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Use of mobile telecommunication technologies in access, use, and exchange of agricultural information among small-scale farmers in Ol'joro-Orok sub-county, Nyandarua County, Kenya

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Abstract:

One of the challenges facing small-scale farmers is the dearth of timely and high-quality agricultural information. The aim of the study was to investigate the use of mobile communication technologies in the access, use, and exchange of agricultural information among small-scale farmers in Nyandarua County and to explore how mobile technologies can be integrated into the county's agricultural information systems to help farmers access timely information. The study used a descriptive survey design. Data was collected from 353 farmers and seven agricultural extension officers through questionnaires and structured interviews. The findings revealed that the that the majority of farmers owned mobile devices, which they utilized to get a variety of agricultural information through voice messages, emails, SMS, and mobile apps. The optimal utilization of mobile communication devices by farmers is, however, hampered by poor internet connectivity, costly mobile phones and data bundles, a lack of awareness and training, insufficient access to electricity, and a lack of support from local and national governments. The study concludes that the increase in usage of mobile communication devices among farmers provides many opportunities for agricultural information access, use, and exchange if it were not for the infrastructural challenges. In order to enhance the integration of mobile services with agricultural systems and provide farmers with agricultural information, the study recommends setting up county agricultural data centers. To effectively address infrastructural issues, the county government should work more closely with various stakeholders.

Keywords: Agricultural information, Agriculture information systems, M-services, Nyandarua county agricultural systems, agricultural data centres.

Introduction: Mobile communication technologies are rapidly penetrating rural communities and becoming more appropriate for underprivileged communities; they are

used to access and exchange agricultural information and extension and advisory services (World Bank, 2017). ICTs give farmers timely access to high-quality information, lower the cost of access for farmers and extension agents, remove institutional barriers to information provision, and present a variety of opportunities for rural populations (Spielman et al., 2021; FAO, 2017). Mobile technologies come in various forms; network technologies, the global system for mobile technology (GSM), wireless fidelity, and smart devices like iPhones, tablets, and smartphones (Khan, 2023; Triggs, 2022; Tao et al., 2021; Yang and China, 2021). Modern technologies such as drones collect agricultural information about soil types, water systems, crop images, and pest infestations and make it available to farmers, agriculture experts, and agronomists (Hafeez et al., 2022). Productivity is increased when farmers have access to such high-quality information attributable to modern technologies. The use of digital technologies will help revolutionize agriculture and aid in poverty reduction (FAO and ITU, 2022). In Africa, several stakeholders, such as the African Union, the Alliance for a Green Revolution in Africa (AGRA), FAO, and the World Bank, among others, have advocated for the adoption of information and communication technology and the digitization of agricultural systems (FAO and ITU, 2022; MoALFC, 2021; AGRA, 2019). FAO and ITU (2022) contend that digital technologies are present in sub-Saharan African nations to various degrees, and most countries do not have basic access. Despite the importance of mobile communication technologies in the transformation of agriculture, several challenges need to be addressed. Factors such as internet connectivity, availability of appropriate content, literacy levels, and the digital divide all influence the use of digital technology for development in Sub-Saharan Africa (AGRA, 2019). The aforementioned challenges influence the uptake and use of digital technology.

Methodology: The research was conducted in Nyandarua County, Ol'joro-Orok sub-county, Kenya. The study used a quantitative research approach using a descriptive survey design. The population of the study was comprised of small-scale farmers and agricultural extension officers in Ol'joro-Orok sub-county. The random sampling technique enabled the study to source data from farmers from five wards in Ol'joro-Orok sub-county. Due to the small number of agriculture extension officers, all seven agricultural officers working in the Ol'Joro-Orok subcounty agriculture office were incorporated into the survey. Data from 353 small-scale farmers was collected through self-administered questionnaires, while structured interviews were used to collect data from the extension officers.

Study findings and discussions: Mobile device ownership among small-scale farmers was high at 93.2 percent and extension officers at 86 percent. The findings accentuate the acceptance of mobile technologies among farmers and extension officers in the Ol'joro-Orok sub-county. The rise in mobile phone ownership is attributed to the continued expansion of telecommunication infrastructure and the accessibility of mobile phones to low-income households in rural Kenya (Krell et al., 2021; World Bank, 2017).

Mobile devices ownership and gender: There was a disparity in mobile ownership among small-scale farmers in the Ol'joro-Orok sub-county; men (62.6%) had more mobile communication devices than women (37.4%). Mobile phone ownership is a vital tool for

women's empowerment (The International Telecommunication Union, 2020). The disparity in ownership among women therefore makes them miss opportunities associated with mobile communication technology, such as access to information and credit facilities offered through mobile money apps, among others. These findings emphasize the gap in mobile technology uptake between men and women.

Types of mobile communication devices owned by the respondents: Mobile communication devices come in a variety of designs. The difference lies in their functionalities, storage capacity, and speed. Small-scale farmers owned different types of mobile communication devices, as follows: 62.6% smartphones, 53.3% ordinary mobile phones, 27.2% tablets, and 17% e-readers. Similarly, 86% of the agriculture extension officers interviewed owned smartphones, and one (14%) also had a tablet. Smartphones were prevalent among farmers and agriculture extension officers. Smartphones offer advanced features such as cameras, global positioning systems (GPS), multimedia messaging services (MMS), internet connections, and the ability to download a variety of apps (World Bank, 2017). As a result, they're in a better position to access and share information. Even though ordinary mobile phones have limited functionality (World Bank 2015), a significant number 53.3% of farmers own them. Regular mobile phones are less expensive, making them more accessible to farmers. However, due to their basic functions, they have limited access to information. Farmers who own regular phones are missing out on mobile services available through smartphone-based applications.

Use of mobile communication devices in access and exchange of agricultural information: A significant number of the farmers 80.7% used mobile devices to access and exchange agricultural information, 19.3% did not. The study used the Pearson correlation coefficient (r) to explore the relationships between age, level of education, possession, and use of mobile communication devices. The results revealed that the respondents' age and education had no correlation on their use of mobile communication devices in this study. However, there was a significant association between mobile device ownership and use by respondents with a P-value (P =.01). As a result, ownership of mobile devices can be regarded as a factor in the use of the devices among small-scale farmers.

Types of Agricultural information accessed by respondents through mobile communication devices: The farmers accessed various types of agricultural information, including market information, new seed varieties and certified seeds, new farming technology, new inputs (fertilizers and pesticides), climate information, post-harvest information, and financial information. On the other hand, agriculture extension officers used mobile phones to communicate and share information with the farmers. According to the extension officers' mobile communication devices, has enabled them to improve their efficiency in service delivery.

Mobile services accessed by small-scale farmers: Mobile services accessed by farmers included Short Messaging Services (55.2%); social media networks (52.1%); mobile applications (51.3%); electronic mails (32.1%; voice messages (26.1%). Other m-services

indicated by extension officers included e-payment services adopted by the county government for offering subsidized services to farmers. The extension officers also used mobile apps such as the Arifu platform, MOALF WhatsApp group, and ViaziSoko apps to share and interact with farmers and other stakeholders. The m-services, according to the extension officers, have increased efficiency in service delivery since they were a quick and inexpensive way to communicate with farmers. The finding revealed was that the county government of Nyandarua is slowly incorporating the use of mobile services into its agricultural services, although some services, such as e-mail and voice services, were underutilized.

Level of use of mobile communication devices in access of agricultural information: Farmers used mobile communication devices to get the information they required, but the extent varied. Ordinary mobile phones had a mean of 2.68 and a SD of 1.650, suggesting that they were the most frequently used devices. Regular mobile phones are presumed to be simple and easy to use because of their basic features. They are also less expensive compared to other devices such as tablets, e-readers, and smartphones, making them more accessible. Smartphones were the second most popular among the farmers, with a mean of 3.05 and a standard deviation of 1.688; however, they were the most preferred among extension officers. A considerable number (36%) of farmers had never used smartphones. This could be due to several factors; for instance, they are more expensive than regular phones, which may affect their popularity. The use of tablets was low among farmers, with a mean of 3.7 and a standard deviation of 1.508. However, few of the farmers owned tablets, which may have influenced their use. The use of e-readers among farmers had a mean score of 4.08 and a standard deviation of 1.305. The level of use of tablets and e-readers among farmers could have been affected by accessibility since few farmers owned e-readers and tablets. The findings demonstrated the rise in the use of mobile devices among farmers compared to other traditional sources of information such as radio and TV.

The efficiency of mobile communication devices in access, use exchange of Agricultural information: The reliability of mobile devices in accessing and sharing information received a high rating from farmers. The variable had a mean of 2.58 and a standard deviation of 1.585. While provision of current information had a mean of 3.12 and a standard deviation of 1.597. The farmers' ratings on the ease of access of mobile communication devices showed the opinion was divided, with 41.1% ranking them as efficient and 41.7% rating them as inefficient. While a sizable number of farmers, 17.3%, were undecided. The availability of mobile devices is affected by such factors as the cost of the devices. Krell et al. (2021) posit that the cost of mobile phones impedes mobile ownership, especially among women. The promptness of the mobile devices didn't receive a positive rating, which had a mean of 3.50, with a standard deviation of 1.506. Over 50% of the farmers were not satisfied with the efficiency of the devices in terms of response rate. On the contrary, the extension officer indicated that mobile devices were effective in providing agricultural information to farmers. They hailed the SMS service for its ability to deliver messages to a large number of farmers in the shortest amount of time. The cost of

mobile devices compared to other sources of information had a mean of 3.39, with a standard deviation of 1.526. A significant number 48 percent of farmers noted mobile devices were costly compared to other sources. This included the cost of the mobile devices, bundles, and power supply for charging the devices. The use of mobile devices is linked to ownership, and the cost may be a barrier to their use.

The importance of mobile communication devices among small-scale farmers: The significance of regular mobile phones had a mean of 2.42 and a standard deviation of 1.634. Ordinary mobile phones are rudimentary GSM-enabled devices with minimal capabilities and limited functionality, but they had the highest rating. The extension officers, noted they are easily accessible, easy to use, and less expensive. They are less complicated to maintain than smartphones, and the phone's battery can last for up to three days. Smartphones had a mean of 2.91 and a standard deviation of 1.692. They received a higher rating compared to e-readers and tablets. The agriculture extension officers elucidated that smartphones are critical for sharing information and general communication. Both tablets and e-readers didn't receive positive ratings in terms of their significance. Tablets had a mean of 3.33 and a standard deviation of 1.612. While e-readers had a mean of 3.69 and a standard deviation of 1.422, however, only 27.2% of farmers had tablets, and 17% owned e-readers, which may have influenced their perceptions of the devices.

Factors that influenced the use of mobile communication devices in the access, use, and exchange of agricultural information: Combinations of factors impacted small-scale farmers' use of mobile communication devices.

The availability of reliable power supply was a major concern. The Kenyan government has been connecting rural communities to electricity through the last mile project, yet there is still a shortage in power supply. Mobile devices rely on power and must be recharged regularly, and a lack of reliable electricity makes it difficult to use them. Solar power, for example, should be considered as a potential alternative. The study revealed farmers had a major influence on the use of mobile devices among their peers. It illustrates the role that social systems play in the diffusion and adoption of new technologies, which is explained by Rogers' DOI theory.

The availability of low-cost mobile devices affected 45.6% of the farmers. There is a strong link between mobile devices' usage and ownership. Therefore, the cost of mobile devices may impact their uptake among small-scale farmers. The potential of mobile devices to provide easy and quick access to information influenced 46.5% of farmers. Mobile devices are presumed to have advantages over other traditional sources of information such as newspapers, agricultural publications, and libraries because they provide easy and quick access to agricultural information. Internet connectivity influenced 44.5% of respondents. The reliability and cost of the internet have been a challenge in rural Kenya (Krell et al.2021). Family and friends are part of the social system and influenced 39.9% of respondents to use mobile devices. The findings confirm the role of the social system in the spread of technology. The social system as advanced in Roger's (1983) theory

was still relevant in the diffusion of mobile devices among small-scale farmers. The ease of use of mobile devices was mentioned by 39.7% of farmers as a factor that influenced their use. The findings show that more than 50% of the farmers were not affected by the complexity of mobile devices. It is worth noting that 57.5% of the participants were aged between 18 and 41 years. This age band could be presumed to be well versed in digital skills and can comfortably use and navigate the digital realm. Training and awareness influenced 38.8% of farmers. Training can help reduce the uncertainty associated with the adoption of mobile technology. Although education did not have a significant relationship between small-scale farmers' and mobile device usage, the extension officers noted that literacy levels among elderly farmers influenced their use. According to the extension officer, the elderly farmers were only able to operate basic phones with limited capabilities compared to smartphones.

Challenges experienced by small-scale farmers in the use of mobile devices in the access, and use, of agricultural information: Several barriers remain in the way of fully realising their potential including internet connectivity and the high cost of data bundles. The Nyandarua County government's integrated development plan (2018), had also highlighted the lack of a 4G network as a cause of inconsistent connectivity. Lung'ahi (2014) and Thuo, Njoroge, and Wamalwa (2019) also cited inadequate network connectivity in Laikipia and Murang'a, highlighting the difficulty of internet access in rural Kenya. The inadequacy of the power supply was identified as a challenge by 49.6% of respondents due to its high cost and unreliable nature. Mobile devices require a consistent source of electricity to function because they are energy-dependent. Lack of adequate support from the national and county governments was a concern for 47.9% of the respondents. Agriculture is a devolved function whose growth is overseen by the county governments. As a result, the county government should help in terms of funding ICT initiatives, capacity building through training, employment of professionals and experts, and improvement of the infrastructure. Other challenges raised by farmers were the high cost of mobile devices, a lack of training on how to use smartphones, and a lack of awareness about how to utilise mobile communication devices. The above challenges hinder the adoption and use of mobile devices among farmers. Therefore, farmers are missing the opportunities presented by mobile technologies. The challenges of ICT infrastructure are well documented in Nyandarua County's Integrated Development Plan, CIDP2, (2018) and this research validates them. The study agreed with Dhehibi et al. (2020); Thuo, Njoroge, and Wamalwa (2019) that small-scale farmers in rural areas faced challenges due to infrastructural limitations and defects as well as socio-economic, institutional, and environmental factors. Therefore, insufficient infrastructure impedes the use of ICTs in rural regions.

Integration of mobile communication devices into Nyandarua county agriculture systems: There was a consensus among 87.5% of the farmers that the county government should integrate mobile communication technologies into its agricultural systems. The inclusion of mobile technologies into the Nyandarua agriculture systems would help

disseminate timely information to rural farmers. It would provide farmers access to high-quality data to help them make better decisions, increase productivity, and manage their farms better.

There were several m-services suggested by farmers that the county government should integrate with the agricultural systems. Over half, 54.1% of small-scale farmers suggested mobile app services, though the extension officers interviewed reported that mobile apps such as Viazi Soko, Arifu Platform, and e-payment platform are already in use by the county government. The findings revealed a gap in awareness of the existence of mobile services among farmers, as reported by the extension officers. Alerting services were suggested by 50.7% of the respondents to be included in the M-services, while 50.4% wanted the county to introduce SMS services. A further 40.5% wanted e-mail services. However, the county government was already using SMS services, as reported by the extension officer. This demonstrated a lack of awareness among farmers of the available m-services offered by the county government. A similar report on the lack of awareness among farmers about m-services was reported by Lung'ahi (2014) in the Sipili Ol'moran ward, where farmers were unaware of the Soko+ SMS service. The findings demonstrated a communication gap on the available m-services that resulted to the underutilisation of the m-services among farmers.

Improvement of the mobile devices in access, use and exchange of agriculture information among small-scale farmers: The study found that small-scale farmers in Ol'joro-Orok sub-county had embraced the use of mobile devices however, the usage was low. As a result, there was a need to enhance their use. There were several proposed strategies on how the county government could improve the use of mobile devices among farmers including frequent training of the farmers; improvement of the ICT infrastructure. Agriculture is a devolved function, and it is the responsibility of the county government to invest in the proper ICT infrastructure. To harness the full potential of new ICT innovations requires favourable government policies and investment in telecommunication infrastructure (Omulo and Kumeh, 2020). The request for the establishment of data centres and information centres was suggested by 56.7% of respondents. The extension officers noted that the county government should establish well-equipped data centres at the ward levels. This would bring mobile services closer to farmers and make agricultural information dissemination easier and more effective. The data centre should become the county's agricultural information coordination hub, delivering much-needed information and bridging the knowledge gap among rural farmers. There was a need to provide cheaper and more affordable mobile devices to farmers. Various stakeholders and the county government can devise techniques to provide subsidized mobile devices, similar to how the government frequently provides input subsidies to farmers.

A total of 45.3% of the respondents suggested the provision of mobile services. However, as stated previously, the county government had SMS and e-payment services but a large number of farmers were unaware of the available m-services such as SMS, mobile apps, and e-payments, indicating a gap in communication.

Mobile communication technologies cannot be successfully integrated into agricultural systems without adequate ICT infrastructure, such as reliable internet access, a consistent power supply, qualified employees, ICT specialists, and supportive ICT and information policies. The county government should therefore invest in proper infrastructure that supports mobile technologies.

Conclusions: The study concludes that there was a high penetration of mobile devices among small-scale farmers, which was a positive indicator of mobile technology acceptance and could have an impact on agriculture. However, there was a glaring disparity in mobile device ownership between women and men, which was a concern. Despite the opportunities provided by mobile technology to small-scale farmers, several obstacles stand in their way of realizing their full potential, such as poor internet connectivity and the high cost of data bundles; inadequate power supply; insufficient support from both national and county governments; and the high cost of mobile communication devices. Some of the challenges are institutionally based, such as inadequate power supply and poor internet connectivity being beyond farmers' control, which necessitates national and county governments developing possible solutions to help mitigate the challenges. Despite the above problems, mobile devices offer opportunities for small-scale farmers to access timely agricultural information, and there should be concerted efforts to improve their usage.

Recommendations:

1. The study recommends setting up data centers in the sub-counties to act as the county government's agricultural information hubs and coordination centers. This will help farmers access information with greater ease.
2. To address the issue of an unstable power supply, which hinders the usage of mobile devices in rural communities, the county government of Nyandarua as well as the national government should make sure that every household in the county is connected to a dependable supply of electricity.
3. Agriculture is a devolved function in Kenya; hence, the county government should invest funds in training and hiring more agriculture extension officers in order to increase capacity.

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