Journal of the Saudi Society of Agricultural Sciences xxx (xxxx) xxx

Contents lists available at ScienceDirect

Journal of the Saudi Society of Agricultural Sciences

journal homepage: www.sciencedirect.com

Information and communication technologies (ICTs) usage among agricultural extension officers and its impact on extension delivery in Ghana

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ARTICLE INFO

Article history:
Received 23 April 2020
Revised 2 January 2021
Accepted 2 January 2021
Available online xxxx

Keywords:
ICT
Impact
Agriculture
Extension
Ghana
Technology

ABSTRACT

In recent years, the agricultural industry has been experiencing an ever-increasing application of information and communication technologies globally. This new revolution has been touted to impact efficiency and productivity in the agricultural extension services within the agriculture sector. Notwithstanding this, empirical research need to be carried out amongst its users in the sector to ascertain these assertions. Therefore, the main objective of this study is to assess the use of Information and Communication Technologies (ICT) among agricultural extension workers and its implications on extension service delivery. A simple random sampling technique was used to select 153 field extension workers, and a structured questionnaire was used to elicit information from the respondents. The data obtained were analysed using IBM SPSS Statistics software version 22. The study revealed that agricultural extension officers use ICT for personal communication, but not mainly for extension activities. It was recommended that the agricultural extension services provide intensive ICT training for the agricultural extension workers to enhance ICT incorporation into extension advisory service.

1. Introduction

The application of Information and Communication Technology (ICT) across different sectors of the global economy has become a game changer in boosting work efficiency and productivity. The agriculture sector in the global economy is one of the industries experiencing tremendous ICT application in all spheres of its operations. Daum (2020) observed that in recent years, ICTs had become one of the main driving tools used by farmers to manage the essential factors of production (land, labour, capital, and soil) in agriculture. ICT applications have the potential to identify and find solutions to some of the numerous problems faced in the field of agriculture, which includes prolonged droughts, pest and disease outbreaks, seasonality and spatial dispersion of farming; high transaction costs and information asymmetry (Anh et al., 2019). ICT application along the agricultural value chain (from farm to fork) could offer the opportunities for actors within the chain to obtain accurate, timely, and relevant information; which will not only contribute to profitability but also enhance food security, sustainable and remunerative agriculture (Purnomo & Lee, 2010). ICT also has the potential to resolve the challenges faced by governments, farmers, and other land users in valuation, registration, and taxation of land. For instance, in India, the digitalization of land administrative activities saved farmers close to 1.32 million working days of man-hours and about 806 million Rupees in bribe due to the improved system, which reduced corruption levels (Daum, 2020). The application of ICT in agricultural activities across the globe is not only gaining popularity but also transforming the sector's businesses.

The agriculture sector has experienced a new technological revolution for the past ten years. Compared to a decade earlier, this new technological revolution, has the potentials to respond to farmers' needs accurately and swiftly. Wolfert et al. (2017) observed that technological advancement in the area of digital platforms, such as e-commerce, agro-advisory apps, big data, computational power, and satellite systems like remote sensing, among

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Peer review under responsibility of King Saud University.

Production and hosting by Elsevier

https://doi.org/10.1016/j.jssas.2021.01.002
1658-077X/

others, quicken communication and information sharing among farmers in recent years. Mobile phones that have internet connectivity (smartphones) are the most widely used ICT devices across the globe (O'Dea, 2020). Research published by Statista (2020), showed that the number of smartphone users around the world were 3.2 billion in 2019, and forecasted that this figure could reach 3.8 billion by 2021. The research further indicated that developing countries have the highest share of smartphone users worldwide (see O'Dea, 2020). The pace at which ICT application is growing in every sector of the world has triggered the development of different ICT applications in the agriculture sector to aid the rapid access to information by farmers, extension services, and other players within the sector.

Extension services globally involve dissemination of knowledge, agricultural information, and new technologies to farmers and rural dwellers. According to the International Food Policy Research Institute (IFPRI), agricultural extension (also known as agricultural advisory services) plays a crucial role in promoting productivity, increasing food security, improving rural livelihoods, and promoting agriculture as a pro-poor economic growth engine (IFPRI, 2020). The extension services introduce new ideas and technologies to rural inhabitants by using different approaches and methods. The main reason for using these approaches is to help farmers understand the information presented to them by the agricultural extension officers; in so doing, they may adopt the new technologies to improve their livelihoods and make them resilient to challenges facing their farming activities. Davis and Franzel (2018) emphasised that, agricultural extension and advisory services can be a powerful tool to help smallholders break the cycle of low productivity, vulnerability, and poverty. The extension services stand a better position of providing farmers with knowledge and tools about modern agricultural practices, greater access to finance, and market solutions. Extension and advisory services are essential to rural and subsistence farmers who are the central pillar of agriculture and food supply chains in low-income countries (Francis, 2014). The extension services use a multidisciplinary tool that combines educational methodologies, communication, and group techniques to promote new technologies, communicate information, and to share knowledge among farmers and rural dwellers (Sousa et al., 2016). The agricultural extension services whose core mandate is information dissemination among farmers is an area where ICTs can contribute significantly.

ICTs have the ability to intensifying the linkage between extension, research, and farmers. ICT can be a medium through which information on new research findings can be communicated to extension workers by the research institutions for onwards communication to farmers. Also, farmers can use the same ICT platform to communicate feedbacks on the new technologies from their field experiences to the extension workers for a relay to the research institutions for appropriate action. Furthermore, ICT has the means of creating a platform (WhatsApp or Facebook group) that will have farmers, extension workers, and researchers onboard to share valuable information for a rapid response, which will help break the weak linkage between these three parties. Annor-Frempong et al. (2006) argued that ICTs are among the modern tools that facilitate rapid information delivery and knowledge sharing among farmers, extension agents, and other stakeholders such as research institutions (in Purnomo & Lee, 2010). Globally, there are several ICT programmes and applications that have been designed to enhance communication among extension workers and other parties within the agriculture value chain. In Afghanistan, an ICT application platform called 'eAfghan' (Bell, 2013) has been created to link farmers to extension workers, research institutions, and other parties that help farmers in Afghanistan to share credible information. Also, Digital Green in Ethiopia has created an ICT agricultural advisory services platform known as FarmStack that integrates farm-level data, local weather, input availability, market information, as well as linking extension system actors and information (DigitalGreen, 2019). Furthermore, the Lifelong Learning for Farmers program in Jamaica has developed an SMS interactive service to offer rural farmers in Jamaica with information on good agricultural practices (K'adamawe, 2012). Lastly, a phone based farmers club called iShamba has been developed in Kenya. The new technology has a call centre, where agricultural extension experts and researchers offer technical assistance to subscribers through SMS or voice call, on issues related to good agricultural practices, weather, inputs, and market information (Tsan et al., 2019). The link between extension and ICTs is becoming progressively widespread as many countries have tested it and gained success. This linkage and success could expand in the future, depending on the knowledge and technical efficiency of the extension officers.

Agricultural extension officers in many developing countries like Ghana are the principal technical officers assisting farmers with information on new technologies in their field of production. Agricultural extension officers in Ghana live among farmers in rural communities, and they are mandated by the Ministry of Food and Agriculture (MOFA) to disseminate proven and accepted agrarian innovation and technology adoption to farmers in a participatory manner (MOFA, 2016). Therefore, the agricultural extension officers are the first point of contact on matters of agriculture amongst rural communities in Ghana. They empower farmers with the requisite knowledge, attitude, and practices for enhancing productivity and welfare (Azumah et al., 2018). Their knowledge and competencies on subject matters are paramount to ensuring good agricultural practices among farmers. Inaccurate information or inappropriate procedures in the use of a particular technology given by agricultural extension officers to their clients will affect not only the farmers' output but also the agricultural extension officers' reputation and the confidence farmers may have in them. Agricultural extension officers therefore serve as the main link between farmers and other players within the agriculture sector. They are well-positioned to have good knowledge of ICTs, and use that acquired knowledge and expertise to disseminate and help farmers improve upon their productivity (Purnomo & Lee, 2010). A good ICT extension delivery programme might help to reach many farmers simultaneously and also overcome the geographical challenges of extension delivery in Ghana.

Currently, there are staffing challenges in the extension services in Ghana, the extension officer to farmer ratio is very low at 1:1500 (McNamara et al., 2014, in Azumah et al., 2018), compared to the Food and Agriculture Organization's recommended number 1:400 (Manfre and Nordehn, 2013). Also, farming communities are geographically located far apart in difficult-to-reach zones, ranging from 15 to about 60 square kilometres and this has to be covered by one agricultural extension officer. Moreover, extension officers lack the needed resources to commute to remote areas to offer services to farmers. Additionally, there are high levels of illiteracy among farmers, which limits their use of ICT and information access (Agula et al., 2018). To overcome these challenges and more, MOFA has introduced the E-agriculture programme, which has E-Farm Information and E-Field Extension components. The extension officers are expected to use an ICT tool to collect field data from different farms and also report any emerging challenge on farmers' fields for prompt action. As this technology is new and requires some level of ICT knowledge to operate competently, it is, therefore, necessary to assess the knowledge and levels of ICT usage among the extension officers who are the frontline operators of this ICT application. Although there is increasing research on ICTs application in the agricultural sector, however, past studies focused more on farmers' technology adoption levels and factors that influence their adoption. For instance, research by Bekoe and

Asiedu-Darko (2014) on "ICTs as Enabler in the Dissemination of Agricultural Technologies in Ghana" found out that farmers' access to information through ICT was deficient as compared to getting information from their peer farmers. Similarly, (Anim-Dankwa, 2018), conducted a study on the "Socio-economic determinants of ICT usage among rural crop farmers in the northern region of Ghana". However, to date, there has not been any empirical research to ascertain the level of ICT use among agricultural extension officers in Ghana. Therefore, this research aims to assess the use of information and communication technologies (ICT) among agricultural extension workers and its implications on extension delivery. The specific objectives are:

1. To identify the type of ICT tools agricultural extension officers in Ghana use and their sources.
2. To examine the extent at which agricultural extension officers in Ghana use ICT tools in performing their tasks.
3. To identify different ICT training programmes agricultural extension officers in Ghana undertake
4. To determine the factors influencing ICT use among extension officers in Ghana.
5. To establish the relationship between gender and time spent using ICT among agricultural extension officers in Ghana.

1.1. Hypotheses

I. Agricultural extension officers who participate in extension organized ICT training regularly are likely to adopt ICT in farmer-extension communication more than agricultural extension officers who do not participate in the ICT training.
II. H0. There is no relationship between gender and time spent using ICT among agricultural extension officers in Ghana.
III. H1. There is a relationship between gender and time spent using ICT among agricultural extension officers in Ghana

1.2. Limitation of the study

The use of ICT tool in this research does not cover traditional media such as Television, Radio, print media, Compact Disc and so on.

ICT tools in this research refer to the modern ICT tools such as mobile phone, smartphone, desktop computer, laptop computer, iPad/Tablet, drone, projectors, software app, the internet, social media (WhatsApp, Facebook, Twitter, and so forth.).

2. Literature review

2.1. ICT devices and software in agricultural extension

There are quite a number of ICT tools and application software available to agricultural extension officers that aid in transferring information and new technologies to farmers across the world.

Annor-Frempong et al. (2006) found that computer hardware, audiovisual, and telecommunication facilities such as mobile phones were relevant devices for extension delivery in Ghana. Tata and McNamara (2016) analysed that cellular phones, Internet, radio, and web-based applications are the major tools for sharing and disseminating agricultural information and knowledge among agricultural extension workers in South Africa. Extension officers in India use Digital Green video technologies to train farmers in rural regions to produce videos among themselves to share good agricultural practices information to boost farm productivity and improve nutrition. The African Farm Radio Research Initiative (AFRRI) also uses radio to educate farmers in rural communities in Africa (FAO, 2017a, 2017b). ICT tools such as Global Positioning System (GPS) has been a game changer in extension information transfer. In the United States, crop extension advisors use rugged data collection devices with GPS for accurate positioning to map pests, insects, and weed infestations in farmers' fields (GPS, 2018).

2.2. Importance of ICT training in extension service delivery

Promoting innovation among farmers needs technical skills and experience from the extension agents. Farmers' adoption of an ICT programme may require the extension officers' ability to combine their practical experience with ICT knowledge acquired to demonstrate how effective the new technology works. Annor-Frempong et al. (2006) noted that ICTs could be a medium for providing access to up-to-date information on agricultural literature and also facilitating information exchange among major actors in the agricultural value chain. It also creates the needed platform to train extension officers on new approaches in extension delivery. Higher knowledge in ICT could ease the workload of extension officers and possibly enhance quality delivery. Tata and McNamara (2018) observed that, extension officers who used ICT in Catholic Relief Services SMART Skills and Farm book (CSSF) project worked with more farmers than those who did not use ICT. They further stated that the use of CSSF enhanced the competency of the extension officers, making them more comfortable using the Internet and also helping more farmers in accessing the Internet than control group extension officers. Despina et al. (2004) found that training in ICT leads to improved computer skills and work efficiency. ICT training for teaching instructors in the United Kingdom was found to help improve their confidence in using ICT devices for instruction (Tata & McNamara, 2018). There are different ways by which ICT training can be organized for extension officers and farmers. In essence, they can be done through formal college teaching methods or an informal procedure such as training workshops. Wu and Wang (2005) proposed that ICT knowledge can also be achieved through on-the-job training to increase extension officers' ability to use technology in their work with farmers. Annor-Frempong et al. (2006) observed that, very few (23.7%) of the extension officers in Ghana have had professional training on ICTs; the majority (40.2%) were noted to have received self-informal ICTs training through the possession of ICTs devices at home.

2.3. Factors influencing ICT USE

The adoption and usage of ICTs among extension officers is influenced by a myriad of factors ranging from institutional, infrastructural to socio-economic factors. Haghighi et al. (2008) observed that, English proficiency skills and the educational level were the main socio-economic factors influencing ICTs application by extension officers in Iran. Similarly, Annor-Frempong et al. (2006) found that socio-economic factors such as low economic status, fear of ICTs, high cost of ICTs, as well as ICT policy, and infrastructure were the leading factors constraining ICTs adoption among agricultural extension officers in Ghana. Also, Strong et al. (2014) found in their analysis of the factors influencing ICT adoption among selected Caribbean farmers that, extension officers' levels of education were the contributing factors influencing their information and communication technology adoption. They observed that higher levels of educational attainment led to increase in technology use among the extension officers. Michailidis et al. (2011), on the other hand, identified age, gender, farm location, and income as the main factors impacting ICT use among farmers and rural dwellers in Greece.

2.4. Gender and ICT use

Women and men play different but essential roles in the agriculture sector; their contributions come together to promote growth and development in the industry. Gender mainstreaming in agricultural extension means recognizing the extension needs of women and men by considering their needs in the planning and implementation of extension programmes to serve them equally and inequality is not perpetuated (Dayanandan, 2011). Therefore, a good ICT knowledge of extension officers is paramount to provide equal opportunities for rural men and women to access agriculture information. It is observed that providing extension services in rural areas is not balanced in terms of gender: women turn to receive fewer extension services compared to their male counterparts (Dayanandan, 2011). Although women's participation in agricultural activities has increased over the years, agricultural extension and information on new technologies are almost exclusively directed to men (Beevi et al., 2018). Despite the essential role played by women in agricultural production, ICT use among women for agricultural purposes continues to lag behind that of men (Huyer, 2005). Ashby (2002) observed that women farmers are excluded in technology design and implementation programmes in Africa, which result in their ICTs adoption challenges. ICT accessibility bias towards women seems to be higher than their male counterparts. Nancy and Helen (2007) found out that females tend to have less access to ICT facilities that may exist in a rural community than their male counterparts. They emphasized that rural information centres or cyber-cafes are mostly found in locations that women may not be comfortable accessing. Social and cultural beliefs in many countries, especially Africa, play a crucial role in deterring women's access to ICTs usage than men. For instance, in Uganda it is reported that girls did not get the opportunity of accessing computers in school laboratory (under a WorldLinks Program) due to socio-cultural norm that prevents girls from running; resulting in boys running to occupy the available computers (Gadio, 2001). Adejo et al. (2013) noted that the men compared to their female counterparts, dominantly have access to radio, television, computer/internet, and GSM telecommunication. Exclusion of women extension workers in ICT programmes could hinder the possibility of effectively introducing new technology to female farmers in areas where socio-cultural beliefs and practices forbid men and women interactions (Beevi et al., 2018). Training Women extension workers in ICT could help fill the extension gaps between men and women in our societies. Lahai et al. (2000) documented that women farmers who were visited by female extension workers in Nigeria participated more in extension programmes and adopted new technologies than women who received extension advisory services from males. Female extension workers who receive regular ICT training with their male counterparts are likely to perform better than their male colleagues. Nancy and Helen (2007) noted in Kenya that, women reported a lower occurrence of technical challenges to using the Farmbook ICT application compared to their male colleagues.

3. Methods and data sources

The study was carried out in four regions in Ghana. The country was divided into two (North and South Regions) based on the climatic conditions and the nature of agricultural practices in these areas. In each Region, two sub-regions and three districts were selected. They were Greater Accra Region (Ada East, Ada West, Ningo Prampram); Volta Region (Akatsi North, Akatsi South, and Ketu North); Brong Ahafo Region (Nkoransa North, Techiman North, and Techiman South) and Nothern Region (Chereponi, Gushiegu, and Bunkpurugu-Yunyoo). The main data for this study were obtained from the primary source. The statistical population for the study was 218, out of which, a simple random sampling technique was used to select 165 field extension workers; but at the time of compiling the data, 153 responses were obtained. The 93% response from the survey deem appropriate for this research (Fincham, 2008). The questionnaire purposely targeted agricultural extension officers because they are the Government body responsible for agricultural information dissemination at the district and local levels in Ghana. A structured questionnaire was used to elicit information from respondents. The data obtained were entered into the International Business Machines Corporation Statistical Package for Social Sciences (IBM SPSS) Statistics version 22 for analysis. Descriptive statistics were employed to illustrate the demographic and other characteristics of the sample. The hypotheses were tested using chi-square.

4. Data analysis and discussions

4.1. Socio-demographic characteristics extension officers

Tables 1–10 below gives detailed information on the socio-demographic characteristics of extension officers surveyed; it comprises of gender status, age, and educational levels. It can be observed that more than 80% of the extension officers were males, whereas females constituted about a fifth of the extension officers (19.6%). This means that, to every five (5) extension officers you may come across, you are likely to meet one (1) female extension officer; which implies that males dominate in agricultural extension activities in the regions surveyed. McNamara et al. (2012, p.16) reported that agricultural extension services in Ghana have a supply-side problem; there are fewer women in the sector. They argued that the shortage of women in agriculture and extension service is not a new issue, but rather, a cultural bias against women based on the roles they should play in society.

Also, it could be observed in Table 1 that the majority of the extension officers (38.6%) surveyed fell within the age group of 31–40 years, followed closely by the 41–50 years age group while the 21–30 years age group were the least among the extension officers (13.7%). The National Youth Policy of Ghana classifies all persons between 15–5 years as a youth and 36–40 years as a young adult (GSS, 2013). Based on this classification, it could be concluded that more than half (52.3%) of the extension officers in Ghana were within the youth and young adult age brackets. Contrary to this finding, Annor-Frempong et al. (2006) and Ogunlade et al. (2014) found in their research that most (31.9%) of the extension agents in Ghana were above 40 years.

Table 1
Demographic background of extension officers.

Demography	Frequency	Percentage
Male	123	80.4
Female	30	19.6
Total	153	100.0
Age		
21–30	21	13.7
31–40	59	38.6
41–50	48	31.4
51–60	25	16.3
Total	153	100.0
Educational level		
Artisan certificate	31	20.3
Diploma	65	42.5
Bachelor	53	34.6
Master's	4	2.6
Total	153	100.0

Sources: field data, 2020.

Furthermore, Table 1 continues to reveal that all respondents have attained different levels of education. Diploma certificate holders were the highest among the respondents (42.5%) followed by bachelor degree holders (34.6%), Artisan certificate (20.3%), and master's degree holders (2.6%) being the least among the extension officers. It implies that the level of literacy among the extension officers in Ghana is high, which could contribute positively to their understanding and application of ICTs in extension communication. Diploma certificate holders were the highest among the respondents because, in Ghana, the minimum educational requirement for extension officers is a diploma. Bachelor and master's degrees are specialization certificates that qualify one to be a head of a unit or a supervisor in the extension department. Artisan certificate on the other hand, ceased to be the minimum qualification requirement for extension service jobs since 2010.

The socio-demography data show that Ghana has young and active educated extension officers, which is good for ICTs adoption and application if the necessary measures are put in place.

4.2. Modern ICT tools used by extension officers

The results presented in Table 2, give details and sources of various ICT devices, apps, and social media platforms frequently used by the extension officers. The table shows that mobile or smartphone was the most common ICT device used by all the respondents. One hundred and fifty-three respondents, representing 100%, use a mobile phone or a smartphone for their personal communication daily. That could imply that majority of Ghanaians use either a mobile or smartphone for communication. O'Dea (2020) noted that mobile phones that have internet connectivity (smartphones) are the most widely used ICT device across the globe. Similarly, McNamara et al. (2012, p.17) observed that Ghana is among the top countries in sub-Saharan Africa with good telecommunication infrastructure and access. Consequently, Ghana's mobile phone telecommunication networks have about 85% nationwide coverage, and approximately 65% of rural dwellers have access to mobile phones. That could be the reason why all the respondents use a mobile phone or smartphone for communication in Ghana. A little over 26% of the respondents indicated that they use a laptop computer to access information; the use of iPad or tablet and a desktop computer was the least ICT devices used by the respondents, representing 17.7% and 12.4%, respectively. That means any ICT programme that the extension services may introduce in extension communication that uses mobile or smartphones technology may be highly patronized in Ghana.

Table 2
Common ICT devices, APPs and social media used by extension officers.

ICT Tools	Frequency	Percentage
Mobile/Smartphone	153	100
iPad/Tablet	24	17.7
Laptop computer	41	26.8
Desktop computer	19	12.4
Internet	145	94.8
Internet source (mobile phone)	141	92.2
WhatsApp	145	94.8
Facebook	102	66.7
Telegram	24	15.7
Twitter	11	7.2
E-extension APP	8	5.2
Plantix APP	1	1.3
Plantwise fact sheet APP	3	2
Open data kits APP	1	0.7
Source of ICT device		
PERSONAL property	150	98
Extension service	21	13.7

It was multiple response; respondents were allowed to choose many options.
Sources: field data, 2020.

The access of information through the internet recorded the highest response from the respondents, as can be seen from Table 2. Over 94% of the respondents stated that they use the internet regularly for communication. They further indicated mobile phones (92.2%) as their main sources for internet connection. The reason for a larger number of respondents depending on mobile phone for internet access could be the introduction of the fourth generation of mobile technology (4G) services by telecommunication companies in Ghana. Although other internet service providers offer similar services, mobile telecommunication networks (4G services) cover most parts of the country including the rural areas. Their services are cheaper and convenient compared to non-mobile internet service providers. The present findings confirm Frimpong and Vaccari's analysis on the internet trends and experience in Ghana. they found that 50% of the respondents used mobile phones as the source of accessing the web all the time, 17% used desktop, 22% used notebook, while 11% used tablets (Frimpong and Vaccari, 2015). Similar research on internet trends by (Meeker and Wu, 2013) revealed that, 75% of web users used mobile phones, while 71% used desktop PCs in China.

Among the software applications (Apps) for agricultural and extension information, E-extension APP was the most popularly used among the respondents, followed by Plantwise fact sheet APP, representing 5.2% and 2%, respectively. Plantix APP and Open data kits APP were the least used APP by the respondents, recording 1.3% and 0.7%, respectively. It implies that less than 10% of the respondents used agricultural and extension information APPs. The finding from this study contradicts the assertion made by McNamara et al. (2012, p.17) that, the Directorate of Agricultural Extension Services equipped the extension agents with a mobile technology, known as E-extension, for extension delivery in Ghana.

In terms of social media, Table 2 shows that a larger number of the respondents used WhatsApp (94.8%) more as compared to Facebook (66.7%), telegram (15.7%), and Twitter (7.2%). The implication of this is that WhatsApp and Facebook are highly preferred among the respondents when it comes to social media choices. WhatsApp and Facebook, in general, are very popular in Ghana compared to the other social media. Many Ghanaians use these platforms to create groups to communicate with their peers at workplaces, schools, churches, among others. That could account for the two taking the lead among the other social media platforms. Ocansey et al. (2016, p.91) in a research to determine the impact of social media on the youth in Ghana found that, WhatsApp and Facebook were the most social media frequently used by Ghanaian youth with 95% of their respondents indicating their preference for WhatsApp while 93.5% also indicated they used Facebook.

Furthermore, Table 2 indicates that almost all the ICT tools the respondents use are their personal properties. It could be seen that 98% of the respondents stated that the tools were their personal property, whereas 13.7% indicated the extension services provided them. That implies that there is little investment in ICT tools purchase by the extension services for its frontline staff.

4.3. The level of ICT tools use among extension officers

Table 3 below shows that the majority (32.7%) of the respondents spend between 7 and 14 h per week using ICT tools to access information. On the other hand, slightly above 32% of the respondents indicated that they use ICT tools in a period of 15–21 h per week. Similarly, another small fraction of 15.7% of the respondents said they spend below 7 h per week using ICT tools, while 36–42 h was the least time spent by respondents in a week accessing information using ICT tools. Having about one-third (32.7%) of the

Table 3
The time respondents spend using ICT tools.

Hours (week)	Frequency	Percentage
Below 7	24	15.7
7–14	50	32.7
15–21	36	23.5
22–28	23	15.0
29–35	14	9.2
36–42	6	3.9
Total	153	100.0

Sources: field data, 2020.

respondents spending between 1 and 2 h a day using ICT tools confirms the result from Table 3, that only 9.2% of the respondents use ICT tools to communicate agriculture and extension information to farmers. Because officially, extension officers in Ghana spend 40 h a week on the field with farmers (Ministry of Employment, 2015, p.14). If ICT tools were used during these periods, it is expected that the number of hours respondents spend using them would considerably increase. This result corroborates the findings by Ocansey et al. (2016) on their research on the impact of social media on the youth in Ghana. They found that 15% of the respondents spent less than an hour per day, and 65% spent 1–5 h per day using ICT devices to access information on social media. It implies that respondents mainly use ICT tools to access personal information.

Assessing ICT tools used by respondents based on gender shows that 9.8% of female respondents spend less than seven (7) hours in a week using ICT tools while 6.5% of male respondents equally spend less than seven (7) hours a week using ICT tools. Also, 27.5% of male respondents said they spend between seven (7) to fourteen (14) hours per week using ICT tools, while 5.9% females also stated that they spend between seven (7) to fourteen (14) hours per week using ICT tools. The least hours spent per week by respondents were 36–42 h, which had 3.3% male respondents and 0.7% female respondents.

A Pearson's correlation was run to determine the strength of the relationship between gender and time spent using ICTs by extension officers in the study areas. The result in Table 5 shows that there was a weak, negative correlation between gender and time spent using ICTs; r = 0.-0.312 and p-value = 0.000. That means that as time spent using ICT increases, the number of users decreases (see Tables 4 and 5). It is therefore concluded that there is a negative linear relationship between gender and time spent using ICTs, hence the null hypothesis which stated that there is no relationship between gender and time spent using ICT among extension officers was rejected and the alternative hypothesis that stated there is a relationship between gender and time spent using ICTs among extension officers in Ghana adopted.

Table 4
Gender of respondents and ICT tool use per week.

Gender	Frequency	Percentage	Hours per week
Male	10	6.5	Below 7 h
Female	14	9.2	
Male	42	27.5	7–14 h
Female	8	5.2	
Male	31	20.3	15–21 h
Female	5	3.3	
Male	22	14.4	22–28 h
Female	1	0.7	
Male	14	9.2	29–35 h
Female			
Male	5	3.3	36–42 h
Female	1	0.7	

Sources: field data, 2020.

Table 5
Correlation analysis of gender and time spent using ICT tools.

		Time (hours) spent Using ICT tools	Gender
Time (hours) spent Using ICT tools	Pearson Correlation	1	−0.312**
	Sig. (2-tailed)		0.000
	N	153	153
Gender	Pearson Correlation	−0.312**	1
	Sig. (2-tailed)	0.000	
	N	153	153

4.4. ICT training programmes extension officers undertake and Sources

The enquiry as to whether extension officers have obtained computer and ICT training shows that more than half (51.6%) of the respondents have not obtained any ICT training at all. 49% indicated they had obtained basic computer training, while 5.2%, 4.6%, and 2.6% received computer hardware, software application, and internet training, respectively as detailed in Table 6. These results imply that professional ICT knowledge among agricultural extension officers was low, and the reason for having more than half of the respondents having no computer and ICT training could be the late introduction of ICT into the Ghanaian educational system (Ministry of Communication, 2015, p.81). The respondents (37.9%) further indicated that they obtained their ICT training from the colleges or universities they studied, as part of their course. 13.8% of the respondents, however, said they learned how to use ICT tools through possession of an ICT device, whereas 5.2%, and 6.5% stated they learned from professional ICT training school and friends, respectively. Annor-Frempong et al. (2006) observed that as low as 23.7% of extension officers in Ghana had obtained professional training on ICTs, and close to one-third of the extension officers (29.2%) also received ICT training on their own.

4.5. Participation in ICT training organized by extension department in the past three years

An enquiry into respondents' participation in ICT training programmes organized by the extension services for the past three years revealed that, only 1.3% of the respondents had participated in extension organized ICT training programme four times in the past three years. 2% also said they only attended extension organized ICT training programme three times, while 5.2% indicated they participated in extension organized ICT training programme twice in the past three years. As high as 90.2% of the respondents revealed, they have never involved in any ICT training organized by the extension directorate in the past three years.

Table 6
ICT training Extension officers have obtained.

Training	Frequency	Percentage
Basic computer knowledge	75	49
Computer hardware	8	5.2
Software application	7	4.6
Internet	4	2.6
No training	79	51.6
Sources of Training		
Professional ICT training	8	5.2
Part of the university/college program	58	37.9
Learned from a friend	10	6.5
Acquired through possession of a device	21	13.8

Sources: field data, 2020. Multiple response.

Table 7
Participation in ICT training organized by extension Department in the past three years.

Number of times	Frequency	Percentage
1	2	1.3
2	8	5.2
3	2	2.0
4	2	1.3
None	138	90.2

Sources: field data, 2020.

4.6. The extent at which extension officers use ICT tools

The assessment of ICT tools usage among respondents in Table 8 revealed that 95.4% use ICT tools to communicate with family and friends. Close to 83% of the respondent said they use them to access entertainment programmes, and more than 54% of them also said they use them for studying and searching for new information. A little above one quarter (28.8%) of the respondents indicated they use ICT tools for business networking, while less than 10% said they use them to communicate agricultural and extension information. Having less than 10% of the respondents using ICT tools for extension activities is worrying, especially, when the ratio of agricultural extension officers to farmers in Ghana is low (1:1500), also there are difficulties of accessing farmers in the remote location (McNamara et al., 2014, in Azumah et al., 2018). Furthermore, it was observed in Table 2 that, the majority of the ICT tools used by the respondents were their private properties, and therefore not designated for extension work activities. That could account for the lower application of ICT tools in extension activities.

Table 9 below gives the results of Pearson correlation result for respondents' participation in ICT training for the past three years, and ICT tools for communicating agriculture and extension information. The Pearson correlation coefficient between the two variables: participation in ICT training for the past three years, and ICT tools for communicating agriculture and extension information = 0.906. That shows that there is a perfect positive relationship between the two variables. That is, as participation in ICT training for the past three years increases, ICT tools for communicating agriculture and extension also increases. It is therefore concluded that the relationship is statistically significant at a p-value of 0.000.

4.7. Factors influencing ICT tool usage among extension officers

Table 10 presents the factors that affect ICT tools use among respondents. The Means were calculated on a Likert scale, where 1 = not a major factor; 2 = not a factor; 3 = somehow a factor; 4 = a factor 5 = A major factor. Among the factors, weak network connection (mean = 4.359, std = 0.7998) was found to be the most influential factor among respondents, followed closely by a lack of training opportunities (mean = 4.124, std = 0.8909). Respondents also indicated that a lack of ICT infrastructure (mean = 3.373, std = 0.8877) and the cost of ICT tools (mean = 3.033, std = 0.9629) were also influential in their ICT tools use. Low education (mean = 1.758, std = 0.8431) and gender discrimination (mean = 1.144, std = 0.6922) were the least influential factors among the respondents. In Ghana, frontline extension officers live in rural communities with farmers, and the telecommunication network connection in those areas are mostly weak, especially rural communities that are far from big cities. That could account for the reason why the majority of the respondents indicated a weak network connection as the most influential factor. It implies that before the extension services in Ghana rollout an ICT programme for extension communication in rural areas, especially those that may rely on mobile telecommunication network connection, the network connection status of the rural communities has to be taking into consideration. Furthermore, the lack of training opportunities was the second most influential factor affecting respondents' ICT tools use. That could have a link to the results obtained in Table 7, which showed that less than 10% of the respondents had the opportunity to participate in ICT training organized by the extension services in the past three years.

Table 8
Uses of ICT tools by respondents.

Uses	Frequency	Percentage
Communicating agric. and extension information	14	9.2
Communicating with family and friends	146	95.4
Studying and searching information	83	54.2
Business networking	44	28.8
Watching entertainment programs	126	82.4

Sources: field data, 2020. Multiple response.

Table 9
Correlation analysis of selected variables.

		ICT tools for communicating agric. and extension information	Participation in ICTs training for the past three years
ICT tools for communicating agric. and extension information	Pearson Correlation	1	0.906**
	Sig. (2-tailed)		0.000
	N	153	153
Participation in ICTs training for the past three years	Pearson Correlation	0.906**	1
	Sig. (2-tailed)	0.000	
	N	153	153

Sources: field data, 2020.

Table 10
Factors influencing ICT tool usage among extension officers (N = 153).

Factors	Mean	Standard deviation
Weak network connection	4.359	0.7998
Lack of training opportunity.	4.124	0.8909
Lack of ICT infrastructure	3.373	0.8877
Cost of ICT tools	3.033	0.9626
Lack of expertise	2.712	0.7752
Physical location	2.575	1.0803
low income	2.425	0.9914
Low education	1.758	0.8431
Gender discrimination	1.144	0.6922

Sources: field data, 2020.
Means were calculated on a scale of 1 = not a major factor; 2 = not a factor; 3 = somehow a factor; 4 = a factor 5 = A major factor.

5. Conclusion and recommendations

This study sought to assess the use of information and communication technologies (ICT) among agricultural extension workers and its implications on extension delivery in Ghana. The general conclusion from this study is that the use of Information and Communication Technologies (ICT) tools is higher among extension officers, but has very little application in extension service delivery. The most commonly used ICT tools by the extension officers were ICT devices (mobile or smartphone, laptop, iPad or tablet, desktop computer), Social media (WhatsApp, Facebook, Telegram, and Twitter), and the internet. More than ninety percent of these ICT

tools used by the extension officers are their personal properties. The majority of the extension officers do not employ ICT tools in extension activities; instead, they spend between seven to fourteen hours per week communicating with family and friends using ICT tools. Close to fifty percent of the extension officers had obtained basic and professional ICT training in software application, computer hardware, and internet access from both professional training schools and informal sources. Also, there is a linear relationship between gender and time spent using ICTs among extension officers. The most critical factors affecting extension officers' access to ICT in Ghana were weak telecommunication network connection, lack of ICT training opportunities, and the lack of ICT infrastructure to cushioning extension activities.

It is therefore recommended that the agricultural extension services should provide intensive ICT training for the extension workers to enhance the incorporation of ICT into extension advisory service.

The extension services should also provide the extension officers with ICT devices and software designed purposely for extension advisory service to enable them communicate easily with farmers.

The extension services should employ and train more female extension officers to bridge the staffing gap between male and female extension officers, this will help in broadening the extension service coverage; especially, in the areas where socio-cultural beliefs forbid male and female interaction

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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