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RESEARCH ARTICLE

SOCIO-ECONOMIC AND TECHNOLOGICAL DETERMINANTS OF MOBILE-BASED AGRICULTURAL INFORMATION ACCESS AMONG SMALLHOLDER FARMERS IN KERICHO COUNTY, KENYA

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Abstract

Mobile phones are increasingly playing an important role in delivering agricultural extension, weather, market and production information to smallholder farmers. Nevertheless, farmers do not engage with mobile-based agricultural information services at the same frequency, and the factors explaining these differences vary across rural contexts. This study examined the relationship between selected socioeconomic and technological characteristics and the frequency with which smallholder farmers accessed agricultural information through mobile phones. A quantitative cross-sectional design was used with 287 small scale farmers who had complete observations. The dependent variable was frequency of mobile-based agricultural information access, categorized as regular, occasional or never. Explanatory variables included age, educational attainment, primary occupation, landholding size, household income, mobilephone ownership and device type. Data were analyzed using cross-tabulations, Pearson's chi-square tests and Fisher's exact tests. Linear-by-linear association tests were also used where ordinal trends were relevant. Age, education, occupation and mobilephone ownership were significantly associated with access frequency. Farmers younger than 35 years recorded the highest regular access rate at 72.0% while farmers aged 56 years and above mainly accessed information occasionally. Regular access was also highest among farmers combining agriculture with commercial business activities and among personal phone owners. Landholding size, income category and device type were not statistically significant. The findings suggest that mobile-based agricultural information access is shaped more strongly by age, education, occupational orientation and direct device access than by farm size, income or hardware sophistication. Digital extension programmes should therefore combine inclusive, basicphone-compatible services with age- and literacy-sensitive delivery approaches.

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Introduction: -

Agricultural information is an important input in smallholder production (Mapiye et al., 2023). Farmers require timely knowledge on market prices, weather conditions, crop and livestock management, pest and disease control, input availability, credit and post-harvest handling (Cherotich & Kibett, 2026). However, conventional extension systems often face constraints related to limited staffing, large farmertoextensionagent ratios, distance, cost and the difficulty of reaching dispersed rural communities (Sasakawa Africa Association, 2025). Mobile phones provide an additional channel through which extension agencies, researchers, agribusinesses and farmer organizations can communicate with producers (Lasdun et al., 2025).

Mobilebased agricultural information services may reduce communication and transaction costs by enabling farmers to receive advisories, contact extension personnel, compare prices and communicate with buyers. Such services may use voice calls, mobile applications and social media platforms, short message service (SMS), unstructured supplementary service data (USSD), and interactive voice response (FAO, 2020). The availability of these channels does not, however, guarantee effective use (Krell et al., 2021). Farmers differ in their access to devices, educational background, digital skills, financial resources, occupational needs and communication networks.

Evidence from rural Africa indicates that age, education, gender, farming experience, device ownership, duration of device ownership, land ownership, and farming experience may influence mobilebased agricultural information adoption. Farmers who own mobile devices and are younger and more educated are often better positioned to use digital services, whereas older, less educated and non-owning farmers may experience greater barriers. Other studies identify the high cost of devices and data, poor network access, low levels of digital literacy, inadequate training, language barriers and unreliable electricity as important constraints to ICT use in agriculture (Mapiye et al., 2023; Musungwini et al., 2024).

The distinction between access and regular use is important. A farmer may own a mobile phone but use it only for personal communication, or may occasionally receive agricultural messages without actively seeking information. Therefore, analysing the frequency of agricultural information access provides a more meaningful indication of engagement than measuring phone ownership alone. This study examined the relationship between selected socioeconomic and technological characteristics and the frequency with which smallholder farmers accessed agricultural information through mobile phones.

Specifically, it sought to: -

1. Determine whether age, education and occupation were associated with mobilebased agricultural information access.
2. Establish whether landholding size and income were associated with access frequency.
3. Assess the relationship between mobilephone ownership, device type and agricultural information access.
4. Identify the implications of the findings for inclusive digital agricultural extension.

The study was guided by the following null hypotheses: -

- H_{01} : Age, education and occupation are not significantly associated with the frequency of accessing mobilebased agricultural information.
- H_{02} : Landholding size and household income are not significantly associated with the frequency of accessing mobilebased agricultural information.
- H_{03} : Mobilephone ownership and device type are not significantly associated with the frequency of accessing mobile-based agricultural information.

Literature Review: -**Mobile phones and agricultural information access: -**

Mobile phones have become important tools for agricultural communication because they support both one-to-one and one-to-many information delivery (Aker et al., 2016; Msoffe & Ngoepe, 2020; Mapiye et al., 2023). Farmers can call extension personnel, receive weather or market alerts, participate in group discussions and access digital platforms (Gitau et al., 2025; Cherotich & Kibett, 2026; EANSO, 2026). In some rural settings, basic phones remain more widespread than smartphones, making SMS, voice and USSD services especially relevant.

Research on mobileenabled agricultural services has shown that farmers commonly seek information on market prices, improved production practices, weather forecasts, input use, crop varieties and post-harvest management (Boukaka et al., 2025; Cherotich & Kibett, 2026). Market information may be particularly valuable to farmers who

sell produce or operate other commercial activities because timely information can support decisions about when, where and to whom to sell (Nwangwu et al., 2024). However, mobilephone access should not be interpreted as a uniform process. The same device may be used for calls, mobile money, social communication, business and agricultural information. The farmer's motivation, skills, network of contacts and perceived usefulness of the information all influence usage intensity.

Age and education: -

Age may affect mobilebased information access through familiarity with digital technologies, willingness to experiment with new communication channels and the ability to navigate mobile services (Wayagi et al., 2025). Younger farmers may also be more likely to use internetenabled services and socialmedia platforms. Older farmers may prefer voice communication or rely on interpersonal contact with extension workers and other farmers (Coggins et al., 2022). Education can improve the ability to read SMS messages, interpret technical information, search for content and use mobile applications. Evidence from agricultural ICT studies indicates that education and digital literacy are important determinants of mobile service use. Nevertheless, education may not produce a strictly linear relationship if services are not designed for educated users alone (Sanga et al., 2025). For example, farmers with primary education may use voice and SMS services effectively, while some highly educated farmers may not be actively engaged in farming.

Occupation, income and landholding: -

A farmer's primary occupation can influence the perceived value of mobile information. Farmers who combine agriculture with commercial business may have stronger incentives to monitor prices, transport arrangements, suppliers and buyers. Commercial activity may therefore increase the need for frequent information access. Income and land size are commonly viewed as indicators of economic capacity. Farmers with greater income may be better able to purchase smartphones, pay for airtime and subscribe to data services. Larger landholders may also have greater incentives to seek production and market information. However, farm size and income do not necessarily determine access where basic phones and lowcost services are widely available. A farmer with a small plot may still require frequent market or weather information, while a relatively wealthy farmer may not use agricultural phone services (Nocezo et al., 2024).

Device ownership and device type: -

Personal ownership gives farmers greater control over when and how they access information. By contrast, farmers who borrow or share phones may face restrictions related to privacy, availability and the ability to save contacts or applications. Previous studies have identified mobiledevice ownership as an important precursor of agricultural information use (Musungwini et al., 2024). Device type may influence the range of services available. Smartphones support internet browsing, agricultural applications, socialmedia groups, video and locationbased services. Basic and feature phones, however, can support voice calls, SMS and USSD. In contexts where agricultural information is delivered through voice or SMS, device sophistication may have little effect on frequency of access. Studies in rural Africa have also reported continued reliance on basic and feature phones, particularly among smallholder farmers (McC Campbell et al., 2023).

Methodology: -**Study area: -**

Kericho County, is located in the former Rift Valley region of Kenya. It is widely recognized as one of the country's most agriculturally productive areas. The county covers approximately 2,454 square kilometers and is characterized by highaltitude terrains, fertile soils, and a favorable climate, with annual rainfall ranging between 1,800–2,400 mm and average temperatures of 18–24°C. These conditions make the county particularly suitable for tea, dairy, and coffee farming, as well as other horticultural activities. Administratively, Kericho County is divided into six sub-counties: Ainamoi, Belgut, Bureti, Kipkelion East, Kipkelion West, and Soin/Sigowet. The population is predominantly rural, with livelihoods largely dependent on smallholder agriculture. Tea farming is the dominant commercial crop, contributing significantly to both household incomes and national tea exports. Dairy farming, coffee production, and subsistence cropping complement tea cultivation, creating a diversified smallholder farming system. Despite its agricultural potential, farmers in Kericho County face multiple challenges, including limited access to extension services, fluctuating market prices, and emerging climate variability. Access to modern agricultural technologies and information is often uneven, particularly among women and youth, due to socio-cultural norms, resource constraints, and infrastructural gaps. Mobile phone penetration, however, is relatively high, offering opportunities for digital interventions aimed at enhancing agricultural productivity and market participation.

Research design: -

The study used a quantitative cross-sectional design. Data were collected from small-scale farmers at one point in time using a structured questionnaire. The design was appropriate for examining the distribution of mobilebased agricultural information access and testing associations between access frequency and selected explanatory variables.

Study population and sample: -

The target population was 1,016 small scale farmers. The analytical sample consisted of 287 smallholder farmers with complete observations for the variables included in the analysis.

The sample size was determined using Yamane's (1967) formula for a finite population: -

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

Where n is the required sample size, N is the target population, and e is the level of precision. The farmers represented small-scale agricultural producers who either owned, shared or had access to mobile phones. The unit of analysis was the individual farmer.

Variables and measurement: -

The dependent variable was the frequency of accessing agricultural information through mobile phones.

It was categorized into three levels: -

- Regular access: frequent or routine access to agricultural information through a mobile phone.
- Occasional access: irregular or less frequent access.
- Never: no mobile-based access to agricultural information.

The explanatory variables were grouped into socioeconomic and technological characteristics as shown in Table 1 below.

Table 1: Categories of variables

Variable group	Variable	Categories
Socio-economic	Age	Below 35 years; 36–55 years; 56 years and above
Socio-economic	Education	Illiterate; primary; secondary; college; graduate
Socio-economic	Occupation	Farming only; farming and service; farming and business
Socio-economic	Landholding	Below 1 acre; 1–2 acres; above 2 acres
Socio-economic	Income	Below KES 100,000; KES 101,000–500,000; KES 501,000 and above
Technological	Mobile ownership	Owner; non-owner
Technological	Device type	Basic feature phone; internet-enabled feature phone; smartphone

The categories were based on the available survey data. Because the income category of KES 501,000 and above contained no respondents in the regularaccess group, the results for that variable were interpreted cautiously.

Data analysis: -

Descriptive cross-tabulations were used to compare the percentage of farmers reporting regular, occasional and never accessing mobilebased agricultural information across categories of each explanatory variable. Pearson's chi-square test was used to assess whether the observed distribution of access frequency differed significantly across categories.

The test statistic was calculated as: -

$$X^2 = \sum \frac{(O - E)^2}{E}$$

where O represents the observed frequency and E represents the expected frequency.

Because some tables contained small expected cell counts, Fisher's exact test was also reported. Fisher's exact test is appropriate when the assumptions of the Pearson chi-square approximation are not adequately met. A significance

level of $\alpha = .05$ was used. Linear-by-linear association tests were conducted for variables whose categories had a meaningful order, particularly age and access frequency. The analysis was bivariate. Therefore, the reported associations should not be interpreted as causal effects or as adjusted predictors. Multivariable logistic or ordinal regression would be appropriate in future analysis to estimate independent effects while controlling for confounding variables.

Results: -

Age and frequency of access: -

Age was significantly associated with the frequency of mobilebased agricultural information access. The Pearson chi-square test was significant, $\chi^2 (4) = 40.876$, $p < .001$, and Fisher's exact test also indicated a significant association, $p < .001$. The linear-by-linear association was significant, $p < .001$, indicating a clear directional pattern across age groups. Farmers below 35 years recorded the highest regular access rate at 72.0%. Among farmers aged 36–55 years, 48.1% accessed information regularly and 50.8% did so occasionally. Farmers aged 56 years and above reported the lowest regular access rate, at 10.4%, while 89.6% accessed information occasionally.

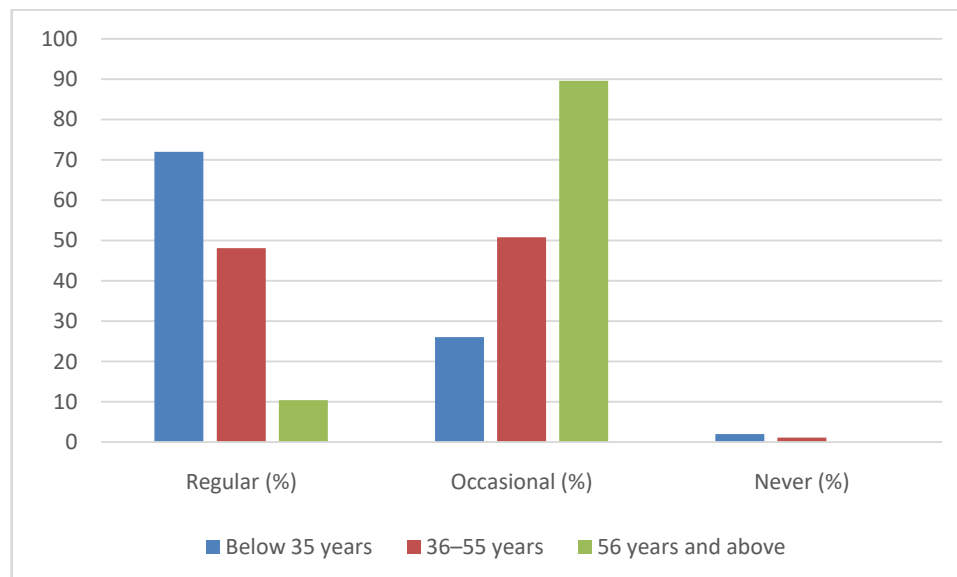


Figure 1: Age and frequency of access

These findings indicate a pronounced age-related digital engagement gap. Younger farmers were substantially more likely to access agricultural information regularly, while older farmers mainly accessed it occasionally.

Education and frequency of access: -

Educational attainment was significantly associated with mobilebased agricultural information access. Pearson's chi-square test produced $\chi^2 (8) = 31.905$, $p < .001$, and Fisher's exact test was also significant, $p < .001$. However, the linear-by-linear association was not significant, $p = .140$, suggesting that the relationship was not a simple increasing or decreasing trend across education levels. Illiterate farmers primarily accessed information occasionally, with 91.7% reporting occasional access and only 8.3% reporting regular access. Regular access was highest among primary school graduates at 60.3% and formal graduates at 71.4%. However, the graduate category consisted of only seven respondents, so the percentage should be interpreted cautiously.

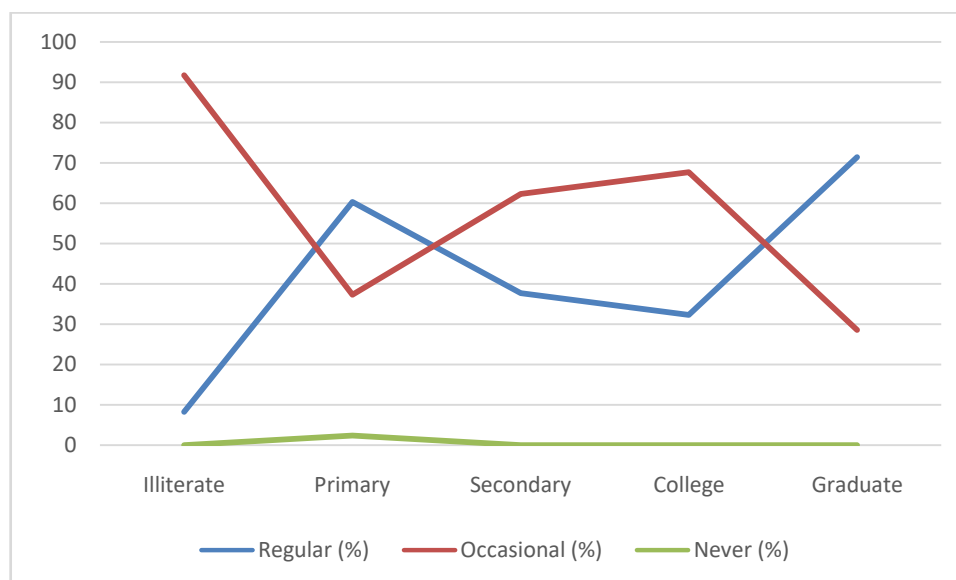


Figure 2: Education and frequency of access

The non-linear pattern may reflect differences in farming involvement, occupation, age, access to services and the type of mobile channels used. The results nevertheless demonstrate that literacy and educational background are important considerations in designing agricultural information services.

Occupation and frequency of access: -

Primary occupation was significantly associated with access frequency. Pearson's chi-square test was significant, $\chi^2(4) = 25.495$, $p < .001$, and Fisher's exact test was also significant, $p < .001$. Farmers combining farming with commercial business reported the highest regular access rate, at 80.6%. Farmers engaged solely in farming recorded a regular access rate of 43.4%, while those combining farming with service employment recorded the lowest rate, at 20.0%.

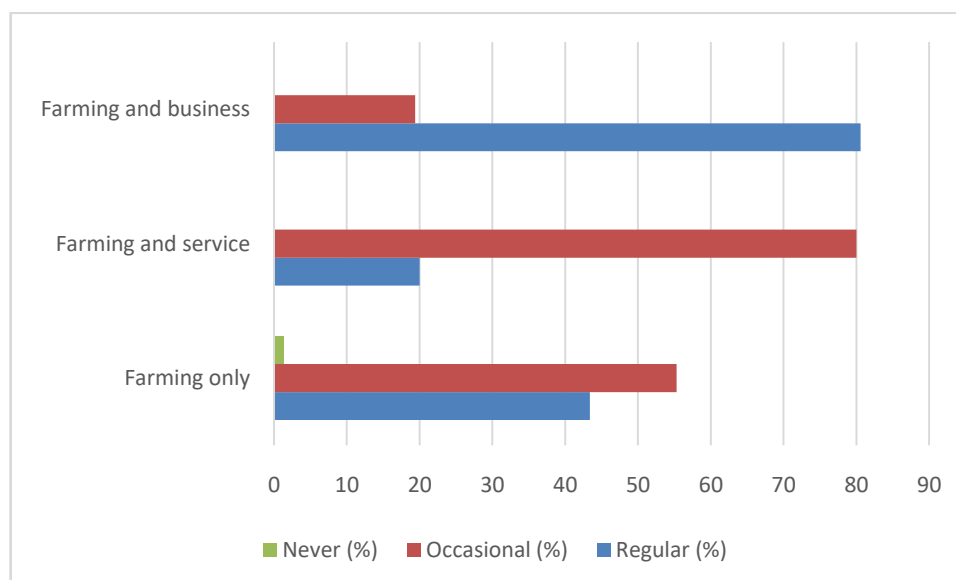


Figure 3: Occupation and frequency of access

The high regular access among farmers engaged in business may reflect their need for timely information on prices, buyers, input suppliers, transport and financial transactions. However, occupation may also be related to age, education and income; therefore, its independent effect cannot be established from the bivariate results alone.

Landholding size and frequency of access: -

Landholding size did not meet the conventional significance threshold. Pearson's chi-square test produced χ^2 (4) = 7.635, $p = .106$, while Fisher's exact test produced $p = .054$. Farmers with less than one acre had the highest regular access rate, at 51.0%, followed by those with 1–2 acres at 44.6%. Farmers with more than two acres had a lower regular access rate of 32.6%. Although the Fisher's exact result was close to .05, the evidence was insufficient to reject the null hypothesis at the predetermined significance level.

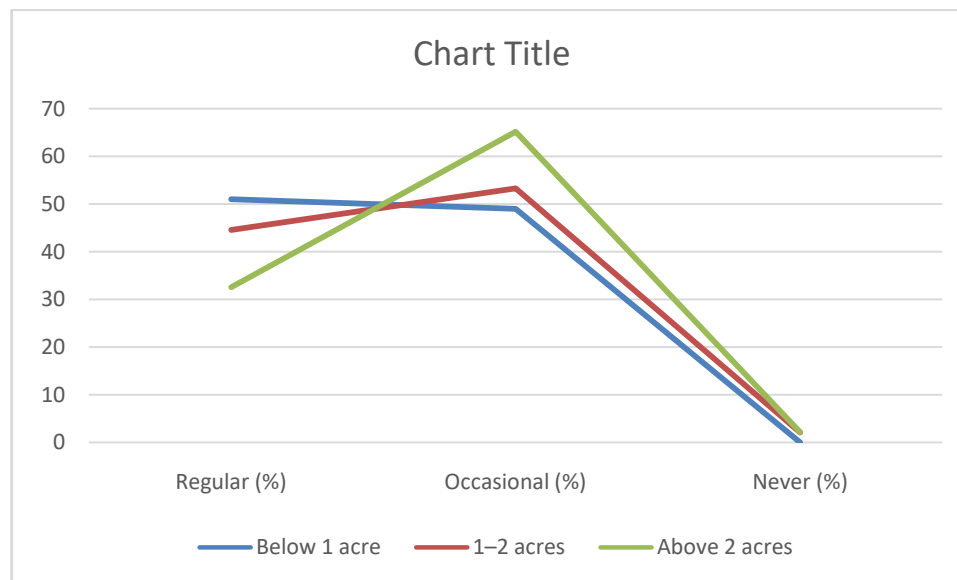


Figure 4: Landholding size and frequency of access

The pattern suggests that larger landholding does not necessarily translate into more frequent mobile information access. Information needs may be high among very small farmers because they depend heavily on timely market and production information, while larger farmers may use other communication channels or rely on established networks.

Income and frequency of access: -

Income category was not significantly associated with access frequency. Pearson's chi-square test produced χ^2 (4) = 6.693, $p = .153$, and Fisher's exact test produced $p = .093$. Among farmers earning below KES 100,000, 47.4% reported regular access. The corresponding figure for farmers earning KES 101,000–500,000 was 41.7%. None of the farmers in the KES 501,000 and above category reported regular access, although the small or empty cells make this category unsuitable for strong statistical interpretation.

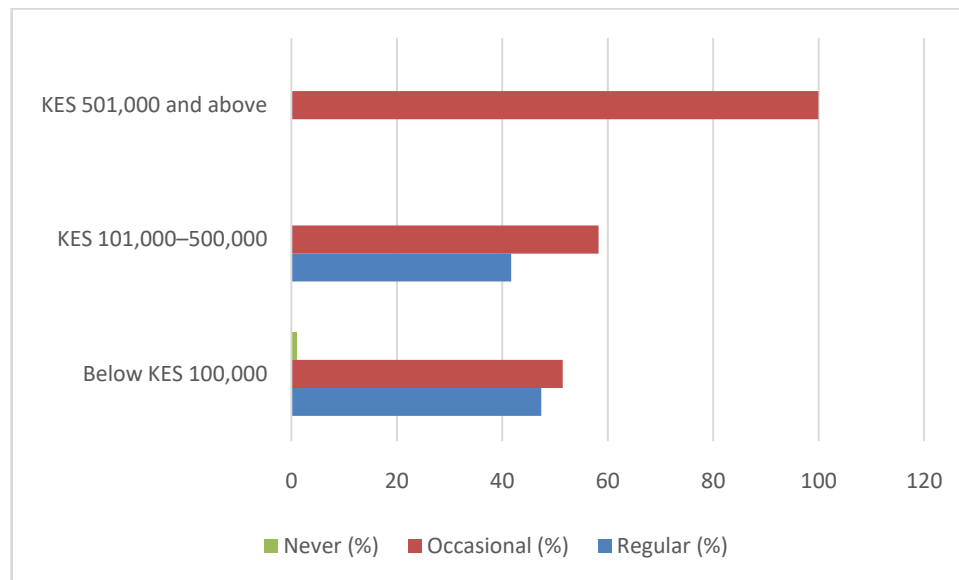


Figure 5: Income and frequency of access

The absence of a significant income relationship may indicate that access depends more on phone ownership, information needs and service design than on income alone. It may also reflect limitations in income measurement, including seasonal variation and possible under reporting.

Mobilephone ownership and frequency of access: -

Personal phone ownership was significantly associated with access frequency. Pearson's chi-square test produced $\chi^2(2) = 12.727$, $p = .002$, while Fisher's exact test produced $p = .001$. Owners recorded a higher regular access rate than non-owners: 47.1% compared with 33.3%. Nonowners also recorded a higher proportion of farmers who never accessed mobile agricultural information, 8.3%, compared with 0.4% among owners.

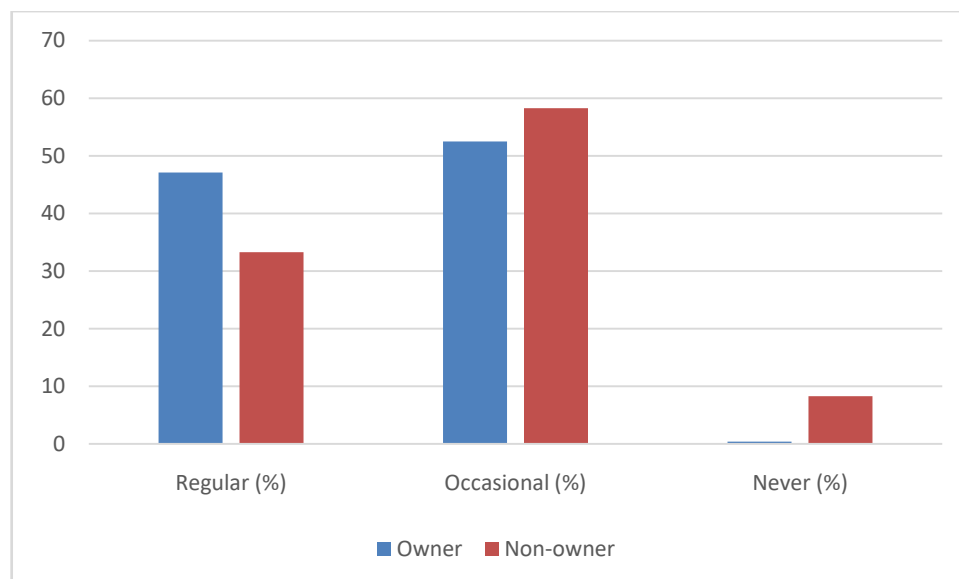


Figure 6: Ownership and frequency of access

The result suggests that personal ownership enhances the opportunity for regular access. Farmers who do not own a phone may depend on borrowing, sharing or assistance from other people, which can reduce privacy, convenience and frequency of use.

Device type and frequency of access: -

Device type was not significantly associated with information access frequency. Pearson's chi-square test produced $\chi^2(4) = 3.846, p = .427$, and Fisher's exact test produced $p = .448$. Regular access rates were similar across device categories: 48.0% for basic feature phones, 37.5% for internet-enabled feature phones and 47.2% for smartphones.

Table 2: Type of device and frequency of access

Device type	Regular (%)	Occasional (%)	Never (%)
Basic feature phone	48.0	51.3	0.7
Internet-enabled feature phone	37.5	62.5	0.0
Smartphone	47.2	50.6	2.2

The similarity across device types suggests that the availability of agricultural information services, rather than advanced hardware alone, may be more important. Basic phones can support voice, SMS and USSD services, which may be sufficient for many agricultural information needs.

Summary of statistical findings: -**Table 3: Summary**

Variable	Pearson χ^2	df	Pearson p	Fisher's exact p	Decision at $\alpha = .05$
Age category	40.876	4	<.001	<.001	Significant
Education level	31.905	8	<.001	<.001	Significant
Primary occupation	25.495	4	<.001	<.001	Significant
Mobile ownership	12.727	2	.002	.001	Significant
Landholding size	7.635	4	.106	.054	Not significant
Income category	6.693	4	.153	.093	Not significant
Device type	3.846	4	.427	.448	Not significant

Overall, age, education, occupation and mobile ownership were significantly associated with the frequency of mobile-based agricultural information access. Landholding size, income and device type were not statistically significant.

Discussion: -**Age related differences in access: -**

The strong association between age and information access suggests that digital agricultural extension is not equally accessible across generations. Younger farmers may be more comfortable navigating digital services, searching for information and integrating mobile communication into daily farming and business activities. The result is consistent with evidence that younger and more educated farmers who own mobile devices are better positioned to adopt mobile technologies for agricultural information seeking and sharing (Musungwini et al., 2024). The low regular access rate among farmers aged 56 years and above does not necessarily indicate a lack of interest in agricultural information. It may reflect barriers related to literacy, unfamiliarity with digital interfaces, language, disability, trust or a preference for interpersonal communication. Digital extension programmes should therefore avoid assuming that non-use is caused by a lack of information demand. Age-sensitive approaches could include voice messages, interactive voice response, local-language services, demonstrations by extension personnel and assisted access through farmer groups. FAO (2023) notes that digital literacy and insufficient digital human capital development remain major constraints to benefiting from digital agricultural extension and advisory services.

Education and the need for inclusive design: -

Education was significantly associated with access frequency, although the relationship was non-linear. This finding suggests that basic literacy may be sufficient for some mobile services, while more complex digital tools may require higher levels of education and digital competence. The relatively high regular access among primary school graduates indicates that advanced formal education is not a prerequisite for mobile-based agricultural information use. The non-linear pattern also warns against treating education as a simple proxy for technology readiness. A farmer with limited formal education may use voice services regularly, whereas a more educated farmer may not be involved in farming or may have little need for agricultural information. Consequently, service design should consider practical literacy, language and user experience in addition to years of schooling. Agricultural platforms should provide content through

multiple formats, including voice, SMS, visual material and human support. Services that depend exclusively on text-heavy applications may exclude farmers with limited literacy or limited experience with smartphones.

Occupational diversification and information demand: -

Farmers who combined agriculture with commercial business had the highest regular access rate. This finding may be explained by a stronger need for timely information. Commercially active farmers may monitor commodity prices, input costs, customer demand, transport conditions, financial services and business contacts. Mobile phones support these activities simultaneously, making the device a production and enterprisemanagement tool. The finding also supports a broader understanding of agricultural information use. Farmers do not necessarily access information only for production decisions. Their needs may include marketing, logistics, financial transactions, procurement and customer relations. Digital extension programmes should therefore integrate production information with market and enterprise information. The low regular access rate among farmers combining farming with service employment may reflect time constraints or a weaker connection between mobile agricultural services and their farming activities. This result requires further investigation because occupation may interact with age, education and farm enterprise.

Farm scale and income: -

Landholding size and income were not statistically significant. This result challenges the assumption that farmers with larger farms or higher incomes necessarily access mobile agricultural information more frequently. Smallholders with limited land may have strong information needs because they face narrow production margins and greater exposure to market and climate risks. The nonsignificant Fisher's exact result for landholding size, $p=0.054$, suggests that the relationship may deserve further study with a larger sample or more detailed landsize categories. Similarly, the non-significant income result may reflect measurement limitations. Agricultural income is often seasonal, diversified and difficult to estimate accurately. A single income category may therefore fail to capture the resources available to a household at the time of phone use. Future studies should consider more direct measures, including monthly expenditure on airtime and data, ability to pay for repairs, access to electricity, household asset ownership and the cost of using agricultural services.

Ownership matters more than device sophistication: -

Mobilephone ownership was significant, while device type was not. This distinction is important. Having personal access to a phone may be more influential than owning an advanced device. Owners can access information when needed, store contacts, receive alerts and communicate privately. Nonowners may depend on others and may not be able to access timesensitive information. The absence of a significant devicetype relationship suggests that basicphonecompatible services remain essential. In several rural African contexts, basic and feature phones continue to be widely used, while high data costs, poor internet connectivity and limited smartphone skills restrict smartphone adoption. Therefore, agricultural information services should not be designed exclusively around smartphone applications (McCampbell et al., 2023). Voice calls, SMS and USSD can reach farmers who do not have smartphones or reliable internet access. Smartphone applications may provide additional functions, but they should complement rather than replace basicphone channels. This approach is also consistent with the evidence that the high cost of devices and internet access, poor network availability and limited digital skills remain barriers to mobile technology use among smallholders (Mapiye et al., 2023).

Implications for digital agricultural extension: -**The findings support five practical implications: -**

1. Use agesensitive delivery models. Older farmers should be reached through voice-based, assisteddigital and locallanguage services rather than textonly platforms.
2. Design for different literacy levels. Agricultural information should be available through SMS, voice, simplified language, demonstrations and pictorial or video formats.
3. Prioritize ownership and access. Interventions should support affordable personal access, community phone points, farmergroup access and shared service models for non-owners.
4. Maintain basicphone compatibility. SMS, USSD and voice services should remain central even when smartphone applications are introduced.
5. Integrate farming and business information. Farmers need market, price, finance, logistics and production information within connected service ecosystems.

Conclusion: -

This study examined the relationship between socioeconomic and technological characteristics and the frequency with which smallholder farmers accessed agricultural information through mobile phones. Age, education, occupation and

mobilephone ownership were significantly associated with access frequency. Younger farmers, farmers combining agriculture with commercial business and personal phone owners recorded higher regular access rates. Landholding size, income and device type were not statistically significant. These findings suggest that frequent access is determined more by demographic characteristics, information needs and direct control over a device than by farm scale, economic category or ownership of a technologically advanced handset. The findings do not imply that income; land size or smartphones are irrelevant. Rather, they indicate that these factors did not explain significant differences in access frequency within this sample. The results should also be interpreted as associations rather than causal effects because the analysis was cross-sectional and bivariate. Digital agricultural extension should therefore prioritize inclusive design. Services should accommodate older farmers, farmers with limited literacy and non-owners, while retaining SMS, USSD and voice functions for basic phones. Smartphone applications can provide additional services, but they should not replace accessible, lowcost communication channels.

Recommendations: -

Based on the findings, the following recommendations are proposed: -

1. Agricultural extension agencies should develop separate communication strategies for younger and older farmers.
2. Voicebased and locallanguage services should be expanded for farmers who experience difficulty reading or navigating textbased platforms.
3. Digital literacy training should be integrated into farmer training, extension meetings and cooperative activities.
4. Mobile agricultural services should remain compatible with basic and feature phones through SMS, USSD and voice communication.
5. Farmer organizations should establish assistedaccess mechanisms for farmers who do not own mobile phones.
6. Digital platforms should combine production advice with market prices, input information, finance, transport and buyer contacts.
7. Future studies should use multivariable ordinal or multinomial regression to identify the independent effects of age, education, occupation, ownership and other factors.
8. Future research should include gender, network quality, mobile expenditure, digital literacy, language, electricity access, type of agricultural information sought and perceived usefulness.

Limitations: -

The study has several limitations. First, the cross-sectional design does not establish causality. Second, the analysis was based on bivariate associations and did not control for possible confounding variables. For example, age may be related to education, occupation, phone ownership and farming experience. Third, the study measured device type but did not provide detailed information on network quality, data expenditure, digital literacy or the specific mobile services used. Fourth, some categories contained small numbers of observations, including the highest income group and the graduate education group. Finally, the accessfrequency categories may conceal differences in the intensity, purpose and quality of information use. Despite these limitations, the analysis provides useful evidence that mobile agricultural information access is socially and technologically differentiated. It also highlights the need to distinguish between owning a device and being able to use mobile technology effectively for agricultural decisionmaking.

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