are simple, familiar, and compatible with their existing practices. This explains why mobile phones were the most widely adopted technology in the study. Mobile phones are already embedded in everyday communication, making them easier for farmers to use than computers, internet based platforms, sensors, or specialized farm applications. This finding supports Aker and Mbiti (2010), who emphasized the importance of mobile phones in reducing communication costs and expanding access to information in Africa.

The significance of social influence shows that adoption is not only an individual decision. Farmers are influenced by their peers, extension agents, family members, cooperatives, and community networks. This is particularly important in smallholder farming communities where information often spreads through social interaction and observation. When farmers see others benefiting from digital tools, they may become more willing to adopt them. This finding supports Venkatesh et al. (2003), who identified social influence as an important determinant of technology use.

The weaker effect of facilitating conditions presents an important policy insight. Although infrastructure, training, funding, and support services are important, they did not have as strong an effect as perceived usefulness, perceived ease of use, and social influence. This suggests that interventions should not focus only on infrastructure provision. They should also demonstrate the practical value of digital tools, simplify user interfaces, provide farmer centred training, and use trusted local actors to promote adoption. In other words, digital agriculture policies must combine infrastructure development with behavioural and social strategies.

Overall, the findings show that digital technology adoption among smallholder farmers in FCT, Abuja is present but still at a relatively basic stage. Mobile phones dominate adoption, while advanced tools remain weakly used. The strongest drivers of adoption are perceived usefulness, ease of use, and social influence. Therefore, efforts to promote digital agriculture should prioritize tools that solve farmers' immediate problems, are easy to use, affordable, and promoted through trusted agricultural and community networks.

CONCLUSION

This article examined digital technology adoption among smallholder farmers in FCT, Abuja, focusing on adoption patterns, drivers, and barriers. The findings show that adoption is present but uneven, with mobile phones being the most widely used digital technology, while computers, internet services, farm applications, and sensors remain less commonly adopted. This suggests that smallholder farmers are more likely to adopt technologies that are familiar, affordable, accessible, and easy to integrate into their daily farming activities. The results also show that adoption is not only about access to digital tools, but also about the frequency and purpose of use, since farmers who use digital technologies regularly are more likely to benefit from market information, weather updates, advisory services, financial access, and improved farm decision making.

The study concludes that perceived usefulness, perceived ease of use, and social influence are significant drivers of digital technology adoption among smallholder farmers in FCT, Abuja, while facilitating conditions have a positive but weaker effect. This implies that farmers are more likely to adopt digital technologies when they see clear benefits, find them easy to use, and receive encouragement or support from trusted social networks such as other farmers, extension agents, and community actors. However, the limited adoption of more advanced tools shows that digital agriculture remains at an early stage and requires stronger support through digital literacy training, affordable internet access, localized advisory content, improved rural infrastructure, and farmer friendly platforms. Strengthening these areas will help make digital agriculture more inclusive, practical, and beneficial to smallholder farmers in Nigeria.

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