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The Use of Digital Agricultural Extension and Advisory Services by Cassava and Sweet Potato Farmers in Moyamba District Southern Sierra Leone

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Abstract: *This study was, designed to look into cassava and sweet potato farmer's use of Digital Agricultural Extension Advisory Services in Moyamba District Southern Sierra Leone. Three hundred (300) respondents were chosen from the total population consisting of three Chiefdoms: Kori, Dasse, and Kamajei. Questionnaires and interview schedules were used. Data was analyzed using the Statistical Package for Social Sciences (SPSS) software. The descriptive statistics was used for tables, frequency distributions and percentages, mean, Variance and Standard deviation. In addition, Pearson's Correlation Coefficient (r), Multiple Linear Regression (MLR) analysis and Problem Face Index table was used. Four distinct clusters such as Digital Novices, Basic Practical Users, Integrated Connectors, and Advanced Analysts, were identified. According to our findings it was revealed that farmers who possessed certain advantages—such as access to loans, secondary and primary education, married couples, large farm sizes, and substantial family labor are better positioned to leverage these technologies effectively. Lack of financial support, high initial costs, and limited connectivity are the most severe barriers. It was concluded that farmers with secondary education who operate large farms with ample family labor resources were uniquely positioned to benefit from the adoption of digital tools and advisory services in agriculture.*

Keywords: Digital tools, attitude of farmers, advisory services, farmers

INTRODUCTION

According to FAO, (2023) Digital agricultural extension and advisory services (AEAS) can be defined as having a great potential to enhance accessibility, delivery, transparency, scope and impacts of information and services for smallholder farmers. It is a technology which can be used by farmers to combine financial and field-level records for all farm activities management. It involves the use of different technologies, which include sensors, drones, accurate irrigation systems, and data analysis. (Singh, N. H et al., 2023). It enables farmers to have access and insight of valuable farming practices which can be managed more proficiently and adopt to best practices and management which ultimately leads to less inputs and hence increase productivity (Singh, N. H et al, 2023).

Digital extension technologies give farmers and extension agents the opportunity to increase agricultural output, make the value chain stronger and contribute to food security (Yingjie Song, 2026). Farmers can obtain better Agricultural recommendations through digital applications and the management of decision-making processes in agriculture or along the value chain is referred to as digital extension technologies (Yingjie Song 2026); Klerkx, Jakku, and Labarthe 2022). It could be the best associated to climate change, which provides information and advice for effective decision-making.

According to N. K. Singh et al, 2023 extension digitalization has high tendency to improve farmers' technical knowhow, ameliorate socio-economic challenges, improve food security, and address environmental impact. The fundamental change in approach toward ICT use has occurred and can aid the agricultural extension personnel solve location-specific barriers to agricultural development, such as making it possible for farmers to get agricultural information on time, connecting the markets, and saving time. (Ochilo WN et al, 2019). The use of ICT devices by the extension professional help in gathering information on different activities and endeavors in the agricultural sector such as crop and animal science, input management, improving market efficiency, reducing waste and analyzing pollution-related issues (Aker JC e al, 2016).

Koyenikan and Ohiomoba, (2021) found that in Edo State mobile phone applications (MPAs), among other ICTs, were tools of great importance for improving and strengthen the performance and activities of field-level workers which enable them to easily collect and spread information used to deal with acclimatizing and reducing the effects of climate change. Spielman et al. (2021) stated that Digital technologies lower the costs of agricultural extension information spreading, assist to provide self and local extension services to farmers at lower costs and the expenses in research. Specifically, the increasing availability and utilization of smartphones offer great opportunity for cultural and agronomic extension and transformation of smallholder farmers and reduce the distance between farmers, extension agents, and researchers which has resulted in considerable gains in agricultural extension efficiency. (Mapiye et al., (2021). However, most research has concentrated on the farmer's perspective with the need to innovate communication services to assist family farmers in fostering stronger agricultural productivity (Fernando, (2021), Steinke, et al., (2021).

Globally, digital extension initiatives are rescinding newly surging, data-rich approaches in agriculture, replacing conventional farmer extension agent engagements with detailed, back-end data collection and analysis procedures Eastwood et al., (2019). Advisories are important to promoting rural livelihoods, attaining food security, increasing productivity, and promoting agriculture as a source of economic growth for the rural poor people (IFPRI, (2020). Both in developed and developing countries, digital extension initiatives are gaining adherence among farmers (Steinke et al., (2021). Thus, digital agricultural extension can enable to bridge the gap of low production, vulnerability, and poverty, particularly for smallholders (FOOD AND Agriculture Organization of the United Nations Rome,2022).

Due to these conveniences, many digital services have been developed in recent years to promote and improve smallholder farmers' liberty to agricultural information. (Baumüller, (2018); Fabregas, Kremer, & Schilbach, (2019). It is anticipated that digital farming will play a major role in solving global food security challenges and in assisting farmers adopt climate-smart agriculture practices.

The main method for the diffusion of knowledge and innovation is public sector-supported agriculture extension services. (Guy Faure et al, 2019, Pallavi Rajkhowa, (2021). In this system, extension agents train both crop and livestock farmers directly regarding best practices or work closely with selected 'model farmers' who try out suggestions on new agricultural inputs and cultivation practices and then communicate these to other farmers. However, the effectiveness of this approach has been limited because of insufficient funding and information that is not personalized to farmers' requirements. (Pallavi Rajkhowa, (2021).

The use of mobile phones and other digital technologies presents golden opportunities to make quality agricultural information accessible to farmers in developing countries (Fabregas et al. 2022). Though digital tools complement conventional digital extension and advisory services (EAS), they pose great challenges. Cole and Sharma (2017) mention the importance and specificity of digital advisories to individual farmer's needs as one such issue. Smallholder farmers in developing countries do not have access to location-specific science-based data as most of the digital EAS tools deliver blanket recommendations with obsolete content (Fabregas et al. 2019; Arouna et al. 2021; Sida et al. 2023).

In Sierra Leone, poverty levels are both absolutely and relatively high, and the adverse effects of the unpredictable weather on its rain fed agricultural production are severe. These fundamental challenges exist against the backdrop that many of the people in all the regions are poor rural farmers whose livelihoods depend on the same unpredictable rains. (Sierra Leone summary poverty assessment, (2014), Sierra Leone constraints analysis report, (2021)

This situation has attracted the attention of development partners and the government to introduce farming innovations to change the status quo. But overcoming these challenges requires the use of more innovative agricultural technology and their delivery methods, coupled with innovative approaches to educate and help farmers understand the essence and benefits of adopting such technologies and this is mostly relied on extension officers to deliver and educate farmers. Unfortunately, Digital agricultural extension and advisory services from extension agents is seldom access. Insufficient rural information access is a key factor that has incredibly restricted farming headway in Africa. (Zhang, Qiang, (2021).

Farmers in Moyamba District are often trapped in a vicious cycle of low productivity and subsistence-oriented farming due to inadequate access to information, technologies, and financial services. Thus, a significant policy question that arises is how information and market access constraints that farmers face can be overcome. (Pallavi Rajkhowa, and Martin Quamin (2021).

The objective of this study was to investigate the socio-economic characteristic and attitudes of farmers towards digital use and advisory services in Moyamba District;

Research Questions

The survey in this research was driven by the following questions

1. What are the specific digital services received on specific extension messages?

2. What are the specific digital channels used in targeting men and women?

3. How has the use of digital and advisory services been informing the people on the issue of Agricultural development in Moyamba District?

4. What are the associated problems of farmer’s accessibility to digital tools and advisory services.

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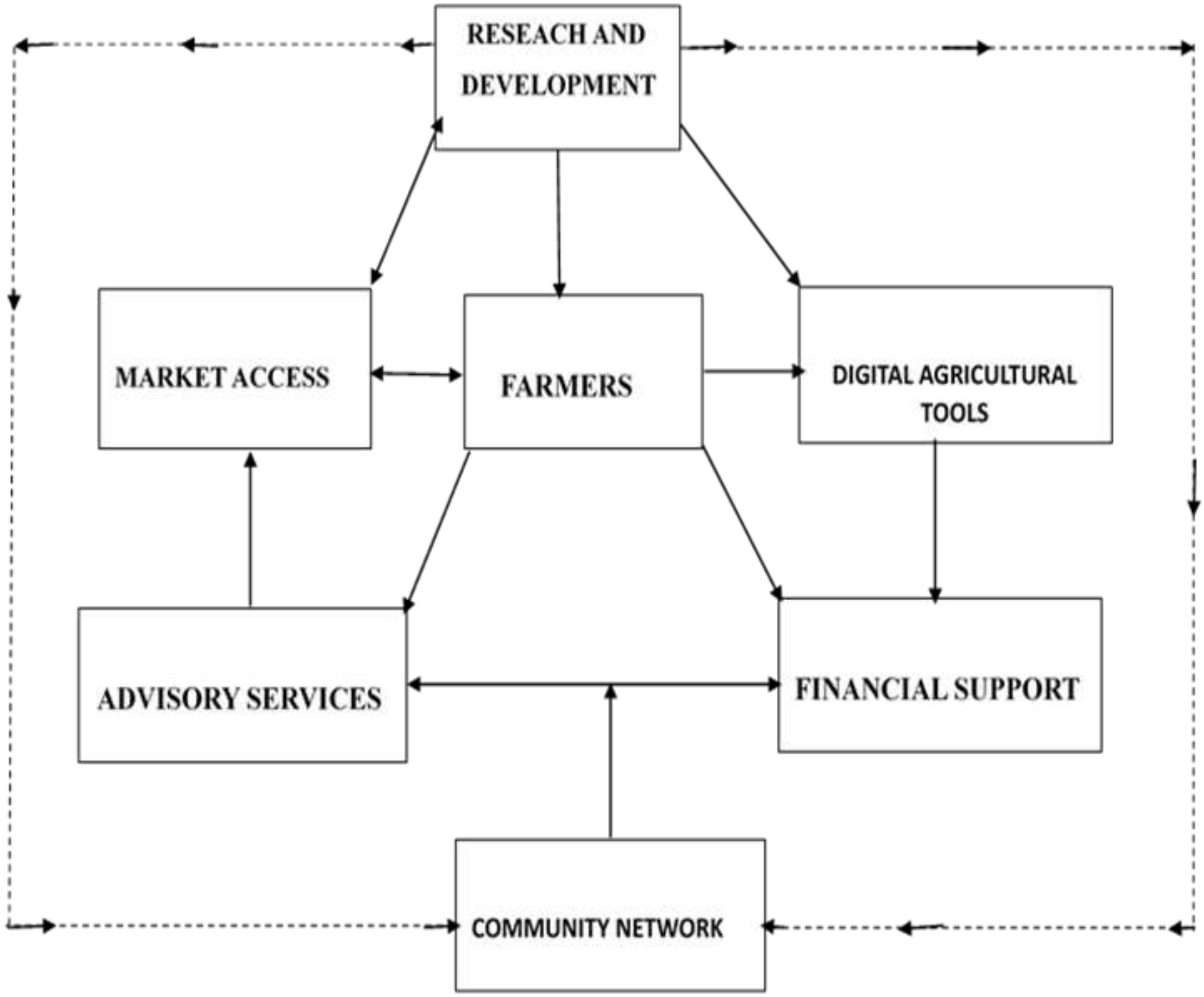

FIGURE 1: CONCEPTUAL FRAMEWORK OF DIGITAL TOOLS ADVISORY SERVICES BY FARMERS

The conceptual framework for farmers using digital agricultural tools and advisory services can be looked at as a central node (the farmer) surrounded by various elements that contribute to their agricultural practices. Below is a detailed description of the diagram:
Central Node: The Farmer

At the center of the diagram is the farmer, representing the main stakeholder in agriculture. This node symbolizes the individual or collective farmers who are engaged in agricultural activities.

Surrounding Elements:
Digital Agricultural Tools:

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These include mobile applications, precision farming technologies, drones, and ICT devices that provide real-time data on soil health, weather conditions, crop monitoring, etc.

Advisory Services:
This consist of extension services provided by agricultural experts, online forums, and platforms where farmers can seek advice on best practices, pest management, crop rotation strategies, etc.

Market Access:
Digital platforms that connect farmers to markets for selling their produce directly to consumers or retailers. This includes e-commerce sites and local market apps.

Financial Services:
Access to digital banking services, microloans, insurance products tailored for agriculture, and financial literacy programs that help farmers manage their finances effectively.

Research and Development:
Institutions providing research findings on new crop varieties, sustainable practices, and technological innovations that can enhance productivity.

Community Networks:
Local cooperatives or online communities where farmers share experiences, challenges, and solutions with one another.

METHODOLOGY

Research Design

The research design for this study was a descriptive survey type, designed to look into the. use of digital agricultural extension and advisory services by cassava and sweet potato farmers in moyamba district southern Sierra Leone

The design was appropriate because it focused on observation and perception of the existing situation described and interpreted what was concerned with issues, conditions, practices, relationships, views, beliefs, attitudes, processes, and trends which made an impact surge.A Survey research design was also used because it is an adoption process with regards to knowledge and the use of digital tools. A Survey research design was also used because it is procedure in quantitative approach which helps to administer questionnaire in order to identify trends in the attitudes, opinion, behavior, or characteristics of population. At the same time, this study employed qualitative technique to answer and understand the impact of the extension approaches (Creswell, 2014).

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Description of the Study area

Moyamba District is a district in the Southern Province of Sierra Leone, with a population of 318,064 in the (2015) census. Its capital and largest city is Moyamba. The other major towns include Njala, Rotifunk and Shenge. (Taylor, and Bankole Kamara, (2014), Manson, et al (2009). The district is the largest in the Southern Province by geographical area, occupying a total area of 6,902 km^2 (2,665 sq mi) and comprises of fourteen chiefdoms.

Moyamba District borders the Atlantic Ocean in the west, Port Loko District and Tonkolili District to the north, Bo District to the east and Bonthe District to the south. The main economic activities include mining (rutile and bauxite), fishing, rice. Cassava and Sweet Potato

Moyamba District is one of the most ethnically diverse Districts in Sierra Leone. The Mende people are the largest ethnic group in Moyamba District; However, there is a large population of ethnic minority groups in the district that make up closer to 50% of the District population, including the Temne people, Fulani, Sherbro, Kissi, Mandingo, and Kuranko.

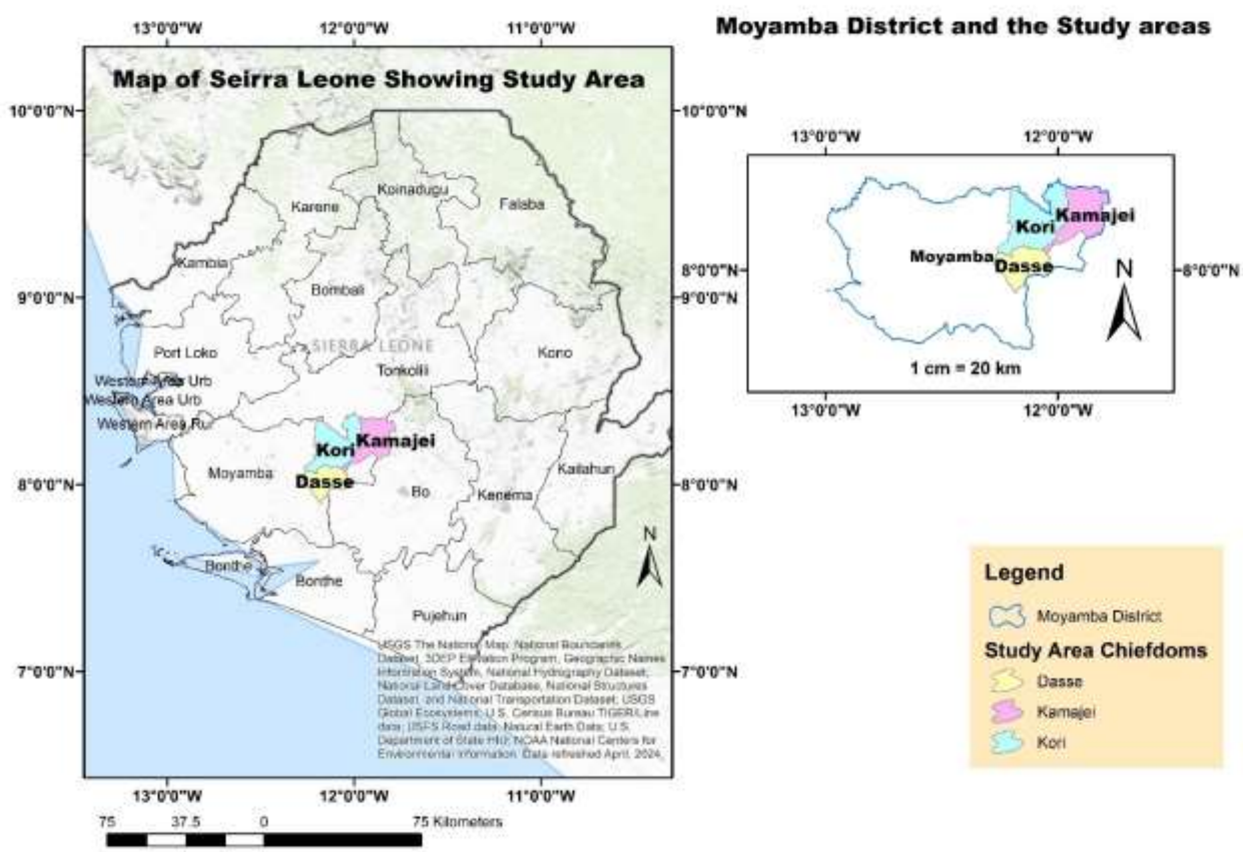

Figure 2. Map of Sierra Leone showing Moyamba District and three Chiefdoms

Target Population

The target population of this study consists of all individuals but a random selection of 300 respondents was made.

Sample Size and Sampling Procedure

Stratified multiple random sampling procedure was adopted to select the extension expert agents and key informants constituting the sample for this study. The sampling aimed at selecting eligible persons with equal probability. The study was conducted in three chiefdoms in Moyamba District, and a total of 300 farmers were selected by simple random sampling from three chiefdoms, Dasse, Kori and Kamajei. Two communities were selected from each of these chiefdoms, totaling to six settlements. and sample responses were obtained from each village. Questionnaires and interview schedules were used to respondents to elicit the needed information. Interview and questionnaires were developed to examine respondents 'socio-economic characteristics and other information for the above-mentioned objectives.

Laswell's model of communication was used in this study. This model is about the process of communication and its function to society. Laswell's model of communication describes an act of communication by defining who said it, what was said, in what channel it was said, to whom it was said, and with what effect it was said. It is usually used on measuring the effectiveness of Digital Agricultural Extension Advisory Services communication although Laswell's model is aimed to study mass communication, it is positively known for being suitable to different situations, including the interpersonal communication. (Aila (2019)
Yamane's formula: $n = N/(1+N(e)^2$. Was used to determine the sample size.

The variables in this formula are:

n = the sample size

N = the population of the study

e = the margin error in the calculation

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Table 1. Sample Selection and Sample Size

Chiefdoms	Total Population of Cassava and Potato Farmers	Subgroups of cassava and potato growers			Sample	
		Cassava Growers	Potato Growers	Both Cassava and Potato Growers	Target Sample	Desired Sample Size
1. Dasse						
Madina	390	182	128	80	140	36.0
Mano	585	286	177	122	253	66.0
Subtotal	**975**	**424**	**323**	**228**	**393**	**102.0**
2. Kamajei						
Fala	336	113	122	101	123	32.0
Senehun	550	222	211	117	210	55-0
Subtotal	**886**	**335**	**333**	**218**	**330**	**87.0**
2. Kori						
Njala	449	220	124	105	192	50.0
Taiama	594	319	146	129	235	61.0
Subtotal	**1,043**	**539**	**270**	**234**	**427**	**111.0**
Grand-Total	2904	1,298	926	680	1,153	300.0

The list of all cassava and potato farmers was received from the Ministry of Agriculture and Food Security (MAFS), Moyamba District. The names of the main cassava and potato producing chiefdoms were then written on pieces of paper, folded, and placed in a black plastic bag. A child (6 years old) from chiefdom was asked to draw from the plastic one-folded paper until the six communities were, respectively chosen. The third stage involved the selection of the participant's or respondents to interview in the study (cassava and potato farmers in the selected communities). This was done using the proportionality factor to select *300* cassava and potato farmers *in the three chiefdoms.* The proportionality factor used is stated as follows:

$$S = \frac{P}{p*n} \quad \text{……………………………... ....} \quad 1$$

Where p = the number of respondents sampled in each community in the chiefdoms; **P** = the number of respondents in all chiefdoms; and **n** = the desired number of respondents selected for study. The proportionality factor ensures that the sample from each subgroup is proportional to the size of that subgroup in the overall population. It is calculated as:

Proportionality Factor = Desired Sample Size = ……………… 2

Total Population Size = Desired Sample Size

Sample for each subgroup = Subgroup Population × Total Population Size

$Sz = \sum (Da_g + Ka + Ko_s)$

Where: ∑ is the sum total

D_{sg} is the subgroups selected from the Dasse Chiefdom

Ka_{sg} is the subgroups selected from the Kamajei Chiefdom

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Ke is the subgroups selected from the Kori Chiefdom
$Sz = \sum D_{sg} + \sum Ka_{sg} + K_o$
Sample from Dasse (S_D)= $\sum$ D = 36 + 66 = 102

Sample from Kamajei ($S_{Ka} = \sum Ka_{sg}$) = 32+55 = 87

Sample from Kori (S_Ke) = $\sum K_o$) = 50.0 + 61 = 111
Total Sample Size = 102 + 87 + 111 = 300
Sample Size = 300

Research Instrument
The main instrument for the study was a structured questionnaire and a focus group guide. The instrument was divided into four sub-sections based on the objectives. *Section A* solicited information on the different digital channel use by farmers in Moyamba Districts; while section B gathered information on the attitudes of farmers towards digital services in Moyamba District. Section C collected statistics on the socio-economic characteristic of the farmers in Moyamba District; and Section D sort information on the associated problems of farmer's accessibility to digital tools and advisory services.

Validity of the Research Instrument
Face and content validity was established by a panel of experts in the discipline of extension and communication to determine the extent to which the instrument measures what it is design to measure. According to subjective assessment of a panel of experts in extension and communication and other related fields of study, relevant specialists at Njala University were asked to assess the content and face validity of the instrument. Each of the experts on the panel was asked to examine the instrument for clarity, wording, length, format and overall appearance, and this ensure that anything that would confuse respondents and research assistants were removed. The experts confirmed the instrument and certify whether it contain items that elicited the intended responses on the use of Digital Agricultural Extension Advisory Services.

Reliability
The reliability of the instrument was determined by trial administration of questionnaires to 10 (3.7% of the sample) respondents in the study area. This was done by test-retest administration of questionnaire within a four-week interval and the needed modifications were made. The result of this test followed by the needed modifications of the data collection

Data Collection
The use of primary and secondary data was employed for this study. Secondary data was obtained from literatures, project reports, official documents, publications and consultations, and library materials among others. Primary data was obtained through the use of structured and validated questionnaire to elicit information from target respondents. Prior to data collection, the first step after the development of research instrument was the recruitment and training of data collectors/enumerators. With the aim of enhancing the quality of data for the study, adequate and

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quality data collectors/enumerators were recruited. The selection and recruitment of data collectors was considered on sex, competency, academic and good command of local language of the study area. A total of five researchers (3 data collectors and 2 facilitators for the focus group discussions) were recruited and given two days vigorous training focusing on practical field experience.

During the data collection period, the researchers made every effort to coordinate, manage and take part in all activities with the aim of maintaining the quality of data. Before commencement of actual field work - data collection, the investigators visited the selected sections in the chiefdom headquarters. The inhabitants selected as respondents in these sections were first contacted and suitable time was agreed upon in order to meet all of them in their respective sections. Data was collected through administration of structured and semi-structured validated questionnaires consisting of both open and closed-ended questions to elicit information from target respondents. Before administering various tools, the aim and relevance of the study was explained to respondents, and it was assured that the information given by them would be kept strictly confidential. The instruction as how to respond to each tool was also explained to the respondents. Respondents were asked to answer questions objectively and without discussing responses among themselves, so that the information reflects the reality of the situation on the ground. Also, focus group discussion was managed by two facilitators. The first facilitator introduced the purpose of the discussion and explained what would be expected of the participants. The first facilitator set the stage for the discussion and explained the procedures and rules; questions were asked, each participant was allowed to speak, and the facilitator moderated but did not participate in the discussion. The second facilitator led the discussion, control the flow and recorded the responses in the field notebook. Detailed accurate notes in the notebooks were noted as key information sources they will become the raw data that led to focus group findings.

Data Analysis

Data was analyzed using the Statistical Package for Social Sciences (SPSS) software. The descriptive statistics was used for tables, frequency distributions, percentages, mean, Variance and Standard deviation. In addition, Pearson's Correlation Coefficient (r), (to study the relationship between the scores of selected profile characteristics and the attitude of farmers), Multiple Linear Regression (MLR) analysis (to study the effect of independent variables on dependent variables) and Problem Face Index, and Logistic Regression Analysis,(used for prediction and classification problem) Logit Analysis(to evaluate the relationship between various predictor variables) ,Path Analysis, Principal Component Analysis, Poison Regression,(a statistical method used to analyze count data thereby allowing research to predict the frequency of event based on various factors), ,Lassayo Regulation, and Media Time Analysis.(the process of collecting and interpreting data about brands coverage in the media)

(PFI)= $(4 \times fv) + (3 \times fh) + (2 \times fm) + (1 \times fl) + (0 \times fn)$ table was used
Multinomial logistic regression was used for predicting farmer digital user class

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RESULT AND FINDINGS

Cluster Segmentation of farmers based on the Digital Agricultural Services Index (DASI)

The cluster was analyzed based on the Digital Agricultural Services Index (DASI) which shows that farmers in the study area fall into four main groups, each with different levels of digital literacy and use of agricultural technology. Cluster 1, called Digital Novices, makes up about 24% of the sample, with DASI scores ranging from 0 to 2. These farmers have very limited exposure to digital agricultural services and most of them rely on traditional information sources, such as local extension agents, radio programs, or other farmers, rather than digital tools. Their low scores suggest that they may lack access to smartphones or stable internet connection and might also need basic digital training. This group will require the support to begin engaging meaningfully with digital agriculture. Cluster 2, the Basic Practical Users, accounts for 51% of the farmers, with DASI scores between 3 and 7. These farmers have some familiarity with digital tools and use them in simple, practical ways, such as, making phone calls, sending or receiving SMS-based agricultural messages, and using mobile money services. However, they rarely engage with more advanced platforms such as mobile apps or online agricultural networks. Their participation shows that they have a foundation that can be built upon, and with the right training and better infrastructure, they could move toward and undertake advanced digital engagement.

The third cluster, called Integrated Connectors, includes 22.5% of the farmers, with DASI scores between 8 and 14. This group is quite comfortable using digital technology and actively connects with different agricultural services. They are likely to use smartphones, social media platforms, and mobile apps to access weather information, market prices, and agricultural advice. These farmers show real potential to become leaders in digital agriculture and can help promote the use of technology within their communities. They could be valuable partners in projects that aim to improve digital skills among other farmers.

The fourth and smallest cluster, the Advanced Analysts, represents just 2.5% of the sample, with DASI scores above 15. These are the highly tech-savvy farmers who use digital tools for advanced purposes such as farm management, data analysis, and online trading. They are the innovators and early adopters in the farming community, farmers who can test new digital tools and provide feedback to improve them. Although they make up a small percentage, their presence is encouraging because it shows that there are farmers who already fully embraced digital agriculture. (Table 2)

Distribution of digital tool usage across farmer clusters based on the digital agricultural services index (DASI)

Table 3. presents how different farmer groups, are segmented by their digital proficiency levels (based on the DASI), and the use of various digital tools and services. The results clearly highlight a digital divide among the clusters, showing progressive adoption of technology from Digital Novices (Cluster 1) to Advanced Analysts (Cluster 4). Farmers in Cluster 1 (Digital Novices) rely

exclusively on traditional tools, with 100% of them using radio as their main source of agricultural information. None in this group use mobile phones or other digital tools, which confirms their minimal engagement with modern technology. This indicates low digital literacy, limited access to devices, or possible infrastructural barriers such as poor connectivity or electricity supply. Cluster 2 (Basic Practical Users) shows a marked shift toward digital engagement, as 100% of the farmers in this group use mobile phones, likely for voice calls and SMS-based agricultural advisories. However, they do not use smartphones, mobile applications, or social media, reflecting a basic level of digital interaction. Their heavy reliance on mobile phones suggests that this group is familiar with basic ICT tools but has not yet transitioned to more advanced digital platforms.

In Cluster 3 (Integrated Connectors), farmers demonstrate more diverse and integrated digital usage. All farmers in this group use mobile phones, and a significant proportion use WhatsApp groups (88.9%), smartphones (44.4%), mobile banking (33.3%), and weather forecasting tools (33.3%). Some also access social media (22.2%) and mobile applications (22.2%). This pattern shows that these farmers are digitally active, using multiple platforms to connect with markets, extension agents, and fellow farmers. Their adoption of smartphones and mobile applications indicates an increasing comfort with complex digital interfaces and real-time information sharing. Farmers in Cluster 4 (Advanced Analysts) represent the most technologically sophisticated group. All of them use mobile phones, WhatsApp groups, mobile banking, smartphones, mobile applications, and precision agriculture tools. A large proportion also use weather forecasting tools (80%), social media platforms (60%), and GIS systems (80%). This demonstrates that these farmers are not only digitally literate but also capable of using advanced data-driven and analytical tools for decision-making. Their engagement with GIS and precision agriculture technologies reflects a strong understanding of digital farming and access to more advanced technological resources. Across the entire sample, mobile phones (85%) are the most widely used tool, showing that basic digital access is common even if advanced usage remains low. In contrast, the use of precision agriculture tools (2.5%) and GIS (2.0%) remain extremely limited, highlighting a large technological gap in the farming community. The progressive increase in the diversity and sophistication of digital tool usage from Cluster 1 to Cluster 4 shows a clear gradient of digital engagement. Our finding is in line with recent national data which shows that while mobile phone penetration is widespread, advanced tools like smartphones and mobile apps remain concentrated among younger, educated, and wealthier male farmers (Statistics Sierra Leone, 2023; Data Reportal, 2023).

Socio-economic and digital profile of farmer segments

Table 4. presents the socio-economic and digital characteristics of four farmer clusters, revealing distinct patterns of technology adoption and livelihood profiles. The segmentation highlights differences in age, gender, education, income, and digital engagement across the farmer population. The overall sample shows an average age of 38.5 years and 45.5% female participation. Cluster 1, identified as traditional radio users, represents 26% of the sample and consists mainly of older farmers averaging 49.1 years of age, with a high proportion of women (68.3%). This group

relies heavily on radio for agricultural information and demonstrates minimal use of digital tools. Cluster 2, the mobile-centric livelihoods group, is the largest segment (44%) with an average age of 41.2 years and moderate female representation (52.8%). These farmers primarily use basic mobile phones for communication and market access but show little engagement with smartphones or advanced applications. Cluster 3, emerging tech adopters, accounts for 23.5% of farmers and includes younger individuals averaging 30.1 years of age, with only 17.8% female representation. They are more digitally active, using WhatsApp, smartphones, and mobile apps to access advisory and financial services. Cluster 4, integrated commercial farmers, makes up 6.5% of the sample and includes younger, more educated, and financially capable farmers with a low female presence (7.7%). Educational levels differ significantly across clusters. In Cluster 1, none of the farmers attained tertiary education, and 84.6% have only primary or non-formal education, indicating limited literacy and technological engagement. In Cluster 2, 40.9% have secondary education, reflecting a moderate educational base sufficient for mobile phone use. Cluster 3 farmers show a balanced distribution, with 51.1% attaining secondary and 25.5% tertiary education, correlating with greater digital adoption. Cluster 4 farmers are the most educated, with 76.9% having tertiary qualifications, highlighting the strong link between education and digital competence. Economic characteristics also show clear progression from subsistence to commercial farming. Cluster 1 farmers have the smallest farm sizes (1.9 acres) and lowest average annual income (3.85 million Leones), reflecting smallholder subsistence farming. Cluster 2 farmers manage slightly larger farms (2.4 acres) and earn 6.2 million Leones annually. Cluster 3 farmers operate moderately larger holdings (3.2 acres) with higher incomes (9.1 million Leones), reflecting growing engagement in market-oriented farming. Cluster 4 farmers, with an average farm size of 7.1 acres and an annual income of 21.5 million Leones, represent the commercialized and digitally integrated group. Experience also varies, with traditional radio users averaging 22.5 years in farming compared to 8.1 and 9.5 years for clusters 3 and 4 respectively, suggesting that younger farmers compensate for limited experience with digital tools and education.

Digital tool usage provides a clear indicator of modernization. Radio use is confined entirely to Cluster 1, while mobile phone ownership is nearly universal (85% overall) and reaches 100% in clusters 2, 3, and 4. WhatsApp and smartphone adoption are concentrated among younger and wealthier farmers, with 80.9% of Cluster 3 and all members of Cluster 4 using WhatsApp. Smartphone ownership follows a similar pattern, with none in clusters 1 and 2, 42.6% in Cluster 3, and 100% in Cluster 4. Mobile banking and app usage also increase with income and education: absent in clusters 1 and 2, moderately adopted in Cluster 3 (around 30%), and dominant in Cluster 4 (above 84%).

Factor loadings of farmers' attitudes towards digital services in Moyamba district

Table 5 presents the factor loadings of farmers' attitudes toward digital services in Moyamba District, showing how each attitude statement is associated with four underlying factors. The first factor, Perceived Usefulness, has high loadings for statements such as digital services improving farm productivity (0.82), mobile apps being useful for farming practices (0.78), online

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marketplaces being useful (0.75), and improved crop management practices (0.71). This indicates that farmers perceive digital services primarily in terms of their practical benefits for productivity and crop management. The second factor, Access and Awareness, captures farmers' access to and awareness of digital tools, with high loadings for having adequate access to digital information (0.79), being aware of available digital tools (0.76), mobile network supporting farming apps (0.68), and reliable internet availability (0.65). The third factor, Trust and Reliability, includes statements such as digital platforms being user-friendly (0.72), services being reliable and consistent (0.69), trusting available digital services (0.66), and feeling secure conducting transactions (0.63), reflecting the importance of confidence and security in adoption. The fourth factor, Digital Literacy Support, has high loadings for receiving adequate training support (0.81), willingness to adopt new technologies (0.73), affordability of digital services (0.68), and government support (0.61), showing that training, financial capacity, and institutional support facilitate adoption. Some items, such as receiving timely weather updates (0.42, 0.35, 0.28, 0.38), observing that other farmers use digital services (0.38, 0.41, 0.32, 0.29), and easy communication through digital tools (0.45, 0.32, 0.37, 0.31), have moderate loadings across multiple factors, indicating that they relate to several dimensions simultaneously. Overall, the analysis shows that farmers' attitudes toward digital services can be grouped into four dimensions: perceived usefulness, access and awareness, trust and reliability, and digital literacy support. This suggests that adoption depends on the practical benefits of digital tools, the availability of infrastructure and information, the reliability and security of services, and the provision of training, affordability, and government support. Our research is in line with studies carried out by (Venkatesh et al., 2003). who said Farmers' attitudes toward digital tools are shaped by perceived usefulness, access, trust, and digital literacy dimensions aligned with the UTAUT framework.

Morris, M.G. and V. Venkatesh (2000) in their study said. empirical evidence suggests that perceived utility and literacy support are the strongest predictors of adoption intent, while trust plays a secondary role. Also Samuel Fiifi Eshun and Evzen Kocenda, 2025 said. financial constraints remain a dominant barrier, negatively influencing attitudes and limiting access, a trend echoed across Sub-Saharan Africa

Adoption of digital tools and average digital agricultural service index (DASI) scores across farmer profiles

Table 6 presents the adoption of different digital tools among farmers segmented into four digital user profiles. Mobile phone ownership is high overall (85.0%) and almost universal among Digital Enthusiasts (98.2%) and Practical Optimists (92.9%), indicating that basic mobile access is widespread, though much lower among Skeptical Traditionalists (46.7%), reflecting limited technology penetration in this group. WhatsApp usage is concentrated among Digital Enthusiasts (58.9%) and is minimal among Access Constrained (4.5%) and absent among Skeptical Traditionalists, showing that advanced communication tools are primarily adopted by younger, tech-savvy farmers. Similarly, smartphone ownership is highest among Digital Enthusiasts (42.9%) but very low in other groups, highlighting disparities in device capability. Mobile banking follows the same pattern: only Digital Enthusiasts (30.4%) use it meaningfully, whereas other groups have near-zero adoption, indicating that financial inclusion via digital platforms is closely linked to higher technology access and digital literacy. Radio usage shows an inverse trend, being more common among older and less digitally active farmers, such as Skeptical Traditionalists (53.3%) and Access Constrained (38.6%), reflecting reliance on traditional media sources for information. The average DASI score, which measures digital engagement intensity, is highest for Digital Enthusiasts (11.2), moderate for Practical Optimists (5.8), low for Access Constrained (3.1), and minimal for Skeptical Traditionalists (1.4). This gradient confirms that digital adoption is closely associated with age, education, and access, with younger and better-educated farmers actively using multiple digital tools, while older and less-resourced farmers remain largely excluded.

Our research is similar to work done by Tadesse and Bahiigwa (2015) who said. empirical evidence suggests that perceived utility and literacy support are the strongest predictors of adoption intent, while trust plays a secondary role.

CONCLUSION AND RECOMMENDATION

In conclusion, the digital transformation of agriculture in Moyamba District is an ongoing but deeply stratified process. The transition from analog to integrated digital ecosystems is not a natural or inevitable progression but is powerfully shaped by a farmer's socio-economic standing and constrained by a tangible lack of financial and infrastructural resources. The smartphone is the critical gateway device, and social messaging platforms like WhatsApp serve as vital enablers for higher-level engagement. These findings necessitate a move away from one-size-fits-all interventions. Instead, they call for a segmented strategy that addresses the specific barriers faced by each farmer group from basic digital literacy and device access for novices to advanced data management support for integrated farmers while simultaneously pursuing systemic reforms to lower the costs of connectivity and devices. Ultimately, bridging the digital divide in Moyamba will require a concerted, multi-stakeholder effort that tackles not just the technological gaps, but the underlying socio-economic inequalities that perpetuate them.

Recommendation

To effectively respond to the adoption of agricultural digital tools, farmers can consider the following recommendations:

1. Farmers should invest time in learning about available digital tools and technologies. This can be achieved through workshops, online courses, or collaboration with agricultural extension services that provide training on how to use these tools effectively.

2. Rather than adopting multiple technologies at once, farmers should begin with one or two digital tools that address their most pressing needs. This incremental approach allows for easier management and adaptation to new systems.

3. Farmers should be open to sharing data with technology providers and other stakeholders. This can enhance the functionality of digital tools and lead to better insights that can improve farm management practices.

4. Engaging with other farmers who have adopted similar technologies can providevaluable insights and support. Peer networks can facilitate knowledge sharing about best practices, challenges faced, and solutions found.
5. Keeping abreast of industry trends and emerging technologies is crucial for farmers. Subscribing to agricultural journals, attending conferences, or participating in online forums can help them stay updated on innovations that could benefit their operations.
6. Farmers should look for digital tools that are customizable to their specific farming conditions and needs rather than one-size-fits-all solutions. Personalized technology solutions are more likely to yield positive results.
7.The Ministry of Agriculture in Sierra Leone offer programs aimed at supporting the adoption of agricultural technologies through grants or subsidies. Farmers should explore these resources as they may alleviate some financial burdens associated with adopting new tools.
8. Farmers can work collectively to advocate for improved technological infrastructure in Moyamba District, such as better internet connectivity, which is vital for the effective use of many agricultural digital tools.

Table 2: Cluster Segmentation of farmers based on the Digital Agricultural Services Index (DASI)

Cluster Number	Proposed Segment Name	DASI Score Range (Theoretical)	DASI Score Range (Actual from Data)	% of Sample
1	Digital Novices	0 - 3	0 - 2	24.0
2	Basic Practical Users	4 - 8	3 - 7	51.0
3	Integrated Connectors	9 - 15	8 - 14	22.5
4	Advanced Analysts	16+	15+	2.5

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Table 3. Distribution of digital tool usage across farmer clusters based on the digital agricultural services index (DASI)

Digital Tool	Overall Sample(%)	Cluster 1. Digital novices(%)	Cluster 2. Basic practical users(%)	Cluster 3. Integrated connectors(%)	Cluster 4. Advanced analysts(%)
Mobile Phones	85.0	0	100.0	100.0	100.0
Radio	25.5	100.0	0.0	0.0	0.0
WhatsApp groups	22.0	0.0	0.0	88.9	100.0
Mobil Banking	10.5	0.0	0.0	33.3	100.0
Smart phones	15.0	0.0	0.0	44.4	100.0
Mobile Application	12.0	0.0	0.0	22.2	100.0
Weather forecasting tools	11.5	0.0	0.0	33.3	80.0
Social Media platforms	8.0	0.0	0.0	22.2	60.0
Precision Agriculture tools	2.5	0.0	0.0	0.0	100.0
Geographic information system (GIS)	2.0	0.0	0.0	0.0	80.0

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Table 4. Socio-economic and digital profile of farmer segments

Characteristic	Overall sample(%)	Cluster 1. Traditional radio users(%)	Cluster 2. Mobile-centric livelihoods(%)	Cluster 3. Emerging tech adopters(%)	Cluster 4. Integrated commercial farmers(%)
SIZE AND DEMOGRAPHICS					
Sample	100	26.0	44.0	23.5%	6.5
Avg. Age	38.5	49.1	41.2	30.1	35.8
% Female	45.5%	68.3	52.8	17.8%	7.7
EDUCATION					
Tertiary	15.0	0.0	5.7	25.5%	76.9
Secondary	35.0	15.4	40.9	51.1%	23.1
Primary/non-formal	50.0	84.6	53.4	23.4%	0.0
FARM ECONOMICS					
Avg. Farm Size (Acres)	2.8	1.9	2.4	3.2	7.1
Avg. Annual Income ('000 Leone)	7,150	3,850	6,200	9,100	21,500
Avg. Farming Experience	14.2	22.5	15.8	8.1	9.5
DIGITAL TOOL USAGE					
Radio	25.5	100.0	0.0	0.0	0.0
Mobile Phone	85.0	42.3	100.0	100.0	100.0
WhatsApp	22.0	0.0	0.0	80.9	100.0
Smartphone	15.0	0.0	0.0	42.6	100.0
Mobile Banking	10.5	0.0	0.0	29.8	84.6
Mobile App	12.0	0.0	0.0	19.1	92.3

Table 5 Factor loadings of farmers' attitudes towards digital services in Moyamba district

Attitude Statement	Factor 1. Perceived Usefulness	Factor 2. Access and Awareness	Factor 3. Trust and reliability	Factor 4. Digital literacy support
Digital services improved farm productivity	0.82	0.15	0.08	-0.03
Mobile apps useful for farming practices	0.78	0.12	0.21	0.06
Online marketplaces useful	0.75	0.18	0.14	0.11
Improved crop management practices	0.71	0.09	0.19	0.13
Farmers have adequate access to digital info	0.24	0.79	0.12	0.08
Aware of digital tools available	0.18	0.76	0.15	0.14
Mobile network supports farming apps	0.21	0.68	0.09	0.17
Reliable internet available	0.16	0.65	0.22	0.13
Digital platforms are user-friendly	0.31	0.28	0.72	0.15
Digital services reliable and consistent	0.25	0.19	0.69	0.18
Trust digital services available	0.22	0.23	0.66	0.21
Feel secure conducting transactions	0.19	0.17	0.63	0.24
Receive adequate training support	0.13	0.22	0.18	0.81
Farmers willing to adopt new technologies	0.25	0.19	0.24	0.73

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Can afford cost of digital services	0.18	0.25	0.16	0.68
Government provides support	0.21	0.28	0.22	0.61
Receive timely weather updates	0.42	0.35	0.28	0.38
Other farmers use digital services	0.38	0.41	0.32	0.29
Easy communication through digital	0.45	0.32	0.37	0.31

Table 6. Adoption of digital tools and average digital agricultural service index (DASI) scores across farmer profiles

Digital Tool	**Overall**	**Digital enthusiasts**	**Practical optimists**	**Access constrained**	**Skeptical traditionalists**
Mobile Phone	85.0	98.2	92.9	78.6	46.7
WhatsApp	22.0	58.9	18.6	4.5	0.0
Smartphone	15.0	42.9	8.6	2.3	0.0
Mobile Banking	10.5	30.4	5.7	0.0	0.0
Radio	25.5	10.7	22.9	38.6	53.3
Avg. DASI Score	5.8	11.2	5.8	3.1	1.4

Authors' Contributions:

This article was chapter by SSK (the main author) at Njala University School of Agriculture and food sciences, involving contributions from all three authors. SK. developed the methodology, . co-supervised, and edited the article with SSK and MPG contributed to the theoretical framework, and SSK, MPG and SK contributed to data curation and review. All authors endorsed the final version of the manuscript.

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REFERENCES

Aker JC, Ghosh I, Burrell J, The Promise (and Pitfalls) of ICT for Agriculture Initiatives. CGD Working Paper 431; 2016. Available:https://www.cgdev.org/sites/defa ult/files/promises-and-pitfalls-ictagriculture-initiatives.pd

Arouna, A., Michler, J.D., Yergo, W.G., and Saito, K. 2021. One size fits all? Experimental evidence on the digital delivery of personalized extension advice in Nigeria. American Journal of Agricultural Economics 103(2): 596-619.

Cole, S., and Sharma, G. 2017. The promise and challenges of implementing ICT in Indian agriculture. In India Policy Forum (pp. 11-12

J. W.Creswel, (2014). Research design: Qualitative, quantitative, and mixed methods approach Poste

Fabregas, R., Kremer, M., and Schilbach, F. 2019. Realizing the potential of digital development: The case . of agricultural advice. Science 366 (6471), p. eaay3038.

Fabregas, R., Harigaya, T., Kremer, M., and Ramrattan, R. 2022. Digital Agricultural Extension for . . Development. In Introduction to Development Engineering: A Framework with Applications from the Field (pp. 187-219). Cham: Springer International Publishing

Fernando AN (2021) Seeking the treated: The impact of mobile extension on farmer information exchange in India. *Journal of Development Economics* 153: Article 102713.\

Koyenikan, M., & Ohiomoba, I. (2021). Technologies Using Telephone. Applications in Edo State, Nigeria. Fudma Journal Of Sciences, 5(2), 434-441. https

Mapiye O, Makombe G, Molotsi A, (2021) Towards a revolutionized agricultural extension system for the sustainability of smallholder livestock production in developing countries: The potential role of ICTs. *Sustainability* 13(11): 586

Morris, M.G. and V. Venkatesh (2000) "Age Differences in Technology Adoption. Decisions: Implications for a Changing Work Force", *Personnel Psychology* (53)2, pp. 375–403

N. K. Singh ,N. H.Sunitha ,Gagan Tripathi , D. R. K. Saikanth , Akanksha Sharma , Asha Elizabeth Jose and M. V. Karuna Jeba MaryAsian (2023).Impact of Digital Technologies in Agricultural Extension Journal of Agricultural Extension, Economics & Sociology Volume 41, Issue 9, Page 963-970, 2023; Article no.AJAEES.104391 ISSN: 2320-7027

Ochilo WN, Ruffhead H, Rumsey A, Chege F, Lusweti C, Oronje M, Otieno W. Can you Ensure that ICT for development apps are downloaded and used? A case study of the plantwise data collection app for plant health in Kenya. Journal of Agricultural & Food Information. 2019; 20:237-53

RKoajkhowaI and Martin Quamin (2021) Personalized digital extension services and agricultural performance: Evidence from smallholder farmers in India the Role of ICT in Enhancing Agricultural Productivity." *Journal of Agricultural Science*, vol. 12, no. 3, pp. 45-60. October 2021

Samuel Fiifi Eshun and Evzenda (2025). Determinants of Financial Inclusion in Sub-Saharan Africa and OECD countries

Spielman D, Lecoutere E, Makhija S, (2021) Information and Communications Technology (ICT) and Agricultural Extension in Developing Countries. *Annual Review of Resource Economics* 13: 177–201.

(Sierra Leone summary poverty assessment, (2014), Sierra Leone constraints analysis report, (2021)

Statistics Sierra Leone, (2023); Data Report. Sierra Leone Annual Agricultural Survey Report

Sida, T.S., Gameda, S., Chamberlin, J., Andersson, J.A., Getnet, M., Woltering, L., and Craufurd, P. 2023. . Failure to scale in digital agronomy: An analysis of site-specific nutrient management decision-support tools in developing countries. Computers and Electronics in Agriculture 212, p.108060

Singh , N. H. Sunitha , Gagan Tripathi , D. R. K. Saikanth , Akanksha Sharma , Asha Elizabeth Jose and M. V. Karuna Jeba Mary(2023). Impact of Digital Technologies in Agricultural Extension Asian Journal of Agricultural Extension, Economics & Sociology Volume 41, Issue 9, Page 963-970, 2023; . Article no. AJAEES.104391 ISSN: 2320-7027

Steinke J, van Etten J, Müller A, et al. (2021) Tapping the full potential of the digital revolution for agricultural extension: An emerging innovation agenda. *International Journal. of Agricultural Sustainability* 19(5–6): 549-565.

Yang, P. & Ou, Y. 2022. Transforming public agricultural extension and advisory service systems in smallholder farming: Status quo, gaps, way forward. Rome. FAO. https://doi.org/10.4060/Cc2131enfood and Agriculture Organization of the United Nations Rome, (2022). Transforming public agricultural extension and advisory service systems in smallholder farming Status quo, gaps, way forward

Yingjie Song, Yi Song, Qiusu Wang (2026). Smart Agriculture Development: How Can Rural Digital Transformation Enhance the Resilience of Food Security? National Liberary of Medicine2026 Jan 24;15(3):426. doi: 10.3390/foods1503042

Zhang, Qiang, (2021). "Farmers' Perceptions and Adoption of Agricultural Technology: Evidence from China." *Technological Forecasting and Social Change*, vol. 135, pp. 1-9