



Research article

Post-Covid-19 pandemic extension delivery: A systematic review of E-extension services prospects in Ghana

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ABSTRACT

The COVID-19 pandemic exposed the limitations of the traditional, in-person agricultural extension services in Ghana. This systematic review investigates the potential and readiness of Ghana to adopt digital agricultural extension services (E-extension) in the post-pandemic era. Employing the Joanna Briggs Institute Critical Appraisal tools, we analyzed institutional and journal articles from 2010 to 2022. Our findings reveal a rapidly growing telecommunication sector in Ghana, with mobile phone usage and ICT adoption exceeding the Sub-Saharan Africa average. This digital infrastructure creates a promising foundation for public E-extension initiatives. However, the review emphasizes the critical need to integrate digital strategies with existing methods to ensure inclusive and effective reach, particularly for marginalized communities. Ultimately, this review highlights the untapped potential of leveraging ICT advancements for resilient and accessible E-extension services in Ghana, offering a transformative pathway for agricultural extension in the post-pandemic era.

1. Introduction

The role of Information Communication Technologies (ICTs) on development, access, and dissemination of agricultural information in small-holder agriculture has become a matter of great importance. It is evidenced that supporting small-holder farmers' information access through ICTs adoption play essential role in increasing their productivity, profitability, and augmenting their livelihoods through enhanced connectivity and knowledge dissemination at individual and community levels [1]. Moreover, adopting ICT in small-holder agriculture has proven not to only facilitates seamless access to vital information, but also serves as a catalyst for transformative change in the numerous challenges faced by small-holder farmers in developing countries [1,2].

Presently, there are more than 12 million smallholder farmers in Ghana who produce bulk of agricultural and food products in country [2]. Meanwhile, most of these farmers farm on family lands with an average size of about 0.6 ha [3,4]. Smallholder farmers in Ghana have limited access to technologies and production resources, therefore, they depend largely on agricultural extension services for production information such as weather forecasts, pests and diseases control, input prices, and market dynamics [5].

The agricultural extension services in Ghana support farmers information access through the pluralistic extension system, which uses multiple strategies such as home and farm visits, commodity-based, and farmer field school [6]. The extension services in Ghana, however, face a myriad of technical and logistic challenges such as understaffed and lack of transportation [7]. For instance, the Food and Agriculture Organization (FAO) recommends that one agricultural extension agent covers four hundred (400) farmers, however in

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Ghana, the ratio of one extension agent to farmers is about 1:1500, which is far lower than the FAO recommended ratio [8]. This impedes their ability to deliver timely agricultural information to smallholder farmers in the country, especially those located in remote and difficult-to-reach areas [6,9]. The woes of extension service delivery in Ghana became apparent during the recent novel corona virus disease (COVID-19) pandemic.

The COVID-19 which emerged in Wuhan, China in the latter part of December 2019 was declared a global pandemic by the World Health Organization (WHO) in March 2020, after it spread across many countries in the world [10]. Right after the declaration, governments across the world became alert, especially those in Sub-Saharan Africa (SSA) that had not recorded any COVID-19 cases. Ghana, a SSA country was no exception. Ghana recorded its first COVID-19 case on March 12, 2020, and by the end of March, the reported cases had exceeded 134 [11]. In response, the government of Ghana promulgated public health measures to control and contain the spread of the virus [12]. The measures included social distancing, banning of public gatherings for funerals, festivals, conferences, group meetings, and a total lockdown in hotspot cities like Accra, Tema, Kasoa, and Kumasi [11,13,14]. While the measures were apt and timely, they negatively affected farmers and agricultural extension services engagement [14,15]. The restrictions obstructed the provision of agricultural extension services like workshops, field visits, training, and input distributions [14]. The agricultural extension agents could not meet farmers in groups and on individual basis, extension activities became a standstill, because the agricultural extension services in Ghana use extension approaches such as home and farm visits which heavily involve physical meetings with farmers [9]. Nevertheless, the COVID-19 pandemic and its associated restrictions have proven that the extension services cannot rely on its current models of extension delivery. Therefore, extension approaches that do not rely heavily on the physical presence of extension agents are needed to enhance effective extension delivery in Ghana.

After easing the COVID-19 retractions, various governments including Ghana are putting measures into place to balance their economic wheels. These measures include implementation of new agricultural policies and reorganizing the traditional agricultural extension models to embrace digital extension delivery. Existing research findings show that SSA is among the top regions in the world with the highest mobile phone penetration rate [16]. The Association of Mobile Network Operators report shows that about 75 percent of the SSA population is connected to mobile network [17]. Further research shows that mobile internet connectivity in the region has increased significantly. For example, 3G coverage expanded from 63 percent in 2017 to 75 percent in 2019, while 4G coverage has doubled to almost 50 percent in 2019 [18]. Moreover, present research findings show that about 91 percent of adults in South Africa own mobile phones; 70 percent in Tanzania and more than 75 percent of adults in Kenya [18]. The increase in mobile phone and internet access has inspired the development of mobile apps like M-Shamba in Kenya and "UPTAKE" in Tanzania to provide agricultural support services [19,20]. However, as research findings show an increase in mobile phone and internet access and the possibility of implementing digital agricultural extension programs across Africa, little is known about the case of Ghana. The reports on mobile phone penetration rate, internet access, ICT infrastructure and digital ecosystem in Ghana are not well established in literature. The available data and research results on the Ghanaian telecommunication and digital system are scattered in literature. Consolidation of existing research findings on the Ghanaian telecommunication system would help to know the appropriate electronic extension services that can be implemented to serve the needs of smallholder farmers. It is therefore important that critical feasibility inquiries are done to apprehend the country's potential to implement electronic agricultural services.

1.1. Agricultural extension systems in Ghana

Agricultural extension services evolved strongly in Ghana in the early 1970s to respond to the World Food Crisis when there was an urgency to increase agricultural productivity in the country [21]. Today, the Ghanaian agricultural extension services adopt the pluralistic extension approach, which involves multiple actors such as the government through the Directorate of Agricultural Extension Services (DAES), Non-governmental Organizations (NGOs), private institutions, and cooperative associations [22].

The largest body that offers agricultural extension services in Ghana is the State, through the DAES under the Ministry of Food and Agriculture (MOFA). MOFA has offices in all the regions and districts in Ghana with technical officers from the extension directorate present to support farmers with extension advisory services. The public extension system in Ghana, like in many other countries, has gone through so many reforms after Ghana's independence. Initially, the agricultural extension approach practiced under the public extension system was the Unified Extension System (UES), however, due to a lack of coordination between extension services and research, the agricultural extension services were decentralised [6,22]. The decentralised system means that the control of the agricultural extension activities by the Ministry of Food and Agriculture has been transferred to the Metropolitan, Municipal and the District Assemblies (MMDAs), which is the lowest arm of government administration in Ghana [6,22,23]. Under the decentralised extension system, the concept of demand-driven extension services was implemented to increase total productivity, farm income, and improve farmers' livelihoods [24]. Today, both public and private institutions participate in extension (pluralistic system) delivery in Ghana where the government (DAES), NGOs, and the private sector work together to support farmers in diverse ways. They use extension techniques like group meetings, home and farm visits, and field demonstrations, which involve physical meetings with farmers [5,6]. Despite the decentralised extension system, extension delivery face series of challenges.

1.1.1. Challenges of extension delivery in Ghana

The review of past research shows that extension delivery faces numerous challenges. Churi et al. [25] observed that the extension services in Ghana face staffing challenges across the various districts in the country which hamper quality information delivery. They found that one extension agent serves more than one thousand farmers and attributed it to the retiring of field staff without replacement (embargo of recruitment). Furthermore, extension and veterinary agents lack resources such as motorbikes, funds, vaccines, and other resources that are vital to their work [7,26]. Farmers' farms are geographically scattered; extension agents can

reach these areas through motorbikes, however, many field agents do not have motorbikes therefore they are unable to visit farmers. Moreover, those who have motorbikes often lack fuel and maintenance support [22]. Poor road networks and lack of access routes to farms in rural areas further impede extension services to farmers in Ghana. Socio-cultural practices coupled with gendered issues further constrain women’s access to extension services [27]. In many rural areas, married women farmers are discriminated against accessing extension services as social cultural norms and practices forbid them from meeting male extension agents without the presence of their husbands [28–30,39].

1.1.2. Extension delivery challenges during and post-COVID-19 pandemic

One of the challenges farmers faced during the COVID-19 lockdown was access to direct extension services. During the restrictions, veterinary technical officers could not visit farmers to perform animal husbandry activities such as castration, debeaking, pests and diseases surveillance [30]. Titigah [31] observed that the ban on public gatherings and social distancing occasioned by the COVID-19 pandemic brought all extension and farmers meetings in districts like East Mamprusi, Nanumba South, Kumbungu and many other districts in Northern Ghana to a halt. Similarly, Ojokoh et al. [32] found that more than 82 percent of farmers in their study farm revenue was affected due to a lack of information and access to market during the COVID-19 restrictions.

Another identified challenge was farmers’ access to input services [11,13,14]. Many crop producers, especially, cocoa and vegetable farmers get farm inputs such as seeds, fertilizers, pesticides, and weedicides on credit from input dealing companies. These companies assign their private extension agents to supply the inputs to farmers, provide advisory services on input use, quality control compliance during production and harvesting of produce and retrieve loans after harvesting either in kind or in cash. However, during the COVID-19 lockdown, farmers could not access inputs and extension visits which delayed their farming operations [14,32]. Additionally, farmers under the government flagship program, Plant for Food and Jobs (PFJ) faced a series of challenges knowing the actual price of input, available inputs, and time of delivery. Prior to the COVID-19 pandemic, extension agents provided these services to farmers through their routine group meetings and farm visits, however the restriction constrained these activities [31]. Lack of trust and the fear of contracting the coronavirus prevented farmers and extension agents’ physical interaction post-COVID-19 pandemic restriction [14,15]. The identified challenges facing extension delivery in Ghana during and after the COVID-19 restrictions are an indication that physical extension contact needs to be complemented with electronic extension services to be able to serve farmers equally.

1.2. Conceptual framework for agricultural extension communication

Currently, agricultural extension services in Ghana rely heavily on the orthodox techniques of disseminating information where extension agents are the main carriers of agricultural innovations, technologies, and livelihood information to farmers. However, these

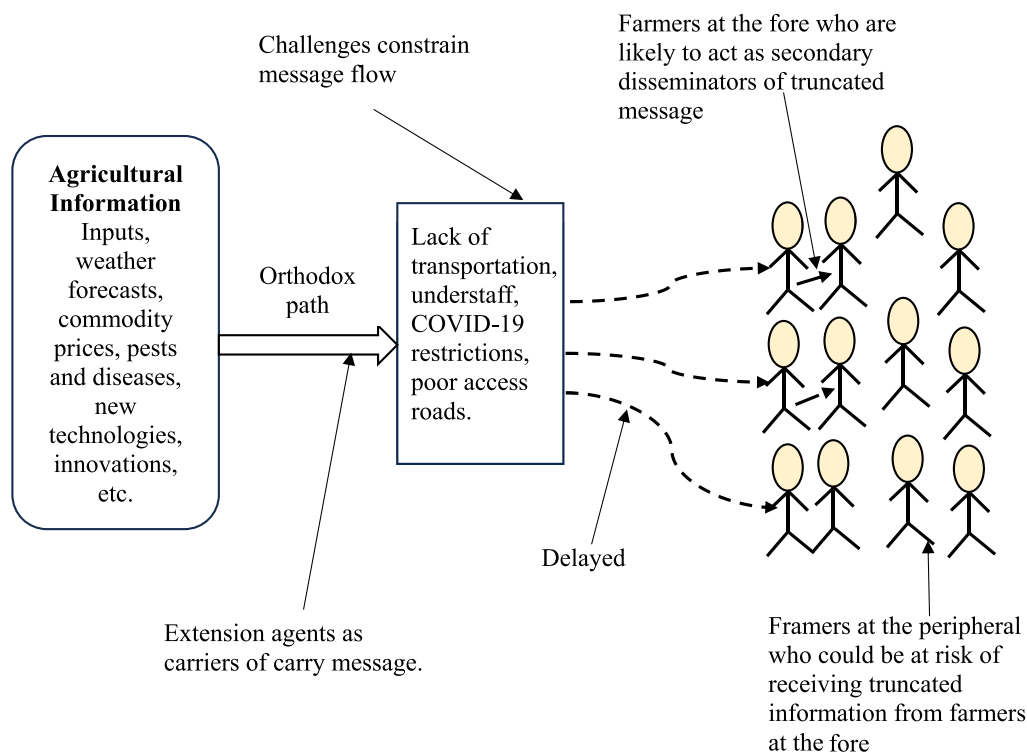


Fig. 1. Conceptual framework of existing agricultural extension delivery system in Ghana. Source: authors’ own construction, 2023.

delivery techniques are constrained by logistical, technical, staffing, and pandemic challenges (represented in the box in Fig. 1). Due to these challenges, agricultural information to farmers does not flow freely (represented with broken lines in Fig. 1); they are truncated or delayed, and few farmers at the fore receive information while those at the periphery do not receive information [22]. Sometimes, farmers at the fore become secondary disseminators, however, the content of the message changes [5].

Agricultural extension can reduce the current challenges of information dissemination through digital technologies. Digital technologies offer multiple systems such as mobile applications, ICT information desks, audio and text messages, social media connection and so forth that can connect extension messages to farmers within a split of second. These systems can connect farmers at the fore and those at periphery at the same time with the same message. While digital technologies have potential to help extension services in Ghana to cover a wide range of farmers, it is important to understand the digital and telecommunication systems to be able to propose the appropriate system that meets the needs of the diverse farmer groups in the country.

1.3. Purpose of the study

To explore the trends in research findings on ICTs penetration in Ghana and the prospects of implementing a public electronic extension (E-extension) service in Ghana. The specific objectives were to.

1. Explore the trend of ICT and telecommunication network development in Ghana.
2. Outline the major challenges associated with ICT use in rural and urban areas in Ghana.
3. Analyse existing e-agriculture services that provide agricultural and extension services to rural and urban farmers.
4. Explore the level of electricity connectivity and expansion in the rural and urban areas.

2. Methods

The study adopted a systematic literature review approach. Systematic literature review offers the appropriate techniques of examine topics in research that have generated public interest within specific time frame, but empirical data is scattered among literature to be compared or contrasted to generate useful data for making informed decisions (20).

2.1. Search strategy and data gathering

The search strategy and data gathering for this review was guided by the Joana Briggs Institute (JBI) Critical Appraisal tools for systematic review. The JBI Critical Appraisal gives guidelines on the critical elements such as defining appropriate inclusion criteria, stating clear search strategy, and sources of literature that was used for the review [33]. Following the guidelines, the review commenced by defining the purpose of the review, the protocols, defining the inclusions and exclusion criteria. Journal and website articles published in English between 2010 and 2022 were selected for review. This year range was purposely selected because the researchers wanted current information that covers trends of technology development in Ghana and other African countries on pre-COVID-19 and post- COVID-19 restrictions. Google Scholar and Scopus were the main search engines used. Other institutional websites such as the Groupe Speciale Mobile Association (GSMA), the World Bank, Afrobarometer, National Communication Authority (NCA) of Ghana, ESOKO, and Farmerline were also searched for literature. The Google Scholar and Scopus served as sources for reviewed articles while quantitative data were gathered by reviewing the websites of credible organizations and institutions that provide updates on ICT, telecommunication, extension and agricultural extension services about Ghana, these included GSMA, the World Bank, Afrobarometer, National Communication Authority (NCA) of Ghana, ESOKO and Farmerline.

The first step involved search of articles using key terms such as *Mobile network use in Ghana, Urban and rural electricity status, digital agriculture, ICT use challenges, internet and telecommunication use in Ghana, COVID-19, extension challenges, digital device, and e-agricultural extension*. The first search yielded 66 results in 0.24 s in Google Scholar and 17 results in Scopus. The various websites also gave varied numbers (see Table 1 for details). The articles were further filtered through content analysis by reading the topics to find the

Table 1
Search engines, number of articles by article topics and method used for analysis.

Search engine	Number of articles	Article topics	Method used	Example of article
Google Scholar	12	E-government; COVID-19: Extension; telecommunication; <i>Mobile network</i> ;	Literature review [5] Conceptual [1] Mixed-methods [1] Qualitative [2] Quantitative [3]	[27,45,49].
Scopus	2	Extension services; extension barriers.	Mixed-methods [2]	[26,28].
Institutional websites	11	ICT adoption; Mobile connectivity; E-agriculture; <i>ICT use challenges</i> .	Literature review [7] Conceptual [1] Quantitative [3]	[34,36,42].

articles that relate to Ghana and have the appropriate key terms. Forty-six articles met the criteria at the second stage and were selected for further reading and scrutiny. At the next stage, the abstracts of the selected reviewed articles and introduction of website publications were read to identify those that cover the digital and ICT information in Ghana; this reduced the number to thirty-four. Finally, after reading through the abstracts and the full papers, fourteen reviewed articles and eleven institutional website publications met all the inclusion criteria, and they were selected for full detailed reading for the review (see [Table 1](#) for details). To establish trustworthiness, the authors had debrief sessions to cross check and discussed the emerging keywords identified from reading the articles. Additionally, an independent researcher reviewed the generated themes by the primary researchers. These additional techniques for trustworthiness helped ensure consistency between coders and transferability of the content analysis to other disciplines.

The content analysis of the chosen literature was guided by the research objectives, which helped identify the key codes. The codes were categorised to form into sub-theme and finally created the main themes for the analysis. The quantitative data were not modified (Figures), however Table was created for proper visualization of the data from NCA.

3. Results

3.1. Trend of ICT and telecommunication network development in Ghana

The content analysis revealed two main themes related to the first objective of the study. These were *mobile network penetration and ownership of ICT devices*. Under the Mobile network penetration, two sub-themes emerged, namely, *telecommunication subscription rate and frequency of mobile internet access*.

3.1.1. Mobile network penetration in Ghana

The result from the content analysis shows that Ghana has higher mobile network penetration rate than many African countries. Ghana's subscriber penetration rate was 55% compared to Nigeria (49.7%), the economic giant of Africa and a neighbour to Ghana in the Western Africa sub-region. Ghana's mobile subscription rate in 2019 was 10.2% higher than the average rate of the SSA region (see [Fig. 2](#)). Ghana's high mobile subscription rate can be linked to the overarching national telecommunication development policy [34]. The sector policy is geared towards making telecommunication and mobile services competitive, affordable, and accessible to all Ghanaians [34,35]. According to a review by Oxford Business Group [36] on Ghana's mobile phone subscription and penetration, the first quarter of 2017 had 35.98 million mobile phone subscribers, which represented about 127% penetration rate. Mobile data subscriptions also reached 21.58 million in the same year, representing a 76.2% penetration rate [36]. The NCA reported that the mobile cellular subscription rate on a monthly basis in 2016 increased from 0.22% to 1.51%, which was the highest in SSA [34]. Per the NCA data, mobile cellular subscription stood at 130 per 100 people in 2020 (see [Table 2](#)). They linked the continuous increased in mobile cellular subscriptions to the government's commitment to telecommunication infrastructure development coupled with good policies and technological innovations. Among the countries in SSA, Ghana was the second highest country with a mobile phone subscription rate. This implies that Ghana stands a better chance than other SSA countries to implement electronic services like e-agriculture that ride on mobile phones and other mobile devices.

3.1.2. Telecommunication subscription rate in Ghana

The NCA's report on the Ghanaian telecommunication industry for the fourth quarter of 2020 showed that mobile voice call subscription rate per 100 inhabitants was 130.85, mobile data subscription was 85.60, and broadband wireless access 0.14 (see [Table 2](#)). Between the third and the fourth quarter, mobile voice subscriptions reduced by 0.33%, whereas mobile data subscriptions increased by 1.93%; Broadband Wireless access on the other hand did not change in rate (see [Table 2](#)). Ghana has four big mobile network operators, three fixed network service operators, and five Broadband Wireless access [38]. These service providers operate on

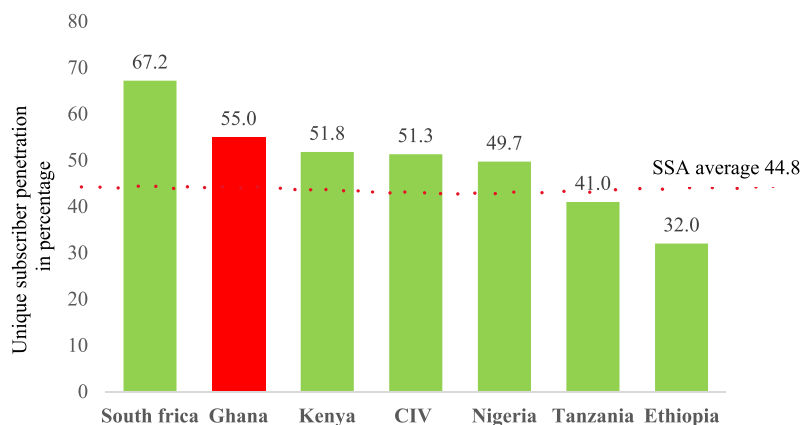


Fig. 2. The state of Mobile network penetration in Ghana as against other Sub-Saharan African Countries. Source: GSMA [16].

Table 2
Telecommunication subscription rate in Ghana in Q3 and Q4 2020.

Service	Quarter -on -Quarter subscription		
	Q3 2020	Q4 2020	Growth (%)
Mobile voice subscription	131.28	130.85	-0.33
Fixed voice subscription	0.98	0.99	1.96
Mobile data subscription	83.98	85.60	1.93
Fixed data subscription	0.26	0.25	-3.09
Broadband Wireless Access	0.14	0.14	0.00

Source: NCA (38).

a competitive basis to offer services under the National Communication Authority's regulation. For instance, Mobile Telecommunication Network (MTN), the leading mobile network operator in Ghana has a market share of 59.7% mobile broadband coverage [34], Surfline is second in line has 29.8%, Broadband Home has 10.1%, and Blu 0.4% while Vodafone Ghana leads in the fixed broadband services [34,36]. Ref (39) reported that the introduction of the 4G service in early 2016 by MTN Ghana increased the speed of internet connectivity and internet data subscription rate. The increasing mobile service subscription and cellular penetration rate place Ghana in a good position to expand digital communication services in the various sectors of the economy including the agriculture.

3.1.3. Frequency of internet access in urban and rural areas in Ghana

The result in Fig. 3 shows the difference between urban and rural internet access on a timely basis. The urban areas had 52 percent internet access daily or a few times in a week as compared to 23 percent in the rural areas. The urban areas access was twice more than the rural area. This suggests unequal distribution of service between the urban and the rural areas. The reason for the wide gap between the urban and rural internet access could be linked to disparities between the urban and the rural areas regarding infrastructure development. Ref [40] posited that government policies regarding infrastructure development always favour the urban areas more than the rural areas, making access to technological and social services easier in the urban areas than the rural areas. Moreover, an introduction of ICT services that use only internet may not be beneficial to most of the rural dwellers; a combination of both internet and non-internet ICT services will be more useful.

3.2. Ownership of communication devices in rural and urban areas in Ghana

The result of communication device ownership showed that mobile phone was owned by 97% of the urban population and 90% of their counterparts in the rural areas. Television was owned by 90% of the urban people while 62% owned it in the rural areas [42]. 88% of the urban people owned radio while 76% of the rural people owned it. Computer was owned by 40% and 14% of people in the urban and rural areas respectively (see Fig. 4). Overall, mobile phone was the highest owned device in both the rural and the urban areas (see Fig. 4). This suggests that mobile phone is a preferable digital communication device in Ghana than other communication devices. It could therefore be the best medium to communicate information to people in Ghana. The differences in the ownership of these devices could result from affordability and connectivity. In terms of television signal connection, the urban areas have a higher advantage over

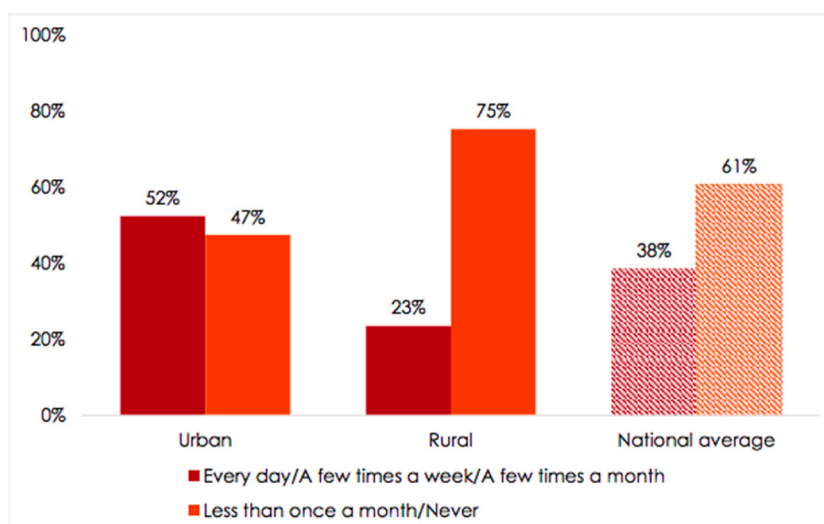


Fig. 3. Frequency of internet access in urban and Rural areas in Ghana.

Source: Afrobarometer [42].

the rural areas due to many private television companies' operations limited to the urban areas. Also, radio is more affordable and economical to use than television; therefore, rural people will choose radio over television in the absence of television networks. Finally, Computer ownership was the least ICT device owned in the urban and rural areas. The ownership and usage of computer in the urban areas was twice higher than in the rural areas. The urban areas have most of the higher educational institutions and other services solution companies, therefore they are in a better position to have access to computers than the rural areas. Two sub-themes emerged under the ownership of communication devices, namely, *distribution of mobile phone ownership and mobile phone and internet use*.

3.2.1. Regional distribution of mobile phone ownership in Ghana

The regional distribution of mobile phone ownership in Ghana shows that Greater Accra, the national capital, has the highest (73.7%) mobile phone ownership, while Upper West was the least region with mobile phone owner (see Fig. 5). Also, from Fig. 5, it can be observed that the regions closer to the capital have more access to mobile phones than those far away. This means that the regions closer to the capital has its shedding effects. Therefore, they stand in a better position to access services offered on mobile phones than the regions far from the national capital. This is a common practice in most developing countries where developments are usually crowded in or around the national capital. Therefore, to ensure equity in digital mobile information access, mobile network development should be evenly distributed across all the regions in Ghana.

3.2.2. Urban and rural mobile phone and internet use

The result in Fig. 6 shows that 67% of mobile phones used in the rural areas were incompatible with internet connection. In contrast, only 43% of mobile phones used in the urban areas were not compatible with the internet (see Fig. 6). The mobile phones in the rural areas with internet accessibility were 14% lower than the national average while the urban areas mobile phones with internet accessibility exceeded the national average by 11% (see Fig. 6). The results in Fig. 6 imply that modern electronic services that do not require internet connections will be more useful in rural areas in Ghana, while digital services with internet access will be more feasible in the urban areas. Broadly speaking, mobile phones without internet access exhibit a higher prevalence in Ghana than mobile phones with internet access, as evidenced in Fig. 6. This suggests that national policy and programs that target ICT services that do not rely heavily on internet access are poised to garner higher acceptance and accessibility on a nationwide scale than ICT services that focus more on internet use.

3.3. Challenges associated with ICT use in rural and urban areas

The theme emerged under challenges associated with ICT use in rural and urban areas were ICT and telecommunication accessibility and demographic and social factors.

3.3.1. ICTs and telecommunication network accessibility

The literature review has revealed series of challenges constraining ICT use and telecommunication network access in both rural and urban areas in Ghana. A study by Musa et al. [43] found that lack of electricity connection and power interruptions were the key factors that affected farmers' and extension agents' agricultural information dissemination and access. It was further identified that technical challenges like limitedness of service, poor network reception; power interruptions and unavailability of customised local contents of digital information were the main challenges that impacted farmers' digital technologies adoption [44,45]. Moreover, limitedness of service, literacy rate, poor reception, power interruptions, and lack of appropriate infrastructure were the major challenges found in the rural areas [46,47]. The result implies that there are many areas in the rural areas that lack quality infrastructure and ICT services. It is therefore important for government and rural development policymakers to include digital infrastructure intervention programs in national and rural development policies to ensure effective infrastructure and services development

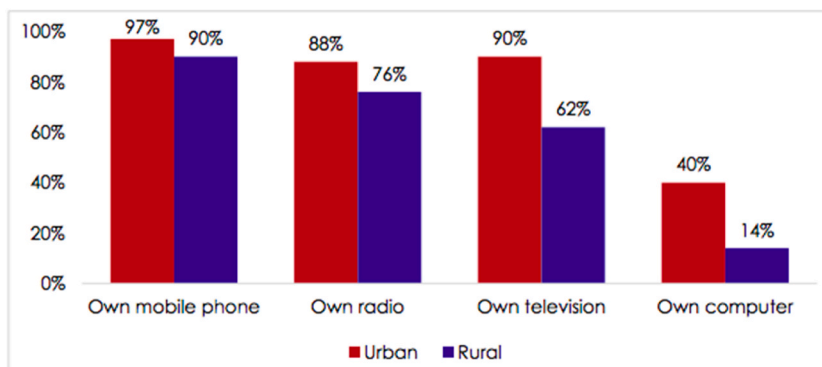


Fig. 4. Ownership of communication devices in Rural and Urban areas in Ghana.

Source: Afrobarometer [42].

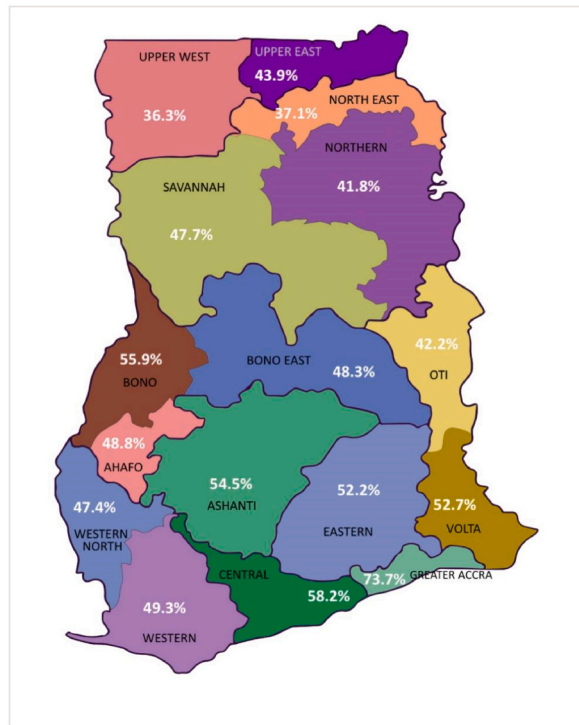


Fig. 5. Regional distribution of Mobile phone ownership. Source: NCA [38].

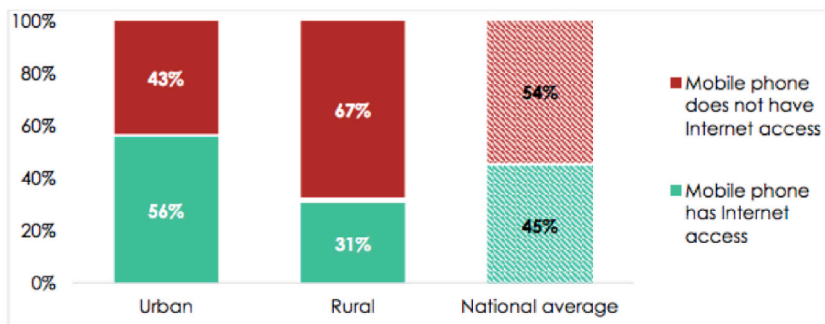


Fig. 6. Urban and Rural mobile phone and internet use in Ghana. Source: Afrobarometer [42].

in the rural areas.

3.3.2. Demographic and social factors

Demographic factors such as farmers’ levels of education, gender, age, and household income levels were identified to constraints ICT use in rural areas in northern Ghana [48]. An empirical study of digital information access among smallholder farmers in Ghana identified socio-culture, illiteracy rate, language barriers, poverty, technical skills of users and gender disparity reduced urban and rural dwellers use of ICT and digital services [49,50]. It was further noted that most of the rural dwellers’ face digital literacy challenges than their urban counterparts [41]. This suggests that basic ICT training is required in rural areas to enable them to navigate through the use of modern ICT devices such as smartphones, tablet computers and personal computers. It was identified that socio-cultural norms and practices prevented many women from using mobile phones [16], which means that there is high inequality in digital services access between women and men; this may have potential to reduce their access to agricultural information. To ensure equity in technology access, an intensive gender education program must be incorporated into extension programs to sensitize men and women about the benefits of gender equal access to technologies and other services.

3.4. Existing e-agriculture services in Ghana

One theme emerged from the third objective, namely, *digital extension service providers*.

3.4.1. Digital extension service providers

The study identified two major digital extension services in Ghana, namely, ESOKO and Farmerline. The two are private own digital solutions that offer agricultural extension services to farmers. They both use call centre model to disseminate agricultural information to contracted farmers [51,52]. Their extension services include sending bulk text messages to subscribed farmers on regular intervals to update them on weather information, pests and diseases projections, market information updates, agricultural credit services, inputs and commodities delivery services [19,52]. It was also found that between the two service providers, ESOKO has larger coverage and more subscribers than Farmerline [20,53]. Both offer services based on subscriptions through groups or as part of a project [20]. This means that individual farmers cannot access their extension services without being part of a project. Their services are offered in few local languages and are limited to specific areas and agricultural enterprises [51]. For instance, both ESOKO and Farmerline services do not cover livestock production [19,51]. The private sector electronic agricultural services are not accessible to all farmers due to its limitedness in services and subscription requirements. This makes it difficult for smallholder farmers to benefit from their services. The public extension can support farmers access by partnering with the existing service providers to make the services available to all farmers or establish a new E-extension system that will provide equal service to all farmers in the various districts in Ghana.

3.5. State of electricity connectivity in rural and urban areas

The main theme found under electricity connectivity and expansion was the level of coverage.

3.5.1. Level of electricity coverage in rural and urban areas

The review results on electricity coverage in Fig. 7 show that 95% of the urban population has access to electricity through the national grid, while 74% of the rural population is connected to electricity through the national grid. The frequency of electricity availability was 82% in the urban areas and 59% in rural areas [42]. The availability and access to electricity in rural and urban areas place Ghana in a good position to introduce and expand digital services in both rural and urban areas.

3.6. Discussion

The aim of the study was to explore the trend in research on ICTs penetration and usage in Ghana and the prospects of implementing a public electronic extension (E-extension) service in Ghana. The results from the review show that Ghana has made a steady progress in the telecommunication industry in SSA. Mobile phone subscriptions and ICT use in Ghana exceeded the regional average and was far higher than most of the leading economies in the SSA region. Simeone [37] posited that ICTs have become important disruptive technology used by most people in emerging economies to connect with family and friends, access information and transact business, and that Ghana has joined the global digitalization trend and exhibiting great potential for growth and development in the new digital environment. The findings imply that Ghana has more potential to enrol in electronic services that use mobile phones and other ICT systems.

It was found that among the common ICT devices used for communication, mobile phone was the most owned and used in the urban and rural areas. Mobile phone has surpassed radio use in both the urban and rural areas this is interesting because past studies have found radio and televisions to be the most used ICT devices in Ghana [54,55]. This suggests that information shared through mobile phones will reach more people than information shared on radio services. Afrobarometer [42] has attributed the growth in mobile phone use to the increasing expansion of mobile telecommunication networks in Ghana for the past decade. Additionally, the increased production of less expensive mobile phones with multi-media features such as radio and internet could also be a driver of

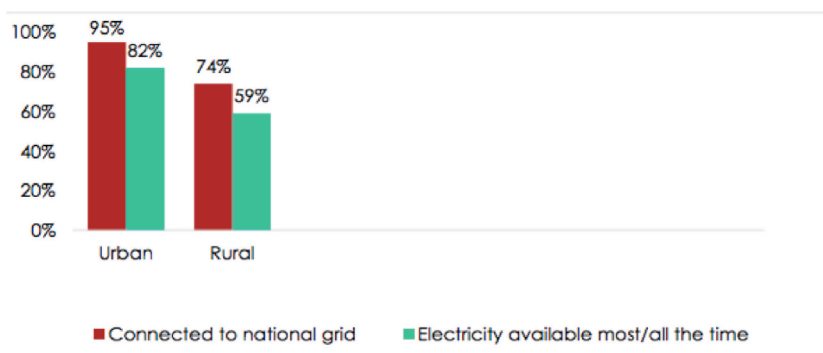


Fig. 7. Level of electricity coverage in rural and urban areas in Ghana.

Sources: Afrobarometer [42].

increased mobile phones used over radio and televisions in Ghana. It was further found that mobile phones with internet access were higher in the urban areas, while mobile phones without internet access were most used in the rural areas. This implies that ICT services that do not depend on mobile internet access will be more compatible in the rural areas than the urban areas.

The results show that there were two main leading digital agricultural service providers in Ghana, namely, ESOKO and Farmerline [53]. They are private digital solutions that provide electronic agricultural services to farmers to complement the public extension services in the country. These companies are privately owned and offer services on a subscription basis [53]. While these companies are helping to improve agricultural extension delivery in Ghana, their services are offered on subscription basis [53], which many smallholder farmers cannot afford. Their services are not directly available to individual smallholder farmers, they can only access the extension services through group subscriptions or being part of a project. Beside this, their services are limited to specific agricultural enterprises and fewer local languages, which imply that farmers who do not practice those agricultural enterprises or speak those languages and are not part of any project cannot access their services. In order to ensure equal access to agricultural information, there will be the need for a public e-agricultural services that will serve all categories of farmers in Ghana.

The findings from the study show that although Ghana has made great progress in ICT and telecommunication penetration and access, there were a few challenges that constrained access and usage in the rural and the urban areas. It was found that the rural areas have less ICT infrastructure and services as compared to the urban areas. As a result, the rural areas face challenges like poor network reception, power interruptions, limitedness of services and unavailability of customised local contents of digital information. Additionally, Alhassan et al. [45] observed that social factors such as illiteracy, lack of skills, gender disparity and cost of service impede rural people access to, and use of mobile phones and internet services in Ghana. Moreover, Ankrah et al. [28] elaborated that sociocultural norms and practices in rural areas prevent many women from using mobile phones. The findings suggest a revision of rural development policies and programs to include a comprehensive cultural education geared towards equality in resource allocation and usage between men and women. There is also the need for government policy to address the equalities between the urban and the rural areas in terms of resources allocation.

It was found that electricity coverage was evenly distributed in both rural and urban areas. However, the urban areas have wider coverage and more days of electricity availability than the rural areas. Electricity is needed to power plants that enable telecommunication networks to operate. It is also needed to charge mobile phones and other electronic devices to communicate and access

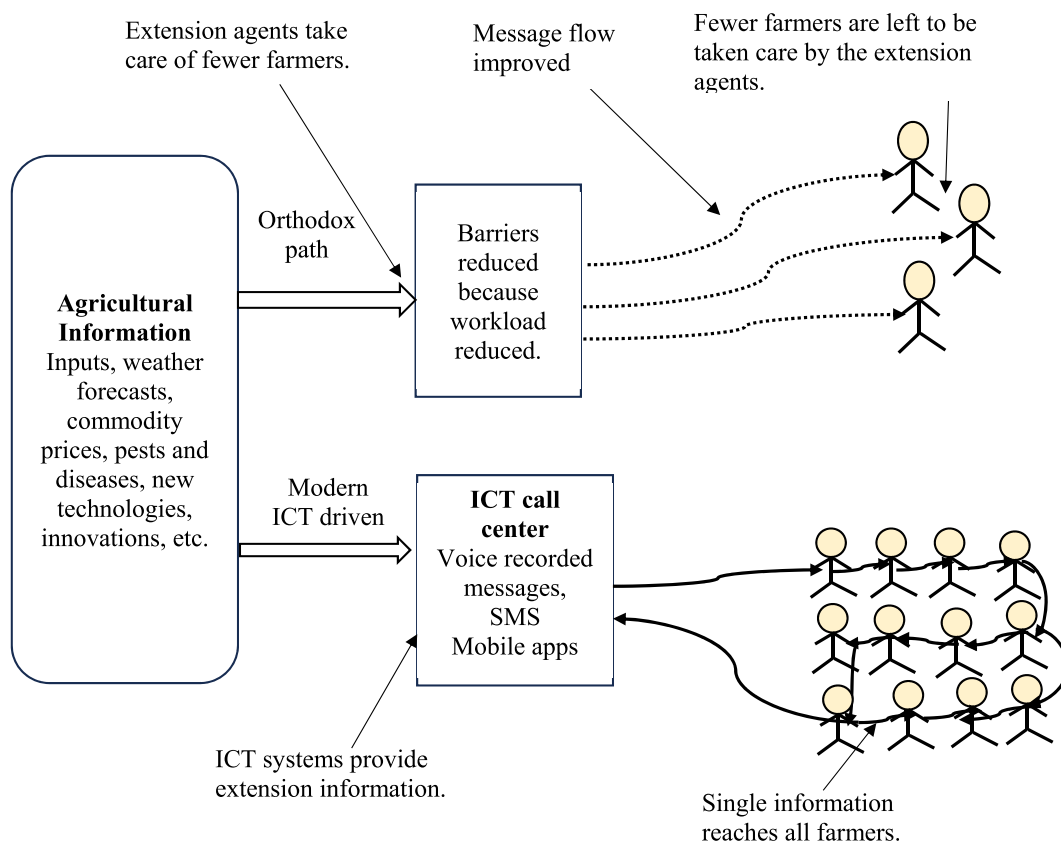


Fig. 8. Recommended integrated extension system. Source: authors' own construction, 2023

information. Therefore, having evenly distributed coverage in the urban and rural areas creates opportunities for the provision of ICT and other electronic communication services in the country. Based on the results from the review, an integrated e-extension system is proposed (see Fig. 8).

3.7. Proposed E-extension system

The results of the review show a well-established and expansive telecommunication system that covers both the rural and urban areas in Ghana. The urban and rural areas showed increased mobile phones subscription and usage. Moreover, electricity coverage is evenly spread across the country. The agricultural extension services can therefore tap into these opportunities and rollout E-extension services as showing in Fig. 8. Agricultural information such as input price, weather forecasts, pests and disease outbreaks among others can be transferred to farmers through SMS, voice recorded messages or by calling farmers directly. A single message sent through the ICT systems can reach many farmers within a few minutes without any physical contact. The farmers can also relay information to extension agents by calling the call centre by dialling an allocated toll-free number or by sending text messages. While the ICT system serve majority of farmers with mobile phone access, the few farmers that will be left can be taken care of by the available extension agents. This process will increase the speed of physical information delivery because there will be only a few farmers to be taken care of by the extension agents. For a start, an ICT call centres can be established across the districts in Ghana, and as farmers get used to the systems, voice recorded messages, text messaging and mobile application services can be added to the services. The ICT services must be enrolled in tandem with the existing orthodox services because the result from the study shows that telecommunication network coverage, mobile phone subscription and electricity coverage have not achieved one hundred percent coverage; meaning, a significant number of people are still not covered or lack access to mobile phones. Overall, the ICT system will reduce the workload on the traditional extension delivery system, making it possible to use the limited resources to cover the fewer farmers without ICT access. This will improve information flow and access to services. Implementation of this model will also bridge geographic barriers, physical meeting problems, staffing issues, and gender barriers (see Fig. 8) because the physical contact between male extension agents and female farmers would be reduced. Overall, the integrated ICT extension model will lead to a quick access to information, services and decision-making between extension officers and farmers.

It should be noted that the ICT system may not completely replace physical extension delivery service, because there are services such as castration, injection, field observations and so forth that require the physical presence of the extension or veterinary agents. Moreover, there may be farmers who may still prefer physical extension meetings to the use of ICT services. The proposed e-extension model will complement extension delivery.

3.8. Conclusions, policy implication and recommendations

The findings from the current study show a rapidly growing telecommunication sector in Ghana, with wide coverage in both rural and urban areas. Mobile phone usage and ICT adoption in Ghana exceed the Sub-Saharan Africa average. Therefore, Ghana is well positioned to implement electronic services such as E-extension. However, there is the need to integrate digital strategies with existing methods to ensure inclusive and effective reach, particularly for marginalized communities. The implementation of the proposed integrated E-extension service will facilitate quick and easy access to timely agricultural information by farmers.

The finding from the current review implies the government's digital development policies must focus more on the rural areas by creating an enabling environment through tax regulations to attract more private sector investments in the mobile and telecommunication industry in the rural areas. Private sector investments in the rural areas would attract other service providers to invest in digital services in the rural are likely to reduce the cost of ICT services in the rural area, enhance better service delivery and stimulate more digital literacy.

Policies geared toward digitalization in Ghana, must understand the difference in the urban and the rural areas so that specific projects that meet rural environments are implemented because one for all projects may end up widening the digital divide gap between the urban and the rural areas.

The current study used a systematic literature review approach, it is recommended that future studies conduct surveys and interviews to gather data from farmers and other stakeholders in the agricultural industry to get a deeper understanding of the challenges they face in accessing and using ICT and telecommunication services in the rural areas.

Future research should bring to light the perception of farmers in relation to using E-extension services, by assessing their experience with usage, cost benefits, challenges, and the amount they would be willing to pay for the service and the means of payment. Past studies in other countries show that farmers prefer paying for services in kind to using physical money.

As 4G and 5G services provide better internet service connections, the government should partner with the private telecommunication network operators to procure and enrol such services in the urban and rural areas.

Finally, investors and private enterprises who plan to invest in digital extension systems in Ghana must note the differences between the urban and the rural areas regarding mobile phone preference to implement digital programs that are susceptible to the rural and urban ecosystems.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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