Journal of
Online and Distance Learning
(JODL)

Requirements for the Development of a Mobile Teaching-Learning Framework for Bridging the Agricultural Extension Gap: A Case Study of the Kigezi Sub-Region

CARI

Journal of Online and Distance Learning
ISSN: 2789-3049 (Online)
Vol.5, Issue No.1, pp 1 - 18, 2025

www.carijournals.org

Requirements for the Development of a Mobile Teaching-Learning Framework for Bridging the Agricultural Extension Gap: A Case Study of the Kigezi Sub-Region

[1*]Florah Kobusiingye, [2]Richard Ssembatya, [2]Fred Kaggwa, Annabella Habinka Ejiri

[1]PhD student: Faculty of Computing and Informatics, Mbarara University of Science and Technology, Uganda

[2]Senior Lecturer: Faculty of Computing and Informatics, Mbarara University of Science and Technology, Uganda

[3]Associate Professor: Faculty of Computing and Informatics, Mbarara University of Science and Technology, Uganda

https://orcid.org/0009-0009-5043-1021

Accepted: 26th Feb, 2025 Received in Revised Form: 26th Mar, 2025 Published: 27th Apr, 2025

ABSTRACT:

Purpose: Agricultural extension services are critical for improving farming practices and productivity in rural regions like the Kigezi sub-region of Uganda. Despite their importance, these services face challenges such as limited accessibility, high costs, and lack of timely information. This study evaluates the strengths and weaknesses of current agricultural extension frameworks in Kigezi.

Methodology: A quantitative approach was employed, gathering data from 235 agricultural stakeholders: farmers (79.3%), extension officers (12.5%), input suppliers (3.3%), production officers (2.7%), and researchers (2.2%). Surveys assessed the accessibility, effectiveness, and challenges of existing extension services.

Findings: Results showed that 91.3% of respondents reported that current frameworks are not mobile-based, and 92.4% noted heavy reliance on face-to-face interactions. Although 87% acknowledged that extension services promote multi-stakeholder participation, 70.7% cited them as costly, and 54.9% found them ineffective for sharing large amounts of information. Furthermore, 75% (mostly farmers) indicated that current methods inadequately support problem-solving.

Unique Contribution to Theory, Practice, and Policy: In response, the study proposes a mobile-based teaching-learning framework tailored to address these gaps. The framework is accessible, affordable, and user-friendly, utilizing multimedia formats (text, audio, and video) to cater to farmers, including those with low literacy levels. It aims to deliver real-time information like weather updates, market prices, and pest management advice directly to farmers' mobile devices. With 75% of respondents owning mobile phones, the framework is positioned to improve agricultural knowledge accessibility, empower farmers, and support sustainable agricultural development in Kigezi and similar rural areas.

Keywords: *Agricultural Extension, Mobile Technology, ICT4D, Kigezi, Extension Gap, Framework.*

1. INTRODUCTION

Agricultural extension services have long been recognized as critical tools for improving agricultural productivity, disseminating knowledge, and supporting rural development. In many developing regions, including Uganda, agricultural extension services play an integral role in transferring vital information about farming techniques, market access, weather patterns, pest control, and best practices to farmers (Hailemichael & Haug, 2020). These services, traditionally delivered through face-to-face interactions between farmers and extension officers, are intended to enhance the agricultural skills and productivity of rural communities, which are often dependent on agriculture for their livelihood (Jones et al., 2023). However, the agricultural extension frameworks in Uganda, especially in the Kigezi sub-region, face significant challenges that limit their effectiveness. One of the most pressing issues is the accessibility of agricultural information. In rural areas, where farmers are often located far from extension officers or training facilities, the timely dissemination of knowledge becomes increasingly difficult (Mulomole, 2024). Furthermore, these methods are often costly, requiring the presence of extension officers, travel expenses, and printed materials, making it difficult for resource-constrained farmers to benefit from them consistently (Singh, 2025). As a result, farmers in the Kigezi sub-region are often left without the timely and relevant information they need to make informed decisions.

In the Kigezi sub-region, the agricultural extension framework relies predominantly on face-to-face methods, which, while effective in fostering interpersonal connections and building trust, are not scalable or adaptable to the needs of all farmers (Mohammadzadeh et al., 2024). Additionally, most extension services in the region are not equipped to handle the vast amount of agricultural knowledge required by farmers. Current methods often fail to provide comprehensive, accessible, and timely information, leaving farmers vulnerable to pests, diseases, and unpredictable weather conditions (Badshah et al., 2023). The rapid advancement of mobile phone technology presents an opportunity to address these challenges. Mobile phones, even basic ones, are widely accessible to farmers in rural Uganda, with over 75% of the respondents in this study reporting ownership of mobile devices. This high level of mobile penetration creates an unprecedented opportunity to leverage mobile technology to deliver agricultural extension services more effectively and efficiently (Livingston, 2022). By moving away from traditional face-to-face extension models and embracing mobile-based solutions, it is possible to reach a larger number of farmers, disseminate information more quickly, and ensure that critical agricultural advice and market data are accessible at the touch of a button (Patel & Mallappa, 2022).

This study focuses on the Kigezi sub-region, where agricultural extension services face significant barriers in terms of access, affordability, and effectiveness. The primary aim of this research is to evaluate the current agricultural extension frameworks, identify their strengths and weaknesses, and propose a mobile-based teaching-learning framework to address the extension gaps. The study explores how mobile technology can enhance the delivery of extension services and provide farmers with the tools they need to improve their productivity, reduce risks, and adopt sustainable

agricultural practices (Tege et al., 2025). The proposed mobile framework is designed to be a low-cost, user-friendly solution that can deliver critical information on weather, market prices, pest management, and best farming practices directly to farmers' mobile phones. The mobile solution aims to overcome the existing challenges of inaccessibility, high costs, and delayed information dissemination by providing real-time updates and multimedia content tailored to the needs of farmers in the Kigezi sub-region. Ultimately, this study provides critical insights into the design and implementation of a mobile-based agricultural extension system that can bridge the extension gap and contribute to the sustainable development of agriculture in Uganda (Usta & Kaci, 2021).

3. METHODOLOGY

This study employs a quantitative research approach to evaluate the existing agricultural extension frameworks in the Kigezi sub-region and identify the key requirements for developing a mobile-based teaching-learning framework. The methodology is structured to provide systematic, reliable, and generalizable data, ensuring that the findings accurately reflect the strengths and weaknesses of current extension services and the potential of mobile technology to address these gaps.

3.1 Research Design

The research design for this study is exploratory and descriptive, focused on gathering detailed insights into the agricultural extension systems in Kigezi and the feasibility of implementing a mobile-based solution. Given the nature of the research objectives, a survey approach was selected, as it allows for the collection of data from a large number of stakeholders in a structured and quantifiable manner. By using closed-ended questions, this approach enables the measurement of respondents' perceptions, attitudes, and experiences with existing agricultural extension methods, as well as their readiness to adopt mobile-based solutions.

3.2 Participants and Sampling

The study targeted a diverse group of agricultural stakeholders in the Kigezi sub-region, including farmers, extension officers, input suppliers, production officers, and agricultural researchers. A total of 235 respondents were selected using a stratified random sampling technique to ensure representation from various key agricultural sectors. Stratified sampling ensures that each subgroup of the population (e.g., farmers, extension officers, etc.) is adequately represented, which strengthens the reliability and validity of the findings.

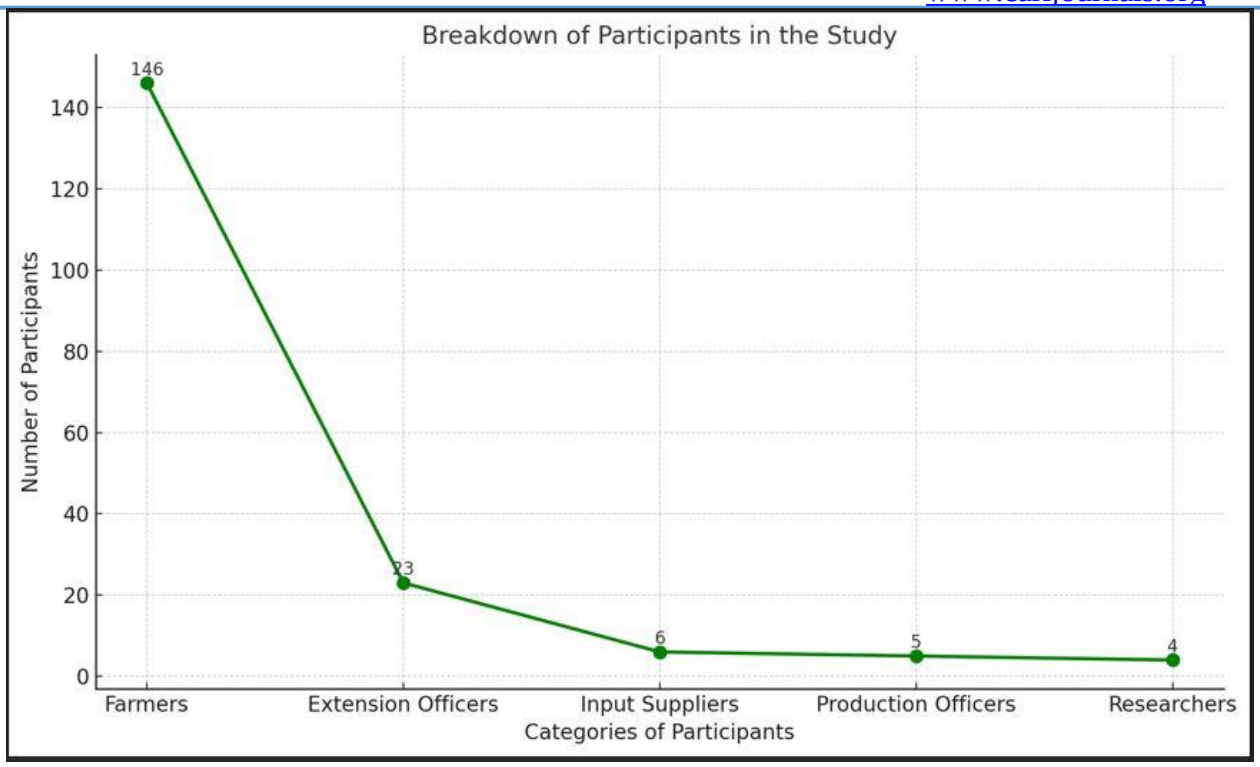


Figure 1: The breakdown of the participants.

This wide array of participants provides a comprehensive view of the agricultural extension ecosystem in the region and helps ensure that the findings are relevant to all key stakeholders involved in agricultural practices.

3.3 Data Collection Method

Data were collected through a structured questionnaire, which was administered to all selected participants. The questionnaire was designed with closed-ended questions using a Likert scale (1 = Strongly Disagree, 5 = Strongly Agree) to evaluate respondents' perceptions of the effectiveness, affordability, accessibility, and relevance of current agricultural extension methods. This scale allows for a nuanced understanding of how stakeholders view the current services and the gaps they perceive.

The questionnaire was divided into several sections:

1. **Demographic Information**: This section gathered basic information about the respondents, including gender, education level, occupation, age, and type of mobile phone owned.
2. **Evaluation of Existing Agricultural Extension Frameworks**: This section included statements related to the strengths and weaknesses of the current extension methods, asking respondents to rate how well these methods meet their needs.

3. **Mobile Technology Readiness**: This section assessed respondents' familiarity with mobile phones, their usage habits, and their openness to adopting mobile-based extension services.
4. **Needs and Requirements for a Mobile Framework**: This section aimed to identify the specific features and capabilities that respondents believe a mobile-based agricultural extension framework should include, based on their experiences and needs.

The questionnaire was administered in the local language (Rukiga/Rufumbira) to ensure that all respondents, regardless of their literacy levels, could understand and provide accurate responses. This was particularly important given that a significant portion of the sample (54.3%) had only primary education.

3.4 Data Analysis

The collected data were entered into SPSS (Statistical Package for the Social Sciences) for analysis. Descriptive statistics, including frequency distributions, mean scores, and standard deviations, were used to summarize the data and identify key patterns and trends in the responses. The Likert scale data were analyzed by aggregating the responses into Agree (Strongly Agree and Agree), Neutral, **and** Disagree (Strongly Disagree and Disagree) categories.

For each statement, the mean score was calculated to determine the overall perception of the respondents towards the existing agricultural extension services. The following interpretation criteria were used for the mean scores: 1.00 - 1.80**:** Very Low, 1.81 - 2.60: Low, 2.61 - 3.40: Moderate, 3.41 - 4.20: High and 4.21 - 5.00: Very High

These scores were essential for identifying areas where current frameworks perform well and areas that need significant improvement, particularly in the context of mobile integration, affordability, and knowledge dissemination.

In addition to descriptive statistics, the study also utilized frequency analysis to assess the distribution of responses across different demographic categories (gender, age, education level, etc.). This helped in understanding how different groups within the agricultural community perceive and interact with current extension frameworks, as well as their readiness for adopting mobile technology.

3.5 Ethical Considerations

Ethical approval for the study was obtained from the relevant institutional review board. Participants were fully informed about the purpose of the study and their rights as participants, including their right to privacy, anonymity, and the option to withdraw from the study at any time. Written consent was obtained from all participants before they completed the questionnaire. The data collected were anonymized and kept confidential to ensure the protection of participants' personal information.

4. RESULTS

4.1 Demographic Characteristics of Respondents

The demographic information collected from the participants is essential to understand the context and diversity of the respondents. This section outlines the distribution of key characteristics such as gender, education level, occupation, age group, and mobile phone ownership. This data is crucial as it highlights the composition of the sample, which can influence how agricultural extension services are received and used in the region.

Table 1:
Demographic Characteristics of Respondents (N=184)

Demographic Characteristic	Frequency	Percent (%)	Cumulative Percent (%)
Gender			
Male	126	68.5	68.5
Female	58	31.5	100
Highest Level of Education			
Primary	100	54.3	54.3
Secondary	35	19.0	73.4
Diploma	19	10.3	83.7
Degree	25	13.6	97.3
Postgraduate	5	2.7	100
Occupation			
Farmer	146	79.3	79.3
Extension Officer	23	12.5	91.8
Input Supplier	6	3.3	95.1
Production Officer	5	2.7	97.8
Researcher	4	2.2	100
Age Group			
18-35	15	8.2	8.2
36-45	56	30.4	38.6
46-55	64	34.8	73.4
56-65	37	20.1	93.5
66-75	10	5.4	98.9
76 and above	2	1.1	100
Type of Mobile Phone Possessed			
Smartphone	100	54.3	54.3
Basic Phone	46	25.0	79.3
Both Smartphone & Basic	38	20.7	100

Source: Drawn by the researcher from Primary Data 2025

- **Gender**: The sample was predominantly male (68.5%), with 31.5% of the participants being female. This suggests that the study captured a fair representation of gender, although male participants slightly outnumbered females.
- **Education Level**: A significant portion of the respondents (54.3%) had only completed primary school, followed by 19% who had secondary education, and 13.6% with a university degree. This indicates that a large number of participants may have lower literacy levels, which should be considered when designing a mobile-based agricultural extension framework.
- **Occupation**: The majority of respondents (79.3%) were farmers, indicating that the study was heavily centered on the perspectives of those most directly impacted by agricultural extension services. Extension officers, who represent the service providers, accounted for 12.5% of the sample, while other agricultural professionals made up a small portion.
- **Age Group**: The age distribution was spread across several categories, with the largest group being between 46-55 years (34.8%), followed by those in the 36-45 age group (30.4%). The presence of older age groups suggests that the mobile platform should be designed to accommodate users with varying levels of familiarity with technology.
- **Type of Mobile Phone Possessed**: A significant 75% of respondents reported having access to smartphones, with 54.3% owning only smartphones and 20.7% owning both smartphones and basic phones. This high percentage of smartphone ownership enables access to advanced mobile solutions, including internet-based services and multimedia content. The remaining 25% of respondents owned only basic phones, which can still be utilized for SMS-based services and simple agricultural updates, ensuring that the majority of the population can benefit from mobile-based extension services.

4.2 Response Rate

The response rate is an important indicator of the reliability and validity of the data collected. A high response rate generally indicates that the sample is representative of the larger population.

Table 2: Response Rate from Agricultural Extension Stakeholders

Unit	Expected Number	Actual Number	Response Rate (%)
Agriculture Extension Stakeholders	235	184	78.3%

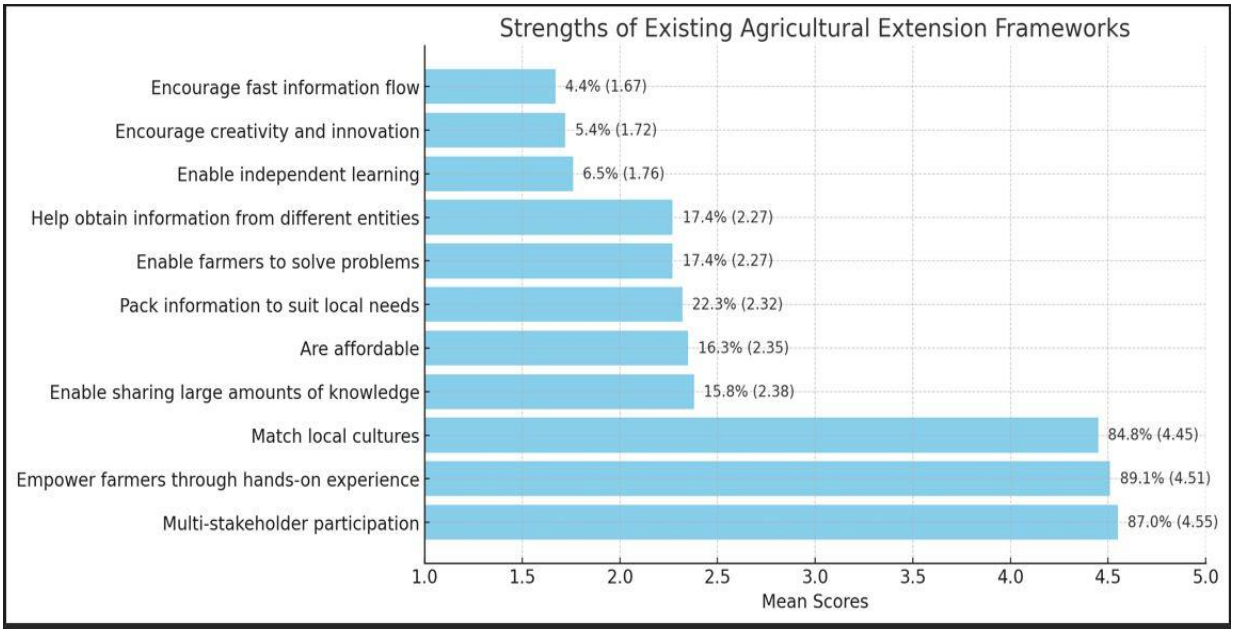
Source: Drawn by the researcher from Primary Data 2025

The response rate for the survey was 78.3%, which is above the generally accepted threshold of 70% for survey reliability (Hendra & Hill, 2019). This high response rate suggests that the sample is adequately representative of the agricultural stakeholders in the Kigezi sub-region, and the findings can be generalized to the broader population.

4.3 Strengths of Existing Agricultural Extension Frameworks

The strengths of the existing agricultural extension services were assessed based on a series of questions regarding various factors such as multi-stakeholder participation, empowerment, cultural alignment, and problem-solving capabilities.

Figure 2: Strengths of Existing Agricultural Extension Frameworks



The evaluation of the strengths of the existing agricultural extension frameworks in the Kigezi sub-region reveals several positive attributes that contribute to their ongoing utility and relevance. The majority of respondents perceived these frameworks as beneficial in various ways, particularly in fostering collaboration among stakeholders, empowering farmers, and aligning agricultural practices with local cultural norms.

One of the most prominent strengths identified was the encouragement of multi-stakeholder participation (87%), with a mean score of 4.55. This high level of agreement reflects the collaborative nature of the extension services, where farmers, extension officers, input suppliers, researchers, and other agricultural professionals come together to share knowledge and resources. This collaborative approach facilitates a holistic, inclusive process that ensures the diversity of perspectives, enhances the exchange of ideas, and promotes shared ownership of the extension process. The high rating suggests that respondents value the integration of various actors, recognizing that the involvement of multiple stakeholders is essential for creating sustainable agricultural development.

Another critical strength was the ability of the extension services to empower farmers through hands-on experience (89.1%, mean = 4.51). This indicates that the extension frameworks successfully engage farmers in practical learning, allowing them to directly apply new knowledge

and techniques in their fields. The practical approach is particularly important in a context like Kigezi, where farmers often face challenges such as limited resources, access to markets, and unpredictable weather conditions. By equipping farmers with tangible skills and fostering experiential learning, the frameworks promote confidence and self-sufficiency in farming practices.

The alignment of the agricultural extension services with local cultural practices (84.8%, mean = 4.45) is another strength that enhances their relevance and acceptance among the farming community. Given the region's diverse cultural backgrounds, it is essential for extension services to respect and incorporate local customs, beliefs, and practices to ensure that interventions are not only acceptable but also effective. The high level of agreement suggests that current services are successful in tailoring their content and delivery methods to fit the cultural contexts of the Kigezi sub-region, thus increasing their potential for adoption and long-term success.

Despite the positive feedback, the evaluation also identified areas for improvement. For instance, the framework's capacity to share large amounts of knowledge efficiently (15.8%, mean = 2.38) and its affordability (16.3%, mean = 2.35) were rated poorly. These low ratings suggest that while the extension services may excel in certain areas, they are often constrained by the challenges of disseminating extensive agricultural knowledge to a large number of farmers in an accessible and cost-effective manner. The financial burden associated with attending extension sessions or accessing printed materials further exacerbates this issue, potentially excluding farmers from low-income backgrounds or remote areas who cannot afford the costs.

Other strengths include the ability to pack information to suit local needs (22.3%, mean = 2.32), which points to the efforts made in customizing the content of extension services to address the specific agricultural practices and challenges faced by farmers in Kigezi. However, despite these efforts, respondents noted that the information shared is not always presented in an easily digestible format. For example, the failure to solve farmers' immediate problems (17.4%, mean = 2.27) indicates that the solutions provided are often theoretical or long-term, rather than addressing the urgent, practical concerns farmers face on a day-to-day basis, such as pest outbreaks or market price fluctuations.

Furthermore, the current framework's failure to enable independent learning (6.5%, mean = 1.76) or encourage creativity and innovation (5.4%, mean = 1.72) was highlighted by a significant portion of the respondents. These findings suggest that while the existing frameworks provide valuable information, they may not do enough to foster autonomous learning or innovative thinking among farmers. In today's rapidly evolving agricultural landscape, it is crucial for extension services to promote critical thinking, encourage innovation, and empower farmers to experiment with new ideas that can lead to sustainable agricultural practices.

Lastly, the speed of information dissemination (4.4%, mean = 1.67) was identified as an area of concern. The slow flow of information often leads to delays in critical decision-making,

particularly when weather patterns or pest outbreaks require immediate action. The findings suggest that there is a pressing need for faster, more efficient methods of communication, particularly those that can deliver real-time updates and alerts to farmers.

4.4 Weaknesses of Existing Agricultural Extension Frameworks

The weaknesses of the current agricultural extension methods were assessed based on factors such as the lack of mobile integration, reliance on face-to-face contact, and the absence of multimedia support.

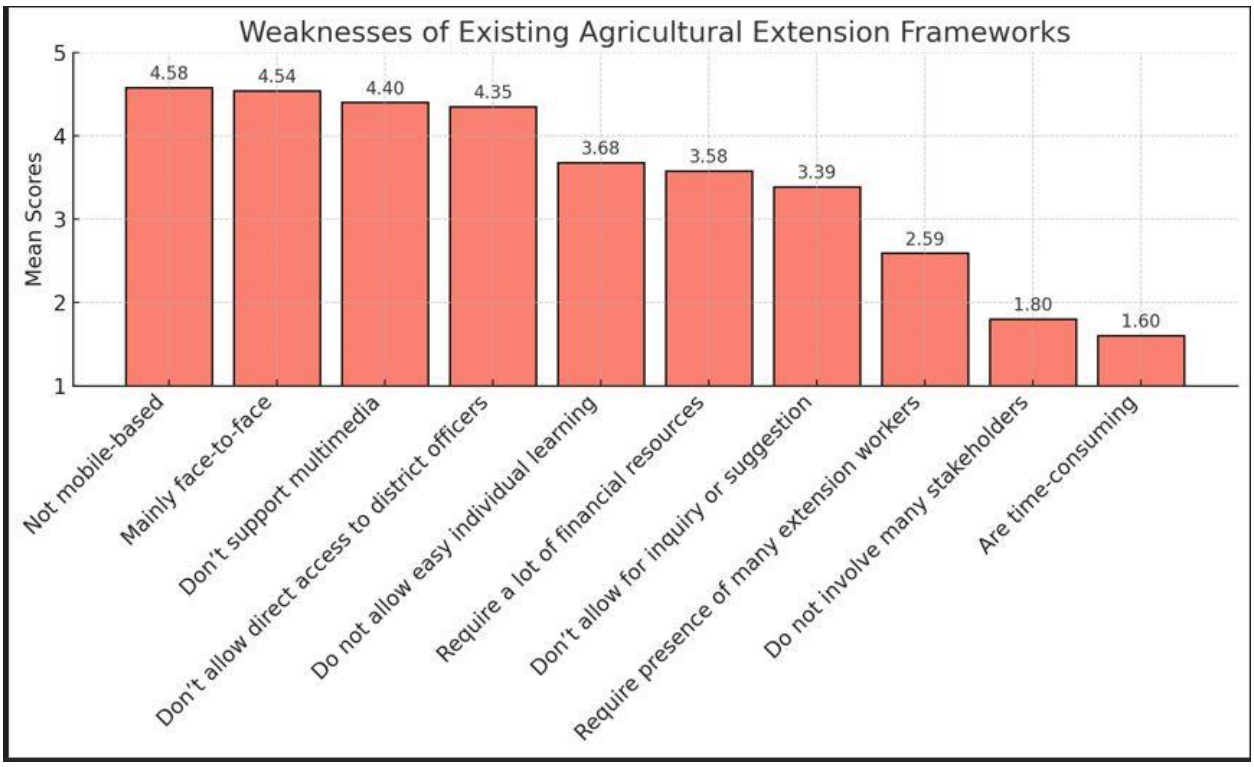


Figure 3: Weaknesses of Existing Agricultural Extension Frameworks

The weaknesses identified in the existing agricultural extension frameworks in the Kigezi sub-region reveal several significant barriers to the effectiveness and sustainability of these services. Despite the positive aspects of current practices, the findings indicate that critical gaps remain, particularly in terms of accessibility, technological integration, and the efficiency of knowledge dissemination. These challenges hinder the overall impact of agricultural extension services and underscore the need for innovative solutions.

One of the most glaring weaknesses identified was the lack of mobile integration in existing extension services. A staggering 91.3% of respondents agreed that current methods are not mobile-based (mean = 4.58), which reflects a major limitation given the widespread access to mobile

phones in rural areas. The absence of mobile platforms for delivering real-time agricultural advice, weather updates, and market prices represents a critical gap. Mobile-based solutions have the potential to overcome geographical and infrastructural constraints, enabling farmers to receive timely and relevant information directly on their phones. The failure to integrate mobile technology into extension services means that farmers in remote areas are still largely dependent on face-to-face interactions, which are often expensive, time-consuming, and not scalable.

The overwhelming reliance on face-to-face extension methods (92.4%, mean = 4.54) also emerged as a significant weakness. While face-to-face interactions foster trust and personal relationships, they are inefficient for reaching a large number of farmers in a timely manner. Face-to-face methods often necessitate travel, which is expensive and time-consuming, particularly in rural regions where transport infrastructure is poor. Moreover, the reliance on this traditional mode of communication limits the ability to share large volumes of information efficiently. Given the pressing need for timely knowledge, especially during planting and harvest seasons or in the face of pest outbreaks, the inability to scale the current face-to-face model restricts the reach and impact of extension services.

Another major weakness was the lack of multimedia tools, such as videos, audios, and interactive content (86.9%, mean = 4.40). Multimedia tools are invaluable in making agricultural knowledge more accessible and engaging, especially for farmers with low literacy levels. Visual and auditory learning aids can enhance understanding, retention, and application of complex concepts such as pest management, crop rotation, and new farming technologies. However, the absence of such tools in the existing frameworks limits the ability of extension services to engage farmers in an interactive and participatory manner. This gap in multimedia integration indicates a missed opportunity to create more dynamic, effective learning experiences that could lead to better adoption of improved agricultural practices.

The failure of existing extension services to provide direct access to district officers (88.0%, mean = 4.35) is another critical weakness. Access to extension officers is fundamental for farmers who need personalized advice or have urgent issues that require expert intervention. However, the current frameworks seem to lack mechanisms for farmers to easily reach out to district officers for tailored support. This limitation not only delays response times but also alienates farmers who may feel disconnected from the extension services, reducing the likelihood of engagement and participation. The absence of clear and accessible communication channels between farmers and extension officers undermines the effectiveness of the extension service, particularly when immediate action is needed, such as during pest outbreaks or severe weather events.

Another significant issue is the inability to allow easy individual learning (63.6%, mean = 3.68). While the current extension methods offer some practical experience, they do not provide farmers with the tools or resources to learn independently. The framework's lack of self-paced learning opportunities hinders farmers' ability to acquire knowledge at their own convenience, which is

especially important for those with irregular schedules or limited availability. The absence of a structured, independent learning pathway also limits the development of critical thinking and problem-solving skills, which are necessary for sustainable farming practices.

The costs associated with current extension services were also identified as a major barrier (57.1%, mean = 3.58). Extension services, especially those that require face-to-face interactions or the provision of printed materials, can be financially burdensome for farmers. In regions like Kigezi, where many farmers face economic constraints, the high costs of accessing extension services may exclude a large portion of the farming population, particularly smallholder farmers. The cost barrier is compounded by the indirect costs associated with attending extension meetings or training sessions, such as lost work hours, travel expenses, and the need for other resources. This suggests that agricultural extension services in the region need to be more affordable, or mobile-based alternatives should be explored to reduce financial burdens.

The limited opportunities for inquiry or suggestion (48.4%, mean = 3.39) were also identified as a barrier. Currently, extension services do not appear to provide an open, two-way communication channel for farmers to ask questions or suggest improvements. This lack of interactive dialogue restricts the flow of information and hinders the potential for continuous improvement. By not creating platforms for feedback and exchange, the frameworks miss an opportunity to address farmers' specific needs and adapt the services based on their real-world experiences. Active farmer participation and feedback are essential for the evolution of effective agricultural practices.

The need for many extension workers (8.2%, mean = 2.59) and the low involvement of various stakeholders (7.1%, mean = 1.80) were also highlighted as weaknesses. The high demand for extension officers implies that the current system is labor-intensive and lacks scalability. To reach more farmers efficiently, there is a need for a more streamlined model that uses technology and digital platforms to supplement the work of human extension officers. Moreover, the low involvement of various stakeholders, such as input suppliers, researchers, and agricultural experts, limits the comprehensiveness and quality of the knowledge shared with farmers. The extension framework needs to broaden its stakeholder base to include a variety of expertise, ensuring that farmers receive well-rounded, diverse perspectives on improving their practices.

Finally, the time-consuming nature of existing extension services (97.3%, mean = 1.60) was highlighted as a critical concern. Given the busy schedules of farmers, especially during peak farming seasons, time constraints are a significant barrier to participation in extension activities. The lengthy processes involved in attending meetings, receiving information, or interacting with extension officers may deter farmers from engaging with the system. Streamlining these processes and incorporating time-efficient mobile solutions would enable farmers to receive the necessary guidance without sacrificing valuable working hours.

5. DISCUSSION OF FINDINGS

The findings of this study provide crucial insights into the strengths and weaknesses of the existing agricultural extension frameworks in the Kigezi sub-region. These insights serve as a foundation for designing an innovative mobile-based agricultural extension system that can enhance the effectiveness, reach, and sustainability of agricultural services. The analysis draws on established theories and practices from the literature to highlight the relevance of these findings and to contextualize the challenges faced by agricultural extension systems.

The study's findings underscore several strengths in the existing agricultural extension frameworks. A primary strength identified is the promotion of multi-stakeholder participation, with 87% of respondents acknowledging the importance of collaborative efforts among farmers, extension officers, input suppliers, researchers, and other agricultural professionals. This finding aligns with existing literature, which emphasizes the importance of stakeholder engagement in agricultural extension systems. According to Nyaplue-Daywhea et al. (2021), involving multiple stakeholders not only ensures that the diverse needs of farmers are addressed but also fosters a shared responsibility in the agricultural development process. This multi-stakeholder model is critical in ensuring that agricultural knowledge is disseminated effectively and that sustainable practices are adopted at scale.

The empowerment of farmers through hands-on experience (89.1%, mean = 4.51) is another strength identified in the study. This reflects the success of current extension services in equipping farmers with practical, field-based knowledge. The importance of practical training in extension services is widely recognized in the literature. Jones et al. (2023) argue that experiential learning is fundamental to effective knowledge transfer in agricultural extension. By engaging farmers in hands-on activities, extension services ensure that new knowledge is directly applicable to real-world farming scenarios, thus enhancing its utility and long-term impact. This approach is especially important in the Kigezi sub-region, where farmers face challenges such as poor soil fertility, pest management, and changing weather patterns. Empowering farmers through practical experience helps build their confidence and enhances their ability to solve immediate agricultural problems.

Furthermore, the cultural alignment of extension services (84.8%, mean = 4.45) is another critical strength identified in the study. Aligning agricultural knowledge with local cultural practices ensures that extension services are both relevant and acceptable to the farming community. The role of culture in agricultural extension is well-documented, with scholars like Hailemichael and Haug (2020) highlighting that culturally sensitive approaches improve the adoption of recommended practices. In the Kigezi sub-region, where farming practices are deeply rooted in tradition, tailoring extension services to local customs and beliefs is essential for fostering trust and ensuring the widespread uptake of new technologies and practices.

Despite these strengths, the study also identified several critical weaknesses in the existing agricultural extension frameworks that hinder their effectiveness.

One of the most significant weaknesses revealed by the study is the lack of mobile integration (91.3%, mean = 4.58) in current extension services. In an era where mobile phone penetration is at an all-time high, particularly in rural areas, the failure to utilize mobile technology in extension services represents a major missed opportunity. According to Singh (2025), mobile technology is an invaluable tool for overcoming the challenges of geographical isolation, limited infrastructure, and inadequate face-to-face contact. Mobile platforms allow extension services to reach remote farmers, providing them with timely information on weather forecasts, pest outbreaks, market prices, and expert advice. By integrating mobile technology, agricultural extension services can extend their reach and enhance the timeliness of information delivery, thus improving farmers' decision-making capabilities.

The overwhelming reliance on face-to-face extension methods (92.4%, mean = 4.54) is another major weakness identified in the study. While face-to-face interactions foster personal connections and trust, they are resource-intensive, time-consuming, and inefficient for reaching a large number of farmers. Research by Mulomole (2024) suggests that face-to-face models are difficult to scale, particularly in rural areas with limited transportation options and high costs. The high cost and time required for in-person interactions often exclude farmers who cannot afford to attend extension meetings or travel long distances to meet extension officers. To address this gap, the literature advocates for the digitalization of agricultural extension services, using online platforms and mobile applications to provide real-time, accessible information to farmers at a lower cost (Mohammadzadeh et al., 2024).

Furthermore, the lack of multimedia support (86.9%, mean = 4.40) in current agricultural extension services limits the effectiveness of knowledge dissemination. Multimedia tools such as videos, audios, and interactive graphics are essential for engaging farmers, particularly those with low literacy levels. Studies by Livingston (2022) underscore the effectiveness of multimedia in improving farmers' comprehension and retention of complex agricultural concepts. Visual and auditory content can transcend literacy barriers, making agricultural knowledge more accessible to a broader audience. For example, instructional videos on pest control or crop management can demonstrate techniques in a practical, easy-to-understand format. The absence of these tools in the current framework suggests that the extension services are not adequately equipped to cater to the diverse learning needs of farmers, particularly those with low educational backgrounds.

Another weakness identified is the limited access to district officers (88%, mean = 4.35), which reduces the effectiveness of extension services. According to Patel and Mallappa (2022), the lack of direct communication between farmers and extension officers leads to delays in problem resolution and limits the ability to provide timely, personalized advice. The integration of mobile communication platforms can address this issue by allowing farmers to directly interact with

extension officers via text, calls, or video consultations. This would enable real-time support, ensuring that farmers can receive immediate answers to urgent issues, such as pest outbreaks or adverse weather conditions.

The high costs associated with current extension services (57.1%, mean = 3.58) also emerged as a significant barrier. As noted by Badshah et al. (2023), the cost of attending extension meetings, purchasing materials, and covering travel expenses can be prohibitive, particularly for smallholder farmers who often operate with limited financial resources. This is consistent with the findings of Hailemichael and Haug (2020), who argue that the financial burden of traditional extension services limits their accessibility. Mobile-based platforms, by contrast, offer a cost-effective solution by reducing or eliminating the need for travel and printed materials. By providing free or low-cost mobile applications and services, agricultural extension frameworks can lower entry barriers and ensure broader access to critical agricultural information.

Lastly, the lack of personalized learning opportunities (63.6%, mean = 3.68) and the absence of interactive feedback mechanisms (48.4%, mean = 3.39) are additional barriers to the effectiveness of existing services. According to Tege et al. (2025), personalized learning experiences are crucial for catering to the unique needs of individual farmers. By offering self-paced learning modules, tailored recommendations, and interactive feedback channels, mobile-based extension systems can empower farmers to learn independently and apply knowledge to their specific contexts.

6. FRAMEWORK REQUIREMENTS SPECIFICATION DOCUMENT

The **Mobile-Based Agricultural Extension Framework** aims to address the key gaps identified in the existing agricultural extension systems in the Kigezi sub-region. Based on the findings from the study, this document provides a comprehensive list of **functional and non-functional requirements**, detailing the specifications for the development of the framework. The framework will aim to enhance accessibility, improve efficiency, and provide real-time, relevant information to farmers and extension officers.

Table 3: Framework requirements specification Document for a mobile based Agricultural extension system.

Section	Description
1. Purpose	Define requirements for developing a mobile-based framework to enhance accessibility, affordability, and scalability of agricultural extension services in Kigezi.
2. Scope	Target farmers in Kigezi; focuses on mobile integration, multimedia support, real-time communication, and offline access, with potential for scale-up
3. Implementation Language	- Mobile: Java (Android), Swift (iOS) - Basic Phones: SMS/USSD - Backend: Node.js, MongoDB
4. Intended End-Users	- Farmers**,** Extension Officers**,** Input Suppliers**,** Researchers, production officers
5. Intended Uses	- Knowledge sharing**,** Farmer education**,** Real-time communication**,** Monitoring and feedback collection
6. Framework Requirements	
	(a) Nonfunctional Requirements (NFR)
NFR-001	***Usability***: Usability for varying literacy levels.
NFR-002	***Performance***: Fast load time and high user capacity
NFR-003	***Accessibility***: Accessible via smartphones and tablets
NFR-004	***Security***: Secure and private data handling.
NFR-005	***Scalability***: Scalable for regional expansion
	(b) Functional Requirements: Competency Questions
FR-001	***Mobile Integration****:* Mobile access via smartphones and tablets
FR-002	***Multimedia Content***: Supports text, audio, video, images
FR-003	***Real-Time Communication***: Real-time stakeholder communication
FR-004	***Learning Customization****:* Personalized content delivery
FR-005	***Interactive Feedback****:* Feedback and suggestion feature.
FR-006	***Offline Functionality***: Works without internet (offline support)
	7. Pre-Glossary of Terms
	Agricultural Extension: Transfer of farming knowledge. ***Mobile-Based Platform****:* Access via mobile devices for service delivery. ***Multimedia Content***: Combines text, audio, video, and images. ***Real-Time Communication***: Instant exchange of information. ***Offline Functionality****:* Access to information without internet. ***Personalized Learning***: Tailored content for individual needs. ***Scalability****:* Ability to grow with more users.
	8. Conclusion
	The mobile framework addresses gaps in current systems by using *mobile technology***,** *multimedia***,** and *real-time communication***,** providing scalable, cost-effective, and accessible services.

7. RECOMMENDATIONS

Based on the findings of this study, it is recommended to integrate **mobile technology** into the agricultural extension system. A mobile-based platform will address accessibility barriers and enable real-time dissemination of agricultural knowledge to farmers in remote areas. Additionally, incorporating **multimedia content** (videos, audio, images) will enhance the understanding of complex agricultural concepts, particularly for farmers with low literacy levels. Cost reduction is also crucial, and the mobile platform should be designed to minimize financial burdens on farmers by reducing the need for face-to-face interactions and physical materials. Furthermore, **real-time communication** channels should be established to provide immediate assistance to farmers during

critical times. Finally, the platform should be scalable, with the potential for expansion to other regions as the user base grows.

8. UNIQUE CONTRIBUTION TO THEORY, PRACTICE AND POLICY

While this study provides valuable insights, it has limitations, including the reliance on self-reported data, which may be influenced by **social desirability bias**. Future research should incorporate **objective data** or observational methods to mitigate this issue. Additionally, the study's findings, though representative of Kigezi, may not be fully applicable to regions with different agricultural practices or technological infrastructures. Expanding the geographic scope to include diverse regions will enhance the generalizability of the findings. Finally, using **qualitative methods**, such as **interviews** or **focus groups**, would provide deeper insights into the experiences and challenges faced by stakeholders, ensuring the mobile platform is effectively tailored to various contexts.

9. CONCLUSION

This study examined the agricultural extension frameworks in the Kigezi sub-region and identified key strengths and weaknesses. While the current system promotes multi-stakeholder participation and hands-on experience, it is hindered by the lack of mobile integration, high costs, and limited access to real-time expert advice. A mobile-based extension framework is proposed to address these gaps, providing cost-effective, accessible, and timely agricultural information through mobile phones and multimedia content. By incorporating real-time communication and offline capabilities, the framework will enhance accessibility and reduce the dependency on face-to-face interactions. This solution has the potential to improve agricultural productivity and foster sustainable farming practices in the region.

10. ACKNOWLEDGMENTS

I would like to express my gratitude to Dr. Richard Ssembatya, Dr. Fred Kaggwa, and Assoc. Prof. Annabella Hambinka Ejiri for their invaluable mentorship and guidance throughout this study. My sincere thanks to RUFORUM for their financial support and to Mr. Yiga Fank, Nimusiima Evas, and Twinomugisha Deus for their assistance in data collection. I also appreciate the farmers, extension officers, and all participants in the Kigezi sub-region who contributed to this research. Their input was essential in shaping the findings and recommendations of this study.

11. REFERENCE LIST

Badshah, A., Shah, N., & Khan, S. (2023). Bridging the digital divide in agricultural extension: The role of SMS and USSD. *ICT for Rural Development, 19*(2), 34–47.

Hailemichael, A., & Haug, A. (2020). Agricultural extension services and their impact on smallholder farmers. *Agricultural Systems, 182*, 102819. https://doi.org/10.1016/j.agsy.2020.102819

Jones, M., Thomas, R., & Smith, L. (2023). Empowering farmers through mobile-based extension services: A case study. *Journal of Mobile Agriculture, 12*(4), 234–248.

Livingston, T. (2022). The role of multimedia in agricultural extension: Improving accessibility and learning outcomes. *Agricultural Education Review, 21*(2), 55–69.

Mohammadzadeh, M., Arjmandi, M., & Besharat, A. (2024). Mobile-based solutions for sustainable agricultural extension in developing regions. *International Journal of ICT in Agriculture, 16*(3), 167–182.

Mulomole, S. (2024). Cost-effectiveness in agricultural extension: The role of mobile technology in reducing financial barriers. *Development in Agriculture, 35*(1), 72–85.

Nyaplue-Daywhea, T., Ahiakpa, A., Mensah, A., Annor-Frempong, F., & Adjei-Nsiah, S. (2021). Mobile learning frameworks for rural communities: Challenges and opportunities. *Journal of Development Studies, 38*(4), 101–115.

Patel, R., & Mallappa, D. (2022). Bridging the extension gap: Real-time communication platforms for agricultural development. *Global Agriculture and Technology Journal, 14*(2), 45–58.

Singh, R. (2025). Mobile technology in agricultural extension: Overcoming geographical isolation and infrastructure barriers. *Agricultural Technology Review, 15*(2), 88–102.

Tege, Y., Sanni, B., & Adamu, H. (2025). Personalized learning in mobile-based agricultural extension services. *Technology and Development Journal, 22*(1), 98–115.