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Assessing the usefulness of the e-Agriculture programme in Ghana using the Technology Acceptance Model

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ABSTRACT

Access to relevant agricultural information holds the potential to significantly contribute to achieving food security. Recognizing this imperative, the Government of Ghana has established an e-Agricultural portal aimed at meeting the extension and informational needs of farmers. However, the effectiveness of this e-resource in enhancing productivity remains uncertain. This study therefore set out to examine the perceived utility, user-friendliness, motivations, and obstacles associated with e-Agriculture resources. Utilizing the Technology Acceptance Model (TAM), our investigation sought to elucidate the factors influencing the adoption of e-Agriculture resources for livelihood development and their impact on stakeholders, namely, farmers and system managers. Our findings indicate that the utilization of e-resources has introduced farmers to novel trends, including knowledge of improved technologies and good agronomic practices. These advancements have translated into increased income and greater financial autonomy. Nonetheless, the study found that the sustainability of the e-Agriculture programme presents considerable challenges, posing a potential threat to Ghana's agricultural sector and food security. Conspicuously, our research revealed that substantial benefits have been derived from the utilization of e-Agriculture resource centres. A significant majority of patrons reported minimal difficulties in accessing and using these resources within their respective centres. Furthermore, e-Agriculture has enhanced their financial inclusion within the agricultural value chain, ultimately improving farmers' access to agricultural credit. As a result, we recommend that the Ministry of Food and Agriculture (MoFA) consider designating e-Agriculture centres as standard cost centres, similar to other departments and state agencies within the ministries.

Keywords: E-Agriculture; agricultural information; smart agriculture; Technology Acceptance Model; Ghana
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Introduction

There are increasing advocates to develop needs-driven innovations to transform the agricultural sector in Global South facing the challenges of food and nutrition insecurity (Degila *et al*., 2023). Successive governments in Ghana and other international development partners such as the Food and Agriculture Organization (FAO) among others, are determined to use the sector as a tool for improving the livelihoods of many Ghanaians. This is clearly evident in the implementation of the flagship policy of agriculture programme known as Planting for Food and Jobs (PFJ) (Ansah *et al.*, 2020; Tanko *et al.*, 2019). Recently, the Planting for Export and Rural Development (PERD) and the

Rearing for Food and Jobs programme another component of the Government of Ghana's agricultural flagship policy programme. (Amissah-Reynolds, 2020; Tandoh-Offin, 2021), have also been launched with the aim at diversifying Ghana's agricultural export capacity to include six major tree crops.

The entire PFJ policy seeks to produce enough food to feed the nation, the agro-processing industry, and export the surplus to reduce the excessive import bills and generate employment for Ghanaians. In view of this, access to relevant agricultural and extension information is crucial and has the potential to contribute to food security, farmers' sustainable livelihoods and improve agricultural productivity (Fasoyiro & Taiwo, 2012). The usefulness of agricultural extension and information services rests on both farmers' access to information and its quality.

The issue of smart agriculture stems from the application of digital agricultural technologies that offer innovative platforms for agricultural service delivery. One such innovation is e-Agriculture that involves, among other things, the use of information and communication technology in agriculture (MoFA, 2017; cited in Abubakari *et al*., 2023). The vision of the e-Agriculture project is "excellence in adopting e-solutions to transform agriculture and the food sector for national prosperity capable of rapid and sustainable growth, inclusive of smallholders with strong linkages to agricultural industrialization." (FAO, 2018). The e-Agriculture resource can offer valuable assistance to farmers engaged in agricultural livelihoods and development in Ghana. Additionally, the dominant contributors aiding in achieving food security and ending hunger can be identified. E-Agriculture resource in our view is simply an enabling tool and platform providing information on agriculture. It is the way it is utilized that determines whether it is useful. What matters most is the content and currency of information and how it is utilized by actors in agriculture, particularly farmers. We adopted the Technology Acceptance Model (TAM) to understand constraints and motivations related to using e-Agriculture for livelihood development. The purpose of TAM was to illuminate the mechanisms underlying technology acceptance, anticipating behaviour and providing theoretical explanations for effective technology application. This study, therefore, sought to investigate the perceived usefulness, ease of use, motivation and constraints of the e-Agriculture resource.

Literature review

According to Degila *et al*. (2023), digital agriculture has emerged as one of the solutions embraced by developing countries to achieve their agricultural transformation. Degila *et al*. (2023) further posit that digital agriculture uses computer and communication technologies to provide farmers with information, services, and new opportunities to increase profitability and sustainability in agriculture. Abdulai *et al*. (2023) also define digital services as the leveraging of digital tools, hardware, and software, to create services that aid agriculture activities and processes at the heart of agricultural transformation.

The concept of e-Agriculture has become very prominent in recent times as a mechanism for the modernisation of agriculture especially in developing nations like Ghana. The concept encompasses the creation of a platform for utilizing Information and Communication Technology (ICT)-mediated tools by practitioners such as extensionists and farmers to promote agricultural production and productivity. (Abubakari *et al*., 2023). Ensuring food security has become an issue of key importance to countries with different degrees of economic development and

Ghana is no exception, while the agricultural sector plays a strategic role in improving food availability (Powlak & Kolodziejczak, 2020). The contribution of agriculture to the development of Ghana's economy cannot be underestimated. Agriculture also contributes about 54% of Ghana's Gross Domestic Product (GDP) and accounts for over 40% of export earnings, while at the same time providing over 90% of the food needs of the country (FAO, 2018). Ghana's agriculture is predominantly smallholder, traditional and rain-fed (FAO, 2018).

Considering the above statistics, one can deduce the important role and contribution of agriculture to Ghana's economy. In agriculture, the role of information in enhancing productivity cannot be over emphasized (El Bilali & Allahyari, 2018; Inusa *et al.*, 2018). Bachhav (2012) states that the use of information in the agriculture sector enhances farming productivity in several ways such as providing information on weather trends, best agronomy practices and access to markets for the sale of agriculture produce.

Timely access to market information helps farmers make accurate decisions about what crops to plant and where to sell agricultural produce (Yankson *et al.*, 2016). Information needs of farmers change from time to time due to changing agricultural technologies, environmental changes, agricultural policies, and the emergence of agricultural innovations (Lioutas, 2014; Tomlinson & Rhiney, 2018; Zhang *et al.*, 2016). Baah & Anchirinah (2011) suggest that access to the right information is crucial, and lack of it is more critical in agriculture than in other areas of human endeavor. Bello-Bravo & Anne (2023) confirm the study by Baah & Anchirinah (2011), and posit that agriculture information benefits smallholder farmers by improving food production and increasing agriculture development and information on farming practices, market prices, and disease and pest control. Empirical literature suggests that there is a direct linkage between the application of technology and high productivity. The use of technology by farmers has been known to play a central role in Agriculture (Sharma *et al.*, 2012; Wolfert *et al.*, 2017) and improving upon their farm production (Stočes *et al.*, 2016).

Flor & CisnerosIt (2015) propose that the term e-Agriculture may be used to refer to any form of electronic media used in promoting and supporting agricultural programmes, projects, and activities. They cited an example of utilizing radio or television to disseminate innovation or support capacity development programme of national agriculture agencies. Additionally, e-Agriculture refers to a global organization or a Community of Practice, engaged in the use of Information and Communication Technology for agricultural production, marketing and advocacy (Chandra & Malaya, 2011; Thankachan & Kirubakaran, 2014). Part of this movement champions mobile phones and texting services for agricultural market information and crop decision support systems as well as food policy advocacy (Flor & CisnerosIt, 2015).

Lantzos *et al.* (2013) submit that there is an array of powerful technologies that large scale farmers employ to manage their farms. This consistently has made the processes involved in farming to become less laborious. By using these farm management applications and software, farmers can track all the management data and keep records for investments and working practices (Ochilo *et al.*, 2019). Degila *et al*. (2023) cited a typical case of Esoko's work in Ghana, and postulate the company's design of a platform to help collect full information and to provide digitization tools, analytics, biometric profiling, and communication services. This start-up

is a handy tool for digitizing agricultural supply chains, inventory or impact tracking, GIS mapping, or engaging and providing communities with agronomic advisories, climate-smart contents, weather, nutrition, or market information (Esoko.com, 2023).

One such software is the Farm Manager application. The introduction of Farm Manager android application which has been made freely available, is being used by more than 1000 farmers in Greece (Lantzos *et al.*, 2013). The interface of the application which works on a smartphone has been made very easy to use especially by old farmers who may not be very conversant with technology. Thus, in the view of Lantzos *et al.* (2013, p. 589), "Even the best software if it is supplied with bad user interface and not easy operation, will never be adopted by farmers. Farmers require software that is easy to operate and ask only for the specific data required to complete an operation or a process."

Several prospects and challenges on e-Agriculture has been espoused in the literature. Discussing the challenges and prospects of e-Agriculture in Rural Development in the Indian context, Chandra & Malaya (2011) intimate that Information and Communication Technologies (ICTs) play a key role in the development and economic growth of India where ICTs were used as collaborative tools across the sectors of the agriculture production chain. However, e-Agriculture was yet to find its feet as compared to other sectors.

Namisiko & Aballo (2013) in their study of the current status of e-Agriculture in the TransNzoia County in Kenya found that there was a high level of awareness in terms of deployment and adoption of e-Agriculture among farmers. This was, however, impeded by a low level of deployment and adoption of these technologies was still a pipedream. Similarly, Pivoto *et al.* (2017) reveal that though Smart Farming had high prospects in Brazil, interoperability among systems, low level of education and knowledge of farmers, poor telecommunications infrastructure on rural properties, difficulties in manipulating data and information obtained from equipment and machines were barriers to the adoption of Smart Farming technologies. From the ongoing literature review, it can be concluded that the role of the telecommunications is enormous in activities ranging from the cultivation of crops, sale and management of farms.

A review of the literature also revealed a paucity of literature on farmers' use of the technology for managing farm practices within the Ghanaian landscape. Accordingly, we explore this subject matter further by conducting a study in Ghana. Perhaps, this study would provide a basis for generalization based upon which regulatory frameworks could be introduced to ensure efficiency in the rapidly growing use of technology by farmers' thereby boosting agriculture productivity in the country.

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) was proposed by Davis (1989) to predict the acceptance and use of new information technology (software and information systems) within organizations. In the model, behavioral intention can be explained by an individual's attitude towards using the system and its perceived usefulness. Attitude towards the use of the system, in turn, can be explained both by its perceived usefulness and its perceived ease of use. Perceived usefulness was defined by Davis (1989) as the degree to which individuals believe that using a particular system would enhance their job performance (Davis, 1989). In contrast, perceived ease of use relates to the degree to which individuals believe that using a particular system would require no effort.

(Davis, 1989). By hypothesis, the greater the perceived usefulness and the perceived ease of use, the better are people's reactions towards the innovation and the higher their intention to adopt it.

According to TAM, perceived usefulness is also influenced by perceived ease of use. All other things being equal, if the easier the system is to use, it would be more valuable. (Davis, 1989). Across the many empirical tests of TAM, perceived usefulness has consistently been a strong determinant of usage intentions. TAM is considered to be well-established and robust. The model consistently explained a substantial proportion of usage intentions and behavior variance. Several studies had extended the TAM model by emphasizing antecedents of ease of use and perceived usefulness or added additional components to the model to account for the context-specific nature of adoption studies.

TAM has been criticized by Chuttur (2009) as having questionable heuristic value, limited explanatory and predictive power, triviality and lack of any practical value. These criticisms later led to a modification of the theory into the Technological Acceptance Model 2 and the Unified Theory of Acceptance and Use of Technology (UTAUT) model. For example, Venkatesh *et al.* (2012) added the subjective norm construct, and the new model became known as TAM 2. The model has been applied by some authors (D'souza *et al.,* 2021; Manjeese, 2013; Sarker *et al.,* 2019) in their respective studies on e-Agriculture. For example, Sarker *et al.* (2019) applied the model to determine extension workers' attitudes toward e-Agriculture. Manjeese (2013) also applied the model to understand the factors influencing the adoption and use of internet-agriculture by small-scale farmers in Zimbabwe. While previous studies focused on factors influencing adoption of e-Agriculture, D'souza *et al.* (2021) assessed consumers' acceptance of E-commerce to purchase geographical indication-based crops while applying the TAM model. As applied in this study to assess the e-Agriculture development in Ghana, the TAM model is concerned with determining the perceived usefulness, ease of use, motivation and constraints of the e-Agriculture resource. The model is relevant to this study because, in the view of Davis (1989) it can be used to predict the acceptance and use of new information technology (software and information systems). The TAM model has a direct relationship to this research and will guide the study in meeting the objective of assessing the utility of the e-Agriculture programme within the Ghanaian landscape so as to make policy recommendations for its improvement.

The case

Ghana's flagship e-Agricultural programme sponsored by the World Bank was aimed at modernizing agricultural production by providing a platform to enable agricultural specialists to share experiences, good practices and resources for sustainable agriculture in line with Ghana's ICT4AD policy. Through its implementation, it was envisioned that it would bridge gaps by enabling:

- Farmers to have direct access to content through modern technologies like the mobile phone, as well as direct access to extension officers;
- Effective knowledge sharing without limits to language, literacy, distance, and affordability;
- The establishment of public-private partnerships in the collation and dissemination of agricultural information;
- Promote and support the development of local content in local languages

The programme was implemented through four main components: e-Agriculture portal (accessible at www.e-agriculture.gov.gh); Toll-Free Interactive Voice Response (IVR); Multi-Directorate Call Centres; and Resource Centres. The online portal is to provide a one-stop-shop site to publish information on new and current activities in the agricultural sector and all actors in the agricultural value chain. Toll-free IVR is a multilingual local language system that provides farmers with desired agricultural information when they need it. Unlike the IVR system, multi-directorate call centres situated within the resource centres cater to the needs of farmers who want to have conversations with experts in the domain of interest. The pivot around which all the other services operate is the resource centres which is focused on farmer information and technology training to promote agricultural entrepreneurship and strategic project planning. The government established three of these centres strategically located in the three ecological regions of the country namely Accra which is located in Greater Accra region, Kumasi, located in Ashanti region, and Tamale, located in the Northern region to embody the full range of environmental, agro-ecological and socio-cultural conditions in the coastal, middle and the northern belts of the country respectively. The focus of this study is on these three centres to help us understand the interactions of farmers with e-Agriculture resources and how the centres have been utilized to support agricultural activities in Ghana from the perspectives of managers and patrons of these centres.

Materials and Methods

This case study research focuses on the Ministry of Agriculture (MoFA's) e-Agricultural centres. A case study is an enquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident and in which multiple sources of evidence are used (Pickard, 2007; Yin, 2004). In a case study enquiry, the researcher collects in-depth data on the research questions relative to a programme or an event (the case) to learn more about an unknown or poorly understood situation (Bryman 2004; Creswell 2014). Creswell (2014) further posits that case studies are a design of enquiry found in many fields, especially in evaluation, in which the researcher develops an in-depth analysis of a case, often a programme, event, or activity.

In this study, we used both primary and secondary data sources of information. We administered structured and semi-structured interview questionnaires to managers of the three centres in Ghana as a way of gathering primary data. Semi-structured interview questionnaires were administered to some users of the centres who were conveniently sampled because they were readily available and willing to participate in the research (Etikan *et al.*, 2016). The e-Agriculture resource centres were essentially chosen as a case based on our own judgement and as a result of their relevance to the research. This purposive sampling yardstick reinforces the view of De Vaus (2002) who posits that purposive sampling is a form of non-probability sampling where cases are judged as typical of some category of cases of interest to the researcher. Additionally, these centres have similar basic characteristics and attributes of the population of e-Agriculture centres in Ghana.

Our interests were put first because of the fact that agriculture is the backbone of Ghana's economy and also the government's determination to end hunger, achieve food security and improve nutrition and promote sustainable agriculture in Ghana in fulfilment of global Sustainable Development Goals (SDG) 1, 2 & 4. The study population comprised managers of these centres. In all, three managers, and 60 users i.e. 20 selected

from each region's center, were interviewed. Interviews were recorded with consent from participants and later transcribed. Table 1 lists all participants interviewed. Participant IDs start with the center code followed by the participants number and in no particular order in which they were interviewed. Regarding participants, 'P' denotes users while 'M' denotes the manager of a center. This was done for the purposes of anonymity and confidentiality.

TABLE 1
Centre codes and number of interview participants

Centre Code	Manager	Number of Participants
C1	1	20
C2	1	20
C3	1	20

Source: Field data, 2022

Results and Discussion

Services Commonly Provided/Used

We first sought to determine the category of people that patronized the centres studied. It emanated from our interviews with managers of the centres that people from diverse backgrounds, irrespective of sex, age groups, occupation, and level of education often visit their centres for varied services. For instance, a manager of a center intimated:

> *Mostly, you have agricultural extension agents (AEAs), farmers, fisher folks, foresters and loggers. It will even interest you to note that some researchers, university and Senior High students often come here to conduct their research. (C2, M)*

The manager of another center also indicated:

> *In summary, I would say we often have agricultural service providers, agricultural researchers, agriculture sector policymakers, agribusinesses be it large, medium or small local enterprises and stakeholders from other sectors in e-Agriculture related activities coming to us for information. (C3, M)*

The study also sought to find out the services most commonly provided. Interviews with managers and users of the centres revealed that one centre had a variety of more complex services and resources provided to farmers in the region. These include the Interactive Voice Response (IVR), Multi-Directorate Call Centre, Resource and e-Learning Centre, e-Field Extension Service Delivery/Farmer Registration (National Farmers' Database) 34, e-Library, and e-Extension Web Portal. The other two e-Agriculture centres studied were however inadequately resourced. Table 2 gives a breakdown of the average daily users and number of basic equipment in the centres. The manager for Centre 3 attributed the dwindling user patronage to the COVID-19 pandemic. He indicated that before the pandemic set in, they used to have up to about 100 patrons visiting the centre daily.

TABLE 2
Breakdown of number of patrons and equipment

Number of:	Centre 1	Centre 2	Centre 3
Average number of daily patrons	75	50	Less than 20
Computers	40	10	15
Projector	2	-	1
Photocopier	1	1	-
Server	1	-	-
Generator	1	-	-
Printers	3	1	1

Source: Field data, 2022

These centres were mostly restricted to services such as supply of information on simple farm accounting and records keeping systems, dissemination of improved technologies to farmers, pest and diseases management systems, good agricultural practices and the use of computers and internet services for data processing. Radio programmes have a compelling effect on the character, actions, opinions, development, or behavior of people. We probed to find out if there were an existence of community radios in the study areas. It emerged that none of the study areas had a community radio. However, one of the centre managers intimated they had considered setting up a community radio. He indicated:

> *The setting up of a community radio is currently underway in conjunction with Farm Radio International (FRI)* which is a *non-profit organization focused on using radio to help African farming communities help themselves. The purpose of the community radio is to disseminate early warning (weather/temperature/pests/diseases/) information to remote farmers cheaply). This is to prevent crop/animal/human-being losses and mitigate the effects of natural adversities. (C1, M)*

Christiaensen (2016) advocates that presently, TV and radio are noteworthy, as they convey current agricultural information to literate and illiterate farmers alike even in the interior or rural areas within a short time. It was, therefore, quite disturbing to note that none of the study centres had a functional community radio station.

Perceived usefulness of the e-Agricultural resources

A key to achieving impact from the research-based knowledge is improving the knowledge-base of extension workers and equipping them in their day-to-day engagement with farmers (Yazdanpanah & Feyzabad, 2017). According to the TAM, perceived usefulness represents the degree to which a person believes that using a particular system would enhance his or her job performance (Davis, 1989). Within the context of this study, it was to assess the perceived usefulness of the e-Agriculture resource centres and how they have impacted their respective communities from the perspective of users who are direct beneficiaries of these resource centres. Responses from participants revealed that enormous benefits had been derived with regards to the use of e-Agriculture resource centres. For instance, a participant indicated:

> *I observed that several e-Agriculture platforms have been linked to the e-Government platforms. This has helped to educate me and also some of the youth who are new in agriculture on some of the best agricultural practices. (C2, P5)*

Similar sentiments were expressed by another participant:

> *The usage of e-resources has awakened me to how faster and easier agricultural activities may be carried out now which we often refer to as smart agriculture. As relevant stakeholders in the agriculture sector, we can now recognize, locate and utilize the specialized knowledge currently embedded in the*

> *organizational databases and the processes and routines to boost production. (C3, P20)*

Comments from a participant from another centre were also not far from those of participants in the other centres. He intimated:

> *MoFA's e-Agriculture platform has enabled me as a fish farmer to conveniently and cost effectively obtain information and connect with other local fishermen in other fishing farming communities. Also, it has enabled me to connect with agricultural service providers for fast learning of good fishing practices, sharing of knowledge and achieving better access to markets for my fish produce. (C1, P15)*

Another participant noted:

> *I think I like this whole idea of the e-Agriculture platform linked to the e-Government platform. This facilitates convergence, traceability and a one-stop shopping for agricultural stakeholders with unique identifier sharing experiences. (C2, P7)*

From the above, it may be observed from the responses of participants that they found the e-Agriculture resource useful since it enabled them to share and transfer knowledge and information with other actors within the agricultural sector. It has been found that knowledge sharing among players in the agricultural eco-systems is essential for accelerating the transfer of verified, credible and up-to-date knowledge to wider audiences and members of the agricultural community (Cadger *et al.*, 2016; Concu *et al.*, 2020).

From research perspective, sharing knowledge and exchanging data have created opportunities to involve more stakeholders in agricultural research which is often facilitated by a networking capacity and an improved e-learning environment. The findings of this present study are similar to that of Nedumaran & Manida (2020) whose study on e-Agriculture and rural development in India also found that generally, farmers had increased their yields over the years through timely information on agriculture.

Ease-of-use of the e-Agricultural resources

Perceived ease-of-use represents the degree to which a person believes that using a particular system will require less effort (Davis, 1989). This is however influenced intensely by attitudes toward the technology being introduced, the behavioral intention to use, and its actual use. By hypothesis, the greater the perceived usefulness and the perceived ease of use, the better people's reactions toward the innovation and the higher their intention to adopt it. According to TAM, perceived usefulness is also influenced by perceived ease of use because, all other things being equal, the easier the system is to use, the more useful it can be (Davis, 1989). We sought to find out if generally, the e-Agriculture resources were easy to use. The majority of patrons did not encounter any challenges in using the e-Agriculture resources in their respective centres. For instance, a patron of one of the centres had this to say:

> *For now, I only use the computers in the centre to surf the internet for information and also process data. That is not so much of a difficulty for me because I have a bit of knowledge in ICT. (C3, P16)*

Quite aside from that, it also came to light that patrons of these centres were taken through a series of training to enable them easily use the equipment provided at the centre. A participant intimated:

> *Before we began using facilities at the centre, we underwent training, especially with more complex resources and equipment at the centre. So at least I have a fair knowledge of how every equipment in this centre operates. My only challenge was with surfing the e-Library to find relevant materials but after an information literacy class organized by the manager of our resource centre, I have overcome that challenge. (C1, P9)*

Managers of the centres also revealed that they were mostly on standby to render help to patrons who were encountering some bit of difficulty in using their resources. They revealed that continuously teaching patrons how to use some of the equipment had made them very abreast thereby increasing their confidence in using the e-Agriculture resources. Previous studies show that technical support has a positive effect on perceived usefulness and ease of use (Patel *et al.,* 2016; Mercurio & Hernandez, 2020).

Motivation for the use of the e-Agricultural resources

This section analyzed the motivation of patrons to use the e-agricultural resource centres. Motivation from resource centres is key to the successful adoption of e-agriculture. Questions relating to motivation for use revealed that huge economic benefits were being derived from patronizing these e-Agricultural resource centres. Participants revealed that e-Agriculture had improved financial inclusion within the agricultural value chain. This had ultimately led to improved access to agricultural credit by most farmers. A participant pointed out:

> *There has been improved funding coordination and communication processes of the larger input distributors providing financing who often received the funding from banks while retailers acted as intermediaries in providing credit directly to farmers. (C3, P14)*

Similar views were expressed by a participant when he asserts:

> *Through the availability of improved technologies and good agronomic practices, production levels have increased which translates into more revenue. (C2, P15)*

This view is affirmed by Li *et al.* (2020) who suggest that sustainable e-Agriculture based on blockchain technology brings great convenience to farmers' sales, increasing by 25% on average compared with traditional agriculture, thus bringing vitality to the sustainable development of agricultural products.

It also came to light from interviews with participants from the three study centres that e-Agriculture activities have several prospects for the growth of pro-poor economic communities since it considers the poor's livelihood. As such e-Agriculture-enabled services that are useful for improving the capacity and livelihoods of poor smallholders are growing quickly. In economic terms, agricultural informatics' role is to reduce the information search costs in the agriculture

value chain. As intimated by a participant:

> *The e-Agriculture programme ensures that we smallholder farmers benefit from commercialization in agriculture by participating in the market taking cognizance of the fact that increased commercialization shifts farm households away from traditional self-sufficiency goals and toward profit and income-oriented decision-making. (C1, C19)*

Another key finding from interviews suggests that providing agricultural information and networking increases the efficiency of the whole agricultural value chain. In the view of a participant:

> *It is in the interest of all of us stakeholders in the agriculture value chain, whether you are a farmer, fisherfolk, forester, animal husbandry, development partners, NGOs, CSOs, FBOs, processors, transporters, retailers among others to embrace e-Agriculture since that is the new trend. (C2, P3)*

It also came to light from the study that e-Agriculture economically gives advantages to expand profitability, expand quality in items, rake higher returns and expand profitability. Also, expanded productivity, simple information on climatic condition, dampness, soil type and crop design were identified as agrarian knowledge acquisition that could be shared quickly using technology.

Challenges to the adoption of e-Agriculture

We sought to find out from managers of these centres some of the challenges they encountered in managing and running these e-Agriculture resource centres. A major challenge of running these e-resource centres espoused by a manager was finance to acquire and maintain ICT facilities. For instance, one of the managers of a centre intimated:

> *One of our biggest challenges in running our information centres for farmers is inadequate content and resources. This is because we barely get sufficient institutional support. (C3, M)*

Managers of other centres also lamented that settling monthly utility bills such as internet bandwidth and electricity were some of their biggest challenges in running their information centres. Similar to other developing world contexts, findings by Saidu *et al.* (2017) on the challenges in the application of ICT in Agriculture in developing countries revealed that fluctuating power supply and poor internet infrastructure continues to impede ICT implementation in agriculture. Managers of the centres lamented that they did not get sufficient support from relevant institutions that are supposed to support such initiatives. Basic equipment to run these centres were woefully inadequate to meet the support needs of users. This was even worsened by the low availability of furniture. For example, as reported by the manager of one of the centres, there are situations where 10 users share one computer due to lack of computers.

It may thus be deduced that the lack of commitment and clear decisions on investments in technology coupled with low budgetary allocation from financiers like

government and donors to support e-resource centres and weak information technology infrastructure pose serious challenges to such laudable e-Agriculture initiatives in Ghana. We further probed to find out if there were other alternative sources of funding centre managers often relied on to augment their finances and also support their programmes. A participant lamented:

> *Sometimes we try to reach out to NGOs in the region but unfortunately, most of the NGOs in the region are not agriculture related so they are unable to support us. (C3, M)*

With these challenges, e-Agriculture implementation in Ghana stands a reduced chance of adoption and sustainability. Similar to previous studies in other developing country contexts (Chauhan 2015; Saidu *et al.*, 2017), it is interesting to note that the cost of technological and communication infrastructure far exceeds the budgets allocated to institutions mandated to run these centres. Khetarpal (2014) contends that technologies are either limited or non-existent in low-income per-capita countries. This could be a clear case of the e-Agriculture centres studied considering that they face a major problem of securing a steady stream of revenue to sustain the centres.

The problem about the lack of adequate finance could largely be attributed to the fact that these community resource centres solely depend on Government of Ghana (GoG) funding. While the public would like to continue patronizing these centres at no cost, government subventions cannot maintain and sustain their existing services due to inadequate budgetary allocation. The declining or the complete absence of government support makes it extremely difficult for managers of the e-Agriculture centres to sustain the provision of their services.

Conclusion and Recommendation

In conclusion, very optimum achievements have been made with the e-Agriculture programme. A variety of services are being provided by the various centres through the e-Agriculture programme which patrons and beneficiaries of these programmes admitted had been largely useful to them. The e-Agriculture programme had consequently improved the financial inclusion of a lot of beneficiaries within the agricultural value chain. Also, the study revealed that e-Agriculture activities have several prospects for the growth of pro-poor economic communities since it considers the poor's livelihood. This study makes a practical contribution in the field of e-Agriculture adoption in that access to relevant agricultural and extension information has the potential to contribute to farmers' sustainable livelihoods and improve agricultural productivity. The study further demonstrates the utility of the TAM, originally developed to predict the acceptance and use of new information systems, in assessing the e-Agriculture project. It afforded this research the opportunity to explain a substantial proportion of usage intentions and behavior variance leading to the adoption of the programme in Ghana.

From the foregoing, while one can deduce that the programme has been of tremendous benefits, it is beset with some teething challenges and this poses questions regarding the sustainability of such a laudable project. Sustainability as a concept denotes the ability or capacity of something to be supported, maintained, or sustain itself (Benson & Craig, 2014). The sustainability of the e-Agriculture programme is hinged on the Sustainable Development Goals (SDGs) related to this study which seeks to:

- Goal 1: End poverty in all its forms everywhere
- Goal 2: End hunger, achieve food

security and improved nutrition and promote sustainable agriculture
- Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

Among some of the challenges revealed from the study, the major one identified was funding. Inadequate funding to the centres had resulted in the lack of adequate content and resources and the inability to pay bills such as internet bandwidth and electricity. Basic equipment such as furniture, computers, scanners and other requisite ICT accessories to run these centres were also woefully inadequate to meet the support needs of users. The following recommendations are therefore suggested.

Designate e-Agriculture centres as standard cost centres
The Ministry of Food and Agriculture (MoFA) should categorize e-Agriculture centres as standard cost centres, akin to other departments and state agencies under the ministry's purview. This reclassification would streamline resource allocation and enhance efficiency.

Enhance visibility and functionality of e-Agricultural components
To improve the effectiveness of the e-Agriculture programme, it is essential to make the individual components more visible and functional. Extensive and continuous awareness campaigns should be conducted to educate farmers and other stakeholders about the various facets of the e-Agriculture programme, with a special focus on Interactive Voice Response (IVR) and call centres.

Replicate e-Agriculture centres across all districts
To ensure sustainability, e-Agriculture centres should be established in all districts, accompanied by supportive policies and measures for agricultural adaptation and climate change mitigation.

Introduce fees for services and products
To generate income for sustaining the project, fees should be charged for certain services and products. For instance, a nominal fee could be applied to the content developed, creating a revolving fund to produce more valuable content. To enhance the appeal to farmers, content should be packaged attractively. To manage this, we recommend the formation of Content Committees with diverse membership from major cash and food crop dealers, animal husbandry experts, input dealers, and suppliers in the centre's catchment area.

Address political will and funding barriers
Ensuring the programme's sustainability requires addressing political will and funding challenges. The Government of Ghana should recognize e-Agriculture as a crucial modernization tool for agriculture and allocate sufficient funding accordingly. Policymakers should also bolster risk management approaches by strengthening relevant institutions and infrastructure within the e-Agriculture programme. Moreover, an official national e-Agriculture strategy and policy should be promulgated, developed in collaboration with stakeholders, to guide the national-level adaptive processes of the e-Agriculture programme.

Foster public-private partnerships for telecom infrastructure
Given the hindrance posed by poor telecom networks, the managers of e-Agriculture programs should engage in public-private partnerships. These partnerships should be initiated by e-Agriculture centre managers, collaborating with interested stakeholders such as telecommunications companies. This

collaborative effort can help improve telecom infrastructure and, subsequently, the efficiency and effectiveness of e-Agriculture projects.

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