UNIVERSITY OF CAPE COAST

THE USE OF MOBILE PHONES IN AGRICULTURAL EXTENSION DELIVERY IN THE EASTERN REGION, GHANA

CAROLINE NYAPLUE

2015

UNIVERSITY OF CAPE COAST

THE USE OF MOBILE PHONES IN AGRICULTURAL EXTENSION DELIVERY IN THE EASTERN REGION, GHANA

BY

CAROLINE NYAPLUE

Thesis submitted to the Department of Agricultural Economics and Extension of the College of Agriculture and Natural Sciences, University of Cape Coast in partial fulfilment of the requirements for award of a Master of Philosophy Degree in Agricultural Extension

August 2015

DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original work and that no part of it has been presented for another degree in this University or elsewhere

Candidate's Signature: …….Date……..

Name: Caroline Nyaplue

Supervisors' Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Principal Supervisor's Signature…….Date…… …

Name: Dr. Albert Obeng Mensah

Co-supervisor's Signature……Date…….

Name: Mr. Martin Bosompem

ABSTRACT

The Ministry of Food and Agriculture has adopted mobile phone for extension delivery. However, much was unknown the competencies and frequency of mobile phone use by farmers and extension agents. The study used descriptive correlation design to assess mobile phone use in agricultural extension delivery in Eastern Region, Ghana. Multi-stage sampling and structured interview schedule were used to collect data from 95 AEAs and 330 farmers. Statistical tools such as frequencies, percentages, means, standard deviation, correlation coefficients, T-test and stepwise multiple linear regression were used to analysis the data. The study revealed that socioeconomic, mobile phone background characteristics of farmers and AEAs relate to frequent use of mobile phone for extension delivery. Farmers and AEAs use voice call mobile phone application but differently in extension delivery. Differences exist between AEAs and farmers' competency in the use of mobile phone. While amount of money spent per week and quality of network reception are important factors that influence the frequent use of mobile phone by farmers that of AEAs include type of phone, income, and age. High call tariffs and access to recharge credit were main challenges to using mobile phone for extension. The study recommends among others the need for MoFA to provide training on the use of mobile phone applications and incentives for farmers and AEAs to use mobile phone. Furthermore, more youthful AEAs and females should be recruited as AEAs.

ACKNOWLEDGEMENTS

Many people have contributed to the outcome of this thesis, both directly and or indirectly, but a few stand out in my mind for mention. First and foremost, I am extremely grateful to my Principal Supervisor, Dr. Albert Obeng Mensah, for his patience, time and his invaluable suggestions which made it possible for this work to materialize; I am sincerely grateful. I am equally grateful to my Co-supervisor, Mr. Martin Bosompem, for his invaluable suggestions as well. To you, Professor Festus Annor- Frempong, words are inadequate to describe you, from the start to the end of this work you stood by me, I say a big thank you. To my dreams maker, RTI, EHELD and Cuttington University families indeed you have made me to be who I am today, your memory will never depart from me and my families, I say a big thank to you all. I am also thankful to the lecturers and Teaching Assistant of the Department of Agricultural Economics and Extension for the cooperation and immense assistance for scrupulous scrutiny which shaped this work. A special debt of gratitude is owed to Mr. Selorm Akaba and Mr. Bethel Akpotosu for their help during the collection and analysis of my data. Also, I say a big thank you to all the extension agents and farmers of Eastern Region, without you this work would not have been successful. I am also greatly indebted to my parents Mr. & Mrs. Nyaplue Sr., Pastor Austin & Mother Theodosia Nyaplue Jr., Uncle Peter Deannah, and Seth Nyaplue for their endless prayers, my course mates, especially Annah Indeche, for their assistance and encouragement.

DEDICATION

Dedicated to my caring mother-in-law, Nyomuwolue, adorable husband, Amos and my children; Mercy, Lawrence and Carmos Daywhea.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

AEAs	Agricultural Extension Agents
AMPS	Advanced Mobile Phone Service
CDMA	Code Division Multiple Access
DAES	Directorate of Agricultural Extension Services
DADUS	District Agricultural Development Units
FFSs	Farmer Field Schools
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
GNA	Ghana News Agency
GSS	Ghana Statistics Survey
GSGDA	Ghana Shared Growth and Development Agenda
GSMC	Global System of Mobile communication
GSM	Global system for mobile communication
ICT	Information and Communication Technology
ITDG	Intermediate Technology Development Group
ITU	International Telecommunication Union
MIS	Management information system
METASIP	Medium Term Agricultural Sector Investment Plan

MDGs	Millennium Development Goals
MOFA	Ministry of Food and Agriculture
MTN	Mobile Telecommunication Network
NCA	National Communication Authority
T&V	Training and Visit
UES	Unified Extension System
WIAD	Women in Agricultural Development

CHAPTER ONE

INTRODUCTION

Background to the Study

This chapter presents the background of the study in a general context. It also looks at the statement of the problem, justification of the study, general and specific objectives of the study, research questions, hypothesis, delimitations, limitations and definition of variables.

In this era of globalization, Information and Communication Technology (ICT) has become a powerful tool for improving delivery service and enhancing local development opportunities (Gorstein, 2003). Historically, traditional forms of ICTs have been used in advisory service provision.

ICTs, according to the Technical Centre for Agricultural and Rural Cooperation (CTA, 2003), are technologies which facilitate communication and thus the processing and transmission of information electronically. Akpabio, Okon and Inyang (2007) classified ICTs as technologies and methods for storing, managing and processing as well as communicating information. ICT is an umbrella term that includes anything ranging from radio to satellite imagery to mobile phones or electronic money transfers. ICTs are ideally suited to the task that enhanced interaction because they can expand communication, cooperation

and ultimately innovation among actors in the agricultural sector. ICTs, especially mobile phones can and do drive participatory communication. It empowers individuals and institutions to create access and use knowledge and to communicate in unprecedented ways (Heeks & Molla, 2009). It therefore enough that ICT types range from web enabled network technologies as well as technologies comprising computers, telecommunications and audio visuals. It includes mobile phones, e-mail, television, radio, personal computers and the internet. As stated by Annor- Frempong, Kwarteng, Agunga and Zinnah (2006), ICTs can be seen as a practical tool of facilitating information delivery and knowledge sharing as it is seen in Ghana and in other parts of the world.

Ghana's ICT4AD initiative is the government's long-term strategy for expanding the agricultural sector, initiated in 2003. Its ultimate goal is to transform Ghana into middle-income, information rich, knowledge based and technologically driven economy and society. Many of the programme's objectives focus on the betterment of individuals which calls for the inclusion of ICT in human resource development, education, health and the country's largest employer-the agricultural sector Ghana Statistics Service [GSS] (2003). The agricultural sector currently contributes 23% to Ghana's Gross Domestic Product and employs about 58% of the economically active population (GSS, 2013).

World Bank (2007) highlighted that access to ICT can have a tremendous positive impact on sustainable development and poverty reduction. Extension services help to disseminate information regarding the technology relevant for their geographical areas and cropping system to generate awareness among

farmers by recommending the appropriate quantity and quality of inputs and their timely use. It also educates farmers about good agricultural practices and crop management (Arokoyo, 2005; & Jirli, 2011).

But in sub-Saharan countries and in some regions, recent stagnation has caused a total breakdown of extension services which has led to large gaps in the farm yield and crop productivity (McNamara, 2005). In addition, insufficient extension services and poor access to information have impeded the transfer of technology at the farm level. Therefore, extension agents' knowledge and skills are vital to carrying out effective and efficient extension work. Information needs are growing rapidly with the introduction of modern technology, hybrid seeds and changing climatic conditions. Thus, farmers often find that their traditional knowledge, experience and trial and error to make decisions for day-to-day activities are not very effective in changing conditions (McNamara, 2005).

The high cost of delivering information through face-to-face interaction, crumbling extension services and poor market information has paved the way for the use of modern information and communication technology (ICT) like mobile phones in disseminating agricultural information to targeted farmers. Meera, Jhamtani and Rao (2004) noted that old ways of delivering important agricultural information to clients has been transformed; since the advent of new pattern of agricultural development. They also stated that as dynamic and complex as the world has become, the extension agent must look ahead and align himself so as to take advantage of opportunities when they present themselves and to deal with challenges when they come. Therefore, extension agent should think outside the

box by continually updating and building on their information needs to enhance their service delivery.

The use of mobile phone for information dissemination has direct bearing on dissemination of agricultural information. For example, the e-extension programme being rolled out by Ministry of Food and Agriculture (MoFA) aims to make available timely and relevant agricultural information for actors in the sector. The e-extension is one of government's initiatives for the development of the agricultural sector under the Medium Term Agricultural Sector Investment Plan (METASIP) which runs from 2011-2015. Its goals are associated with global, regional and national development strategies such as the Millennium Development Goals (MDGs) and the Ghana Shared Growth and Development Agenda (GSGDA). These METASIP hope to achieve effective communication through the use of mobile phones. In Ghana, the Global System of Mobile communication (GSMC) has a large market size that cuts across both the urban and rural areas. While the number connected mobile phones rose from 212,548 in 2000 to 284,981 in 2012, the total number of connected mobile phones in the country currently is about 30,629,604 National Communication Authority [NCA] (2014). Coinciding with the growth in coverage of telecommunication, there has been an increase in mobile phone adoption and usage by rural farmers, despite their resource poor conditions.

Statement of the Problem

In this era of technologies, a new way of delivering extension approaches is emerging faster globally. The change of traditional societies in the entire world into societies of information and the methods of disseminating information to farmers are being challenged. Mobile phone can be and is an important channel of achieving such a revolution. When used as a tool for providing farming communities with scientific knowledge, mobile phone can give a new momentum to social organizations and productive agricultural activities (Jagun, Heeks & Whalley, 2007). According to Meera, Jhamtani, and Roa (2004), extension delivery systems need to move from a narrow mind set of transferring technology packages to a more scientific and practical way of transferring information.

However, in spite of the numerous potentials that mobile phone has to offer, different researches (Alexander, Siderides, Koukouli & Antonopoulon, 2010; & World Bank, 2007) have shown that the agricultural sector in Ghana has lagged behind both in terms of the percentage of people with access to relevant communications services and the amounts and ways in which they can be used and Eastern Region is no exception. Although several studies (Aker, 2011; Jensen, 2010; Overa, 2006; & Arokoyo, 2005) and other experiences have shown that mobile phones can make a significant contribution to accelerated agricultural productivity, leading to increased incomes, poverty reduction and improved livelihoods in rural areas, this use is yet to be fully harnessed and realized for accelerated economic growth and poverty reduction. For example, a study conducted by Kwakwa (2012) on Mobile Phone Usage by Micro and Small Scale

Enterprises in Akuapem North District of Eastern Region of Ghana revealed that mobile phone has helped lower operational cost, increase saving, improve communication with supplier/customers and increase profit. In addition, Overa (2006) conducted a case study on traders in Ghana revealed that mobile phones help to improved communication between traders and suppliers. However, most of these studies have been done in other sectors but not in agriculture sector, especially in the Eastern Region of Ghana.

Moreover, considering the rapid growing of mobile phone penetration even in the most remote areas, it's potential of contributing to the spread of innovative technology as well as extension workers' and farmers' utilization of these technologies in carrying out their activities needs to be critically looked at. However, how often AEAs and farmers use the mobile phone for extension delivery has not been studied and therefore cannot be used as an input for any decision making towards strategic extension communication.

General Objective

The general objective of the study was to assess the use of mobile phone in agricultural extension delivery in Eastern Region of Ghana.

The Specific Objectives of the study are:

1. Describe the socio-economic and background characteristics of farmers and extension agents.
2. Determine the frequency of mobile phone usage by farmers and extension agents for extension delivery in the study area.

3. Compare the competencies of farmers and extension agents in the use of mobile phones in extension delivery.
4. Determine factors that influence the use of mobile phone for extension delivery by extension agents and farmers.
5. Identify the benefits farmers and extension agents get from the use of mobile phones.
6. Examine the challenges with the use of mobile phone in extension delivery.

Research Questions

i. What is the socioeconomic and background characteristic of farmers and extension agents in the study area?
ii. How often do farmers and extension agents use mobile phone for extension delivery?
iii. What activities farmers and agricultural extension agents use the mobile phone for?
iv. What mobile phone applications do farmers and AEAs use to communicate for extension delivery?
v. What are the competency levels of farmers and extension agents in the use of mobile phone?
vi. What are the factors that influence the frequency of use of mobile phone applications by extension agents and farmers?
vii. What are the benefits farmers and AEAs get from using mobile phones for extension delivery?

viii. What are the challenges facing farmers and extension agents in the use of mobile phone for extension delivery?

Hypothesis

The following hypotheses have been formulated for the study and will be tested at 0.05 alpha levels.

1. H_o**:** There is no significant difference between the competency levels of farmers and AEAs in the use of mobile phone.

   H_i: There is significant difference between the competency levels of farmers and extension agents in the use of mobile phone.
2. H_o: There is no significant relationship between socioeconomic and background characteristics of agricultural extension agents and frequency use of mobile phone for extension delivery.

   Hi: There is significant relationship between socioeconomic and background characteristics of agricultural extension agents and frequency use of mobile phone for extension delivery.
3. H_o: There is no significant relationship between socioeconomic and background characteristics of farmers and frequency use of mobile phone for extension delivery.

   Hi: There is significant relationship between socioeconomic and background characteristics of farmers and frequency use of mobile phone for extension delivery.

Significance of the Study

The findings of this study will further contribute to the understanding of the role of mobile phone and determinants of its use in agricultural policy formulation, to improve information retrieval and dissemination mechanism in agricultural development in Ghana.

The study wishes to help the ministry of Food and Agriculture and stakeholders to subscribe to relevant extension information packages appropriate to meet information needs of farmers. Finally, the findings of the study will also help both farmers and extension agents to be aware about the importance of mobile phone application in extension delivery.

Delimitation of the Study

The scope of this study will be limited to agricultural extension agents and farmers in the Municipal and District Agricultural Development units in Eastern Region of Ghana. Moreover the scope of the study is limited to the extension information–related part of mobile phone. The components of ICTs in extension delivery are ignored.

Limitations of the Study

Due to limited resources including time, logistics and funds, the study could not cover all AEAs and farmers of Ghana. Therefore, the study will be generalized only to Eastern Region of Ghana.

Definition of Terms

Mobile phone: a channel used to communicate between two people.

Use of mobile phone: in this study, use of mobile phone means the frequency at which AEAs/ farmers used the following mobile applications/services (SMS, voice calling, internet, email, video calling, MMS, and social media- facebook, twitter and whatsApp) to deliver agricultural information.

Mobile phone application: a mobile phone application is a piece of software on a portable device (such as a mobile phone handset, personal digital assistant, or tablet computer) that enables a user to carry out one or more specific tasks that are not directly related to the operation of the device itself. Examples include the ability to access specific information (for instance, via a website/ internet); make payments and other transactions; video record, take pictures; send messages (either via email, whatsApp, facebook); and so on. The application (app) might come preinstalled but more usually is downloaded (for free or for payment) from a wireless network from an online store and may require a live connection to function effectively.

Agricultural extension delivery: disseminating and receiving relevant agricultural information such as market information, weather information, new variety of crops, recommended fertilizer applications, diseases management (crop), pest management, diseases management (animals), weeding and thinning, planting materials, post-harvest handling, cultural practices, fishery, good slaughtering and animal health management through mobile phones.

Competency: competency level in this study means ability to use mobile phone applications such as (voice calls, sending /receiving text message, accessing email/ internet, video calls, receiving/ sending MMS and accessing social media – facebook, whatsApp & twitter) to disseminate agricultural information through mobile phones.

Types of mobile phone**:** type of mobile phones in this study means conventional (ordinary) phone and Smartphone.

Organization of the study

The study is organized and presented in five chapters. Chapter one begins with a general background of the study and this leads to the statement of the problem, objectives of the study and research questions. The chapter further states the significance, delimitation, limitations and definition of terms of the study. Chapter two looks at a review of literatures relevant to the study. It discusses the theoretical framework on which the study was based and related conceptual issues. In particular, the concept of adoption theory and its relationship to the present work is thoroughly explained. Empirical studies related to the study are also reviewed. Chapter three gives a description of the research methods that were used in the study. It describes the research design, population, the sample and sampling procedure, data collection procedures, validity and reliability of the instruments, and data analysis procedures. Chapter four is devoted to results and discussion of the findings in relation to the research questions. The last chapter, Chapter five, contains the summary of the research conducted and key findings,

conclusions drawn from the findings and the recommendations made to address the questions posed and suggestion for further study.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter presents theoretical review and related literatures in the use of mobile phone in extension delivery. The adoption theory was reviewed to inform the study. The chapter is divided into four sections. Section one looks at theories underlying the study; section two presents components of conceptual framework in the study. Section three looks at a brief background of mobile phone penetration in the world, the state of telecommunication, and the overview of agricultural extension in Ghana. The fourth section look at related work in the use of mobile phone in agriculture and lastly, the conceptual framework is presented.

Theoretical Framework

Adoption Theory

The theory of diffusion of innovation defines how innovation is adopted by a social group with the result that the innovation becomes part of the existing social system. Rogers (2003) in his first publication of the theory in 1962 argued that diffusion is the process by which an idea, object or practice perceived as new is communicated to members of a social system through well-defined channels over a period of time. This new idea, object or practice is referred to as

innovation. For diffusion to take place, the innovation must be actionable with relative advantage over the existing one or provide multiplier benefits to an existing one over a period of time. Therefore, in this study, the innovation is the mobile phone usages for extension delivery. The diffusion of this innovation is operationally define in this study as the frequency of use of mobile phone applications such as (SMS sending/receiving, voice calling, video calling/conferencing, whatsApping, accessing internet/ email etc) for extension delivery.

Rogers (2003) categorizes adoption of an innovation into four factors. These include: invention or the innovation itself, the communication channels (diffusion) used to spread information about the innovation, time and consequences. This assumption was also supported by Sunding and Zilberman (2001) who state that adoption of a technology may be measured by "both the timing and extent of new technology utilization by individuals" (Sunding & Zilberman, 2001: 229).

Invention as a Factor of Innovation of adoption

The perceived attributes is based on the idea that individuals will adopt an innovation if they perceive that the innovation has the following attributes. First, the innovation must have some relative advantage over an existing innovation or the status. Aker and Mbiti (2010) and Aminuzzaman, Baldersheim and Jarnil (2003) argued that mobile phone adoption by farmers is predicated on the perception that it is better than most other communication

means, as it is convenient to handle, provides economic advantages and enhances social status of users. Second, it is important the innovation be compatible with existing values and practices.

International Maize and Wheat Improvement [CIMMYT] (1993) argued that a new technology may not be appropriate in every context, but rather its suitability depends on how well it fits the particular farming context. Third, the innovation cannot be too complex. Majority of adoption studies had assumed that smaller holder farmers tended to adopt simple technologies first before moving on to more complex ones, while cheaper technologies may be adopted before the more expensive ones (Kaliba, Verkuiji, & Mwangi, 2000; Qiang, Kuek, Dymond & Esselaar, 2011). Fourth, the innovation must be trialable. Feder and Umali (1993) argued that older farmers may be less willing to invest in technologies that only pay off in the longer term, but may also have more resources to invest in new technologies. On the other hand, younger farmers may be more educated or be more open to trying out new technologies. This means the innovation can be tested for a limited time without adoption. Fifth, the innovation must offer observable results (Rogers, 2003). Tornatzky and Kelvin (1982) find that compatibility, relative advantage and complexity have the most consistent significant relationship across a broad range of innovation.

Communication Channel as a Factor of Innovation of Adoption

Rogers (2003) defines communication as a process in which participants create and share information with one another in order to reach a mutual

understanding. This communication occurs through channels between sources. Rogers (2003) stated that a source is an individual or an institution that creates a message. A channel is the means by which a message gets from the source to the receiver. Rogers states that diffusion is a specific kind of communication and includes these communication elements: an innovation, two individuals or other units of adoption, and a communication channel. Mobile phone and interpersonal communication are two communication channels.

Communication channels also can be categorized as localities and cosmopolite channels that communicate between an individual of the social system and outside sources. While interpersonal channels can be local or cosmopolite, almost all mobile phone channels are cosmopolite. Because of these communication channels' characteristics, mobile phone channels and cosmopolite channels are more significant at the knowledge stage and localite channels and interpersonal channels are more important at the persuasion stage of the innovation-decision process (Rogers, 2003). The use of mobile phone sits within the core value of communities communicating within and between groups for social or economic interactions. It enhances past experiences of communication by removing the awkwardness associated with other communication methods (Qiang, Kuek, Dymond & Esselaar, 2011). This perceived relative advantage of mobile phone arguably increases rate and possibly the growth in mobile phone ownership amongst community members and farmers in particular.

Time as a Factor of Innovation of Adoption

The individual innovativeness concept is based on who adopts the innovation and when. A bell-shaped curve is mostly used to demonstrate the percentage of individuals that adopt an innovation. The first group of adopters is innovators. These are the risk-takers and they are often the first to develop or accept new ideas before others join or accept it. The second group is known as the early adopters. These people represent opinion leaders. They embrace new ideas before the average person. The third and fourth groups are the early majority and late majority. The innovators and early adopters convince the early majority. The late majority waits to make sure that adoption is in their best interests. The final group is the laggard. These are the people who are highly skeptical and resist adopting until absolutely necessary. In many cases, they never adopt the innovation (Rogers, 2003).

Consequences as a Factor of Innovation of Adoption

The innovation-decision process concept is based on time and has five different stages. The first stage is knowledge. Possible adopters must first learn about the innovation and gain a basic understanding of what it is and how it works. Second stage is "Persuasion" in which potential adopters form a positive and negative impression of the innovation. In the third stage, "Decision," is where the adopters actually decide to adopt the innovation or reject it. Fourth stage, "Implementation," occurs when the innovation is actually used. In the fifth stage, "Confirmation," the adopter seeks information about the innovation and either

continues or discontinues the use of the innovation. Understanding the use of mobile phones to aid agricultural development requires an adequate knowledge of the technology and the perceived impacts it has, as well as an assessment of the opportunities and barriers reinforced by the local social structure of the user communities (Avgerou, 2010; Davis, & Asenso-Okyere, 2010).

Factors that Influence Adoption Decisions of Individuals

The decision by an individual's to adopt a technology is influenced by factors within socio-economic environment as all well as their own personal attributes. These have been broadly classified as external, social, personal and technical factors in this study.

Government Policies

Government participation in the telecommunications sector evolved in a nonlinear way (Gómez-Barroso & Feijóo, 2010). The role played by government in telecommunications can be described as promoting the information society. In sub-Saharan countries, providing innovative methods for access to ICTs in rural areas is within the domain of the government. Nowadays, with the increasing pressure of development on governments, ICTs have been seemed to governments as sound fiscal investments relative to other public incentive alternatives than before where the public sector was not considered an investor in telecommunications (Gallup, 2011; ITU, 2012).

The National Communications Commission recognizes several issues that are harmful to this growth of ICTs, such as poor public power supply, poor

security, and high operational costs (Onuzuruike, 2009). But according to Gupta and Sullivan (2010), unreliable electricity and insecurity were found to be the main challenges to operating mobile networks. Notwithstanding, they argued that these challenges were much more prominent in Nigeria as compared to other West African countries with more reliable access to the electricity grid (like Ghana, Cameroon, and Côte d'Ivoire). Gupta and Sullivan (2010) back their argument by calculating the costs of fuel for generators and the cost of running network site in Nigeria. According to them, costs of generators, including a minimum of 20 percent of fuel lost to theft, amounted to 60–90 percent of the costs of running network sites in Nigeria. Base station costs in Nigeria add up to US$ 200,000–250,000, 3.5 times higher than in India (US$ 60,000–70,000).

They further argued that some of these limitations are at least being overcome through passive infrastructure sharing. "Passive infrastructure sharing" is the sharing of non electronic infrastructure, equipment, and services at mobile network base stations, including the site space, buildings, towers, masts, and antennas; power supply, back-up batteries, and generators; security; and maintenance. Passive infrastructure sharing is distinguished from "active infrastructure sharing," which can involve the shared use of electronic infrastructure such as network components (for example, access node switches), radio transmission equipment, and core network software systems (Ghosh, Aggarwal, & Marwaha, 2009).

The works of CIMMYT (1993) and Marra, Pannell and Abadi (2003) revealed that the focus of the adoption literatures has been on the individual

farmers (e.g. the attitude or personality of the farmers or their socio-economic characteristics, such as wealth, landholding or education) and the characteristics of the technologies, rather than the context in which technology adoption and diffusion takes place. Therefore to see the result of mobile phone use in extension delivery, government needs to provide the enable environment for farmers and AEAs. Such environment is reliable electricity, affordable price of mobile phone, and valuable price of agricultural products on the market.

Communication Infrastructure

Several studies argued on factors that influence the choice of subscription to a network. These factors include the qualities of the mobile network and the characteristics of the mobile subscribers, choice subscribing, customer care, discount, promotion and special offers on calls (Birke & Swann, 2006; Corrocher & Zirulia, 2008). Furthermore, Kim and Kwon (2003) stated that in terms of qualities consumers consider network size before subscribing to a mobile network. That is the larger mobile networks have advantage over smaller networks in acquiring subscribers because of intra-network-call discounts and quality-signaling effect. They also argued that mobile network with larger subscriber base attracts more subscribers because with increasing number of users subscribing to a network it becomes more attractive to other people to subscribe to the same network.

Corrocher and Zirulia (2008) found similar result to Kim and Kwon (2003) and Birke and Swann (2006) findings that the larger the customers base of

mobile network, the greater the benefits from adoption. The benefits in terms of calls discount to the same network. Generally, calls that terminate within the same network are relatively cheaper than calls terminating in another network. Thus, customers are likely to pay less for mobile service when the network size is large.

Corrocher and Zirulia (2008) further stated that network effects affect the choice of mobile operator. Network effects in communication are common trend where consumers mostly reason the model of adoption by agents in their social neighborhood. These agents include family, friends and other social groups. Birke and Swann (2006) also stated that social network (friends, family and partners), income and characteristics of the individual mobile subscriber influence the choice of mobile operator. They believe that mobile users in other to avoid high expenditure on phone calls, they try to convinced their friends and family to subscribe to the same network.

According to Verkasalo (2008), a person has to examine the advantages and disadvantages of service before adopting or not. The advantages could be constant contact with family member or friends without any interruption of network. So when the benefit associated with using the service is greater or more than the presumed cost, then the individual will use the service. He further argued that needs are inherent in the person and they tend to direct all behaviour. One way of satisfying these needs is to obtain a good or service; thus, becoming a consumer and in the case of mobile phone services farmer or AEAs, becoming a subscriber or user of the services.

Types of Mobile Phones Used

The services and features offered by mobile phones like calling or receiving, texting, and using of calculator and alarm are to some extend similar but slightly different. There are two types of mobile phones, namely: conventional and smart phones. Tschersich (2010) classified mobile devices by three main characteristics: ubiquity (owner can use the device anywhere), reachability (permanent availability of the device and owner) and localization (e.g. GPS). Only conventional phone and Smartphone can perform these critical and can be defined as mobile device.

1. A conventional mobile phone is considered to first to, first of all, be a phone, but lacks the advanced operating systems found in smart phones. The software inside a conventional mobile phone is limited, but functional. In way of features, conventional phones usually offer a basic camera, simple video capturing, wireless Bluetooth capability and text messaging, address books, calendars, alarm clocks and other basic tools for productivity. These mobile phones may have games, Internet access and with more advanced features including a QWERTY keyboard, and memory cards.
2. A smart phone is basically a small computer. Smart phones have advanced operating systems that go beyond than making phone calls. A Smartphone features Wi-Fi connectivity, fast wireless speeds for data streaming and Web browsing, clear cameras and much more. The ability to run apps allows smart phones to handle email, social networking and office tasks

such as editing documents and creating spreadsheets (Roberts & McIntosh, 2012). In 2012, surveys conducted by Department of Primary Industries (DPI) and other industry organizations in Australia revealed that around half of the grain producers and advisers own smart phones over conventional (ordinary) phones (Lorimer, 2012).

Source of Agricultural Information

Morrow, Kelly and Kirley (2004) stated that in rural development, information which helps farmers to take decision and appropriate action for farming and marketing is an important resource. They indicated that depending upon the kind of information different people use different sources for seeking information. Demiryurek, Erdem, Ceyhan, Atasever and Mayis (2008) also argued that agricultural information disseminated by AEA affects agricultural production in many ways. Firstly, it can help out the farmers to make informed decisions about land, labour, capital, management, and livestock. Secondly, agricultural production can be improved through useful, relevant, and reliable information.

Studies by Mtega (2012), Lwoga, Stilwell and Ngulube (2011), Okello-Obura, Minishi-Majanja, Cloete, and Ikoja-Odongo (2009) investigated the sources of information used by rural communities in accessing agricultural information. This source includes radio, co-farmers, cooperative, extension services and newspapers. Moreover, Nazim (2000), and Farooque (2004) stated that different target groups have different information needs; thus, needing

different information services. Therefore, information providers should assess and recognize their target groups and work out the best means to disseminate meaningful information for sustainable development to such groups.

According to Harande (2009), the major concerns in the agricultural technology transfer process is what technologies are appropriate and available, and how these technologies can be deliver among farmers like oral/verbal means, printed literature and electronic media. In addition, (Harande, 2009) emphasized that in the age of information and technology, delivering of information becomes much easier and nevertheless more complex; thus, it must be transferred to the farmers in the way through the use of approach, which is appropriate, and best supports farmers.

According to Rana (2002) the sources of information is divided into two main categories, interpersonal and impersonal sources. Face-to-face exchanges of information between individual respondents constitute interpersonal methods, whereas exchanges by mobile phone are known as impersonal methods enabling one or a few persons to reach many addressees at a time. Butt (2002) found that most of the respondents (61.60%) obtain information from extension organizations and about half (51.20%) from fellow farmers, followed by print media (46.00%) and research organizations (36.00%) in a study of television viewing habits among farmers in Pakistan.

Furthermore, in Tanzania, a study on maize adoption by Kalba (2008) found extension services as one of the major factors that positively influence the

adoption of new technology. Similarly, Tologbonse, Fashela and Obadiah's (2008) study reveals farmers (72%) seek information from extension agents and friends/fellow farmers (26.7%).

Major Agricultural Enterprise of Farmers

According to Tologbonse, Fashola and Obadiah (2008), most of the farmers seek information on crop production. They assume that because most farmers are mainly crop farmers, they are probably interested in information that would lead to increased productivity. Folitse's (2013) study in Ghana shows that almost all farmers who listen (90.4%) and who do not listen (96.5%) to radio were involved in crop production and animal production.

Farm Size Operated by Farmer

Research revealed that farmers who cultivate farm size ranging from six to twenty acres are assumed to be better off in production than the small scale farmers in the use new of technology. Also, they are willing to try or take advantage of new technology even if they fail because they know this will not affect their income greatly as compared to a small scale farmer whose income is low (Williams & Agbo, 2013).

According to the MoFA (2005), majority of the farmers in Ghana are engaged in subsistence farming using traditional methods and low technologies which do not allow them to cultivate huge acres of land. Therefore, about 31% of the farm holding is less than 1.6 acre, whereas only 18% are more than 4.0ha per farmer in Ghana. Mittal and Tripathi (2009) stated that farm size affects economic benefits of farmers from mobile phone use. They emphasized that

larger-scale farmers are able to get higher benefits from mobile phone use as they are able to access resources concerned with input availability and disease control better. Besides, they are also able to get technical or professional help immediately in case of plant disease. Likewise, farmers with large farms showed to have been privileged to benefit from the information they get on market prices. They are able to overcome any possible constraints on production or market access with greater facility than small land size farmers. Yet, the small-scale farmers gained more knowledge through mobile phones compared with larger-scale farmers (Mittal & Tripathi, 2009).

Williams and Agbo (2013) evaluated the use of ICT in agricultural technology delivery to farmers in Ebonyi state, Nigeria. They found that farm size was positively and significantly related to the dependent variable at 1% level of significance. They concluded that the higher the farm size of the farmers, the more they utilize ICTs as a source of agricultural technology delivery. Similar result was shown in Falola, Adewumi and Olaniyi's (2013) survey which found that the coefficient of the values of farm size was positive and statistically significant, indicating that the more the farmer increase area of land cultivated and the seeds/seedlings used, the more the quantity of output obtained. Therefore they concluded that since farm size had the largest coefficient, this could be that the largest impact on output would be experienced if additional land is put into use.

Membership of Famers' Cooperative

The formation of membership or cooperative group is expected to influence the use of mobile phones service for agricultural activities by farmers which can serve as a source of gathering or passing information and sharing for farming experiences. Ammani, Sani, Kura and Hussaini (2011) conducted a study on agricultural extension services in irrigation schemes under RBDAs' control in Nigeria: The case of Kano River irrigation project. The findings showed that more than 65% of the farmer's interview did not belong to any farmer association or cooperative society. In contrast, Falola, Adewumi and Olaniyi (2013) found membership to positively and significantly relates to use of mobile phone. They therefore concluded that being a member of association enables the farmers to have access to agricultural information in time.

Household Size of Farmers and AEAs

Ogbeide and Ele (2015) argued that farmers with children are able to acquire knowledge on how to use the mobile phone. That is the children teach their parents, particularly the less educated ones, how to make and receive calls, store and retrieve messages, send and receive SMS and MMS. Labonne and Chase (2009) study the impact of mobile phones on the welfare of farmers in the Philippines. The study explored the welfare effect of mobile phones by looking at the consumption patterns of farmers with mobile phones. Their findings showed that mobile phone has a great positive effect on the growth rate of per capita consumption of households.

Financial Capital

Richer farmers or those with off-farm income may be more willing to bear the financial risk in case the technology does not perform well (Ogbeide & Ele, 2015; Marra, Pannell & Adbadi, 2003). DiMaggio and Cohen (2004) explained the positive correlation between the level of income and timing of adoption of new technology. They found that availability of a technology infrastructure shapes inequality by place of location (urban verses rural) that makes income more important. Similarly, Kalba (2008) argues that adoption of certain technology attributes or alternatives (e.g. fixed vs. mobile connection and postpaid vs. pre-paid services) depends on the level of household income over time. In addition, the rate of income depends on the type of occupation, and therefore, it is an important factor for the urgency and relevance of adopting a technology at a given time and within a specific cultural framework Kalba (2008).

On the other hand, Poulton, Kydd and Dorward (2006) stated that limited access to credit may hamper smallholder farmers' level of technology adoption as money lenders may not be willing to tolerate the high risk transaction costs of small disbursements. Also, the seasonality of agriculture and change in climate can hamper regular repayments. At times, access to credit may also be linked to the use of particular inputs, thus limiting technology choices. However, Poulton, Kydd and Dorward (2006) suggested that mobile banking can enable technology adoption by offering transmission services to pay for agricultural technologies or inputs or to repay loans as a way forward in improving farmer's access to finance.

Age as a Factor in Mobile Phone Use

Research places the average age of the African farmers above 50 years and Ghana is no exception. Age of the adopter plays an important role in influencing mobile phone usage. According to Okello, Kirui, Njirani and Gitonga (2012), Williams and Agrbo (2013) and Munya (2001) young people participate in technology irrespective of their locality and that young people have a positive correlation with the use of the mobile phone. Therefore it is expected that young farmers will be prone to use this technology for most of the day-to-day transactions. Age and mobile phone has a relationship through the adaptable nature of young people in technologies. Studies indicated that in terms of technological packages, social and economic considerations, young farmers adopt faster (Okello, Kirui, Njirani & Gitonga, 2012; Williams & Agrbo, 2013; & Munya, 2001). Porcari (2010) argued that young people are far more known with social networking and other recent advances in technologies use than with the older ones because new communication technologies, in many cases are strange to the older generation; therefore, there is a major need for a cultural change so that they can take advantage of these tools to enhance their networking, advocacy and other opportunities to have impact in the farming system.

Richardson, Ramirez, and Haq (2000) study Grameen Telecom's Village Phone Programme in Bangladesh. The study found that “higher expenditures for better service are more likely to come from younger phone users aged 20 to 30, an age group that would more likely be receptive to a wider range of phone services, including card phones”. Similarly, Jain and Hundal’s (2007) study among the

rural people of India showed that the majority of the users (62 %) of mobile phones were within the age group of 20 to 40. Musa (2011) studied the challenges of using information and communication technologies to disseminate agricultural information to farmers in Sudan. In his finding, 26.7 percent of the respondents were between the ages of 20-35 years, 34.2 percent were between 36-50 years, 31.7 percent were between 51-65 years and 7.5 percent were between 66-80 years. He found that majority (61%) of the farmers were 50 years and below, and therefore concluded that they are capable of getting agricultural information much faster than the elderly farmers.

Sex as a Factor in Mobile Phone Use

With regards to sex, FAO (2009) and MOFA (2010) studies revealed that extension delivery in Ghana is a male dominated occupation. According to FAO (2009), male have better social capital which has a direct link with exchange of information and learning as the result they in the majority. MOFA (2010) indicated that despite the fact that women farmers constitute the larger agricultural labour forces in Ghana and the women in Eastern Region are no exception and produce roughly 70 percent of the food crops, they are least served by extension service delivery. World Bank (2007) reported that women are disadvantaged in extension services because of limited access to resources-decision-making power, education, agricultural information and agricultural inputs and credits.

Education as a Factor in Mobile Phone Use

In Ghana, roughly 71.5 percent of the populations are literate (Ghana Statistics Survey, 2010). According to Yasmeen, Abbasin and Hussain (2011), education positively related to the product that boosts up farmer's income. Similarly, Schiffman and Kanuk (2004) argued that education and income are closely related; the more educated a person is, the greater is the likelihood of a high income. Also, DiMaggio and Cohen (2004) stated that educated people are better able to learn and use new technology more and thus they are more likely to be innovative.

Jain and Hundal's (2007) study on rural India showed that a majority of the mobile adopters have education level below metric 10th class, so the diffusion of new technology amount them was relatively slow. CIMMYT (1993) and (Okello-Obura, Minishi-Majanja, Cloete, & Ikoja-Odongo, 2009) argued that literacy level of the farmers is important to their use of mobile phones for information access and can also impact their level of difficulty in navigating through the phone menus frequently written in English. Therefore, the literacy level of farmers affects mobile phone use differently and can influence the level of adoption across the various under developed communities.

Marital Status as a Factor in Mobile Phone Use

Mammo (2013) examines how the use of ICT in farming affected the interest of youth in agriculture. The study interviewed farmers between 24 and 38 years old and discovered a difference in attitude towards ICTs and agriculture

among single farmers and farmers who were married and with children. The study indicated that single farmers originally examine ICTs as a gateway to better jobs and employment outside farming, whilst young farmers with families, without any delay, focus on using ICTs to improve productivity and profitability.

Yakubu, Abubakar, Atala, Muhammed and Abdullahi (2013) study the effects of socio-economic factors on ICTs adoption among extension workers in the north-west zone of Nigeria. The study showed that majority of the extension agents (89.8%) were married, with only 10.2% being single.

Years of Experience as a Factor in Mobile Phone Use

Ibrahim, Adejoh and Edoka (2009) argued that experience is a manner in which one garbles new technology such as mobile phone and use faster in extension delivery. McCall, Dunn and Rosenquist, (2004) defines working experience as knowledge gained over time. Moreover, Sardeshmukh (2008) explained that individuals are shaped by every experience in life, our past and present experiences always affect the development and shape of knowledge, skills, attitudes, ambitions, beliefs and behaviours. In addition, McFarland, and Hamilton (2006) found relationship between work experience and job performance to be influenced by two variables: length of experience and job complexity. Hence, experience is a central force to influence on performance and behaviour.

Frequency of Use of Mobile Phone in Delivering Agricultural Information

Kwakwa (2012) found that roughly 97% of traders do voice calling more than sending text messages. Video calling, internet and email accessing was less used by the respondents. He argued that making voice calls does not require any complex procedure. All that one needs to do is to enter the number and then press the "send" button and as such those with low level of education can easily learn and use. It is therefore user friendly to those who are illiterate. Moreover, he argued that sending of text messages, video calling, internet and email accessing was probably a challenge because it is not user friendly to illiterate and so they will find it uncomfortable to use as compared to calling. Asharf, Akhtar, Sarwar and Ashraf (2005) argued that lesser extent of SMS usages by farmers was due to higher rate of illiteracy. They also argued that the challenges mobile phone users face is because the SMS carries only a limited amount of information and requires a basic level of literacy.

Falola and Adewumi and Olaniyi (2012) conducted a study on constraints to use of mobile phone for agricultural production in Nigeria. The rate at which mobile telecommunications facilities are used for agricultural production was measured on five-point likert scale where an average of 1, 2, 3, 4, and 5 represents where the facility is used seldomly, occasionally, monthly, weekly, and daily. The findings revealed that the respondents used calling four to five times weekly, while "taking pictures for documentary activities" was the least. Crandall's (2011) study on use of mobile phone by Kenyan Farmers revealed that calling using mobile phone was popular than sending SMS. He argued that most

farmers regardless of age, sex, or location, tend to prefer making calls to using SMS and other mobile applications.

Using Mobile Phone in Agricultural Extension Delivery

Katengeza, Okello and Jambo (2011) suggest that among other things mobile phones is used as a gatherer and disseminator of information. Therefore, the difficulty of information shortage faced in the past by farmers or AEAs may be reduced with the advent of mobile phones. Rabayah and Qalalwi (2011) provided similar result that with the help of mobile phone one is able to communicate with customers or suppliers, make arrangement and comfortably deliver their products on time.

In Ghana, Kwakwa (2012) found that mobile phone was used by traders to gather information relating to their activities. These activities include marketing/sales and product delivery/procurement. The study also revealed that 27.7% of the traders access internet using their phone, while 12.8% and 7.4% -use their mobile phones for banking services and data processing respectively; thereby concluding that mobile phone has come to help ease the communication problem between managers and workers.

Mobile phones can be used, according to Dillon (2011), as a means of collecting both farmer and agent-level data; thereby, improving the accountability of extension services. Voice and SMS can be used to collect data on farmers' adoption, costs and yields on a more frequent basis, rather than waiting for annual agricultural surveys, when recall data on costs and production are often subject to

measurement error. In addition, mobile phones can be used to verify agents' visits, similar to what has been done with cameras in Indian schools, and both of these applications could improve the monitoring of extension systems, an oft-noted constraint (Dillon, 2011).

Metz (2012) and Lorimer (2012) argued that agriculturalists tend to frequently use the mobile phones to check the weather and emails and access marketing information, though there is a growing use of the devices for precision agriculture, record keeping and accessing agricultural news and technical information (Lorimer, 2012). According to Roberts and McIntosh (2012), the fact that your phone is always with you and the capabilities means that it has the potential to act as a data logger, and controller for a range of roles instead of having individual units on each item, e.g. Livestock scales, pumps, weather units etc. This has the potential to offer more convenient control and also significant costs savings in the equipment required for each task.

Types of Agricultural Information Delivered to Farmers Using Mobile Phone

Akanda and Roknuzzaman (2012) argued that farmers will use mobile phone to access type of information that is needed most. In Tanzania, Elly and Silayo (2013) study the agricultural information needs and sources of rural farmers. The study employed a survey technique where 120 rural farmers were interviewed and also, in-depth interviews of ten key informants from two villages of Ifunda and 65 Kalenga complemented the survey. The finding showed that 70% of farmers' information needs is about crop and livestock husbandry,

marketing and value addition, disease and pest management and weather information.

Ngathou, Bukenya and Chembezi (2006) argued that extension and other agricultural educators, when selecting methods to deliver information to farmers, should take into account: the type of information to be transferred; their end clients' preferences for receiving information from different sources; and the ability of the information source for transferring the information.

Demiryurek, Erdem, Ceyhan, Atasever and Mayis (2008) also argued that agricultural information disseminated by AEA has an effect on agricultural production in a number of ways. First, it can help out the farmers make informed decisions about land, labour, capital, management, and livestock. Second, agricultural production can be improved through useful, relevant, and reliable information. Harande (2009) argued that the major concerns in the agricultural technology transfer process is what technologies are appropriate and available, and how these technologies can be delivered among farmers like oral/verbal means, printed literature and electronic media. In addition, Harande (2009) stated that in the age of information and technology, delivering of information becomes much easier and nevertheless more complex; thus, it must be transferred to the farmers in the way through the use of approach, which is appropriate, and best supports farmer's production.

Competency in Using Mobile Phones in Agricultural Extension Delivery

In this modern day, use of technology seems to have influence on competency. Competency level in this study means knowledge, attitudes and skills in using the following mobile phone applications such as voice calls, sending /receiving text message, accessing email/ internet, video calls, receiving/ sending MMS and accessing social media –facebook, whatsapp & twitter to deliver agricultural information.

Armstrong (2006) and Ali Hassan, Maimunah, Turiman and Abu Daud (2008) argued that job performance is related to competencies. These competencies remain one of the important variables to use in order to explain the performance of agriculture extension agents as leader to farmers. Hence, competencies could potentially be used to integrate and link an organization's main human resource process such as extension performance management, training and leadership development, succession planning and rewards to the agriculture extension and rural development strategy.

Knowledge, attitude, skills and attributes to develop competency among the AEAs were described by Ali, Ahmad, Tanvir and Muhamad (2009) as four aspect of competency while referring to Bergevoet and Woerkum (2006) level of involvement as one contributor to competency. They describe involvement in term of four aspects. First, it can help the participants such as farmers or AEAs to think in a structured way about reality and to generate knowledge. The second aspect is that professional networks can be developed. The third aspect stressed is participants can create a shared understanding. Finally, it is expected that through

involvement the morale of the participants is boosted. Beside this, they also stressed on the important of knowledge that will drive to high competency among agriculture community including AEAs.

The demography factor also is another important factor for competency. A study conducted by Chizari, Lindner and Zoghie (2009) shows that older AEAs possessed higher level of competency compared to the younger AEAs. According to Chizari, Lindner and Zoghie (2009), the younger and less experienced AEAs needed considerably different training and willingness to make commitment to provide more management and administrative information to the agriculture community; thus, increasing their competency level. A study conducted by Hayrol-Azril and Bahaman (2009) noted that region plays an important role in determining the possessed competency. One of the solutions to this problem is to equally distribute the competency trainings to all of the regions. By doing this, the developed and undeveloped region will have the same development opportunity Hayrol-Azril and Bahaman (2009).

Benefits of Using Mobile Phones in Agricultural Extension Delivery

Researchers survey on ways and which technology best suit the rural dwellers for social and information deliver. Mobile phone best suited for the rural people including the farmers (Okello, Kirui, Njirani & Gitonga, 2012). They argued that interactions with mobile phones are cost effective ways for farmers to stay connected with other stakeholders and also provide them with a sense of security and social status. Agriculture as a means of earning income involves a lot

of interactions. It can be in terms of hiring labour, gathering market and price intelligence, procurement of farm inputs, in search of technical assistance from the extension or expert agents or acquiring weather information (Okello *et al.,* 2012). However, the location of the parties in the interaction, travel distances, ineffective and costly transportation, all encumbrances the ability of the farmers to improve productivity and improve the family and community well-being (Okello *et al.,* 2012; Overa, 2006). Key to these interactions is the need for them to be done in a manner that is timely, effective and efficient. Farmers must adopt a means by which they are able to gain access to obtained information and inputs at the appropriate time in a cost effective manner. Mobile phones have proved to have numerous benefits such as operation benefits; information quality, quality and timely delivery benefits; relational benefits and strategies benefits.

Operational Benefits are associated with reduction in risk and cost of services delivered. According to Overa (2006), Abraham (2006) and Jensen (2010), mobile phones add security to the traders as they are able to report or ask help during risky situations such as road accidents, robberies, car breakdown, or police harassment. Mobile phone can help reduce cost; for example, an extension agent traveling to two or more communities to disseminate information to farmers on an upcoming training can just type the message and press send to all contact and if not all, majority will receive the information in a second and he will have saved himself from motor bike accident and also reduce consumption of fuel for operation.

Increase in income-mobile phone is likely to translate in increase in profitability of farmers that may lead to more intensive farming (Muto & Yamano, 2009; Jensen, 2010). It could then result in increase in production per hectare or cultivation of non-agricultural land or idle lands. This would then result in other multiplicity effects, e.g. benefits to consumers because of reduced gains from arbitrage among producers and production of more goods that are more highly valued on the margin (Jensen, 2010). According to Overa (2006), mobile phone can improve quality information and timely delivery of service by facilitating delivery of agricultural inputs such as fertilizers and seeds. In terms of delivery-vehicle breakdown, another truck can complete the delivery of the broken vehicle just with a call and prevent the rotting of goods especially, perishable goods.

A relational benefit is associated with improvement of communication and relationship among actors. Mobile helps to improve communication networks between farmers and AEAs and reduce cost of travelling Aker (2008), Jensen (2007) and Overa's (2006). They argued that just as more often and open communication can result in better relationship because of better trust and rapport, mobile phone use is also important in reporting dishonest behaviour of intermediaries, trade partners, drivers, or customers. More so, because of mobile phones, the behaviour of dishonest trade participants is easily known by others because of faster information channels. And thus, this saves other potential farmers and trading partners from dealing with them and being cheated as Overa

(2006) found in his study that mobile phone makes reputation building extend to more people in just a short time.

Challenges of using Mobile Phones in Agricultural Extension Delivery

Despite the potential benefits offered with the use of mobile phones in agricultural extension delivery, it has its own challenges. Jafkin (2003) indicated that income, educational background, social and cultural barriers, and the possibility of a person having the basic m-skills can shape the use of mobile. They argued that the use of mobile phone for development can be constrained in two major areas: connectivity and content. Concerning connectivity, penetration rates may overstate true access to mobile phones. An in- depth household surveys data from developing countries show significant differences between rural and urban access. For example, in Brazil the rural penetration rate is 53.2 percent, whereas the urban rate is 83.3 percent; in Bolivia, the figures are 18.7 percent and 77.6 percent, respectively; India, 51.2 percent and 76 percent ; Malawi, 32.3 percent and 72.7 percent; and Ghana, 29.6 percent and 63.5 percent. Clearly, access to mobile phones varies considerably between countries, and wide gaps in rural connectivity still exist in many developing countries International Food Policy Research institute [IFPRI] (2002).

Kwakwa (2012) outlines some constraints faced by mobile phone user in agriculture. These constraints include poor reception, coverage, and cost of using phone, customer services and phone functionality. Whereas, (Richardson, Ramirez & Haq, 2000) argued that lack of available and accessible

communication infrastructure in many rural communities, cost of technologies, lack of favorable policy and lack of stakeholders support in mobile phone planning process as a constraints. Moreover, Tologbonse, Fashola and Obadiah (2008) found lack of funds to obtain information (54.3%) and language barrier (50.5%) as major constraints in Nigeria.

Brief Background of Mobile Phone Penetration in the World

Mobile phones have great potential to transfer information in a speed of light regardless of distance. According to Garreau (2008), mobile phone "is the faster global diffusion of any technology in human history- faster even than the polio vaccine.'' Studies show that mobile phones, being a component of ICT, are now accessible to 90% of the population around in developing countries (de Silva & Ratnadiwakara, 2008; Houghton, 2009; Labonne & Chase, 2009; Rafael, 2003) came up with some facts for its fast penetration. First, it is a potential tool to provide more information to everybody, even to the uneducated since it is very easy to use. Second, it is cheaper to acquire and use compared with other ICTs such as computers or internet. Third, it overcomes geographic barriers as it allows any information to disseminate as fast as the speed of light across space. Mobile phone, according to Aker (2011) and Bhavnani, Chiu, Janakiram and Silarsky (2008), being a cheap and widely-used information and communication technology, has a great potential to solve the problem on costly and lack of accessible information access.

There are 6.8 billion mobile – cellular subscriptions worldwide (ITU, 2013). Of great importance is the fact that the mobile revolution in agriculture is not driven by mobile phones alone, other devices such as smart phones and tablets have already begun to have an impact as information delivery channels. In 2013, there were almost as many mobile – cellular subscriptions of by people in the world, with more than half in the Asia – Pacific region (3.5 billion out of 6.8 billion total subscriptions) (ITU, 2014). According to ITU (2014), although mobile phones have not yet reached total geographical coverage, it expects complete mobile coverage of all rural areas around the world by 2015 or even earlier.

State of Telecommunication in Ghana

Ghana experienced mobile telecommunications in the early 1992. Prior to that, only fixed-line services were available in the country. Ghana's mobile voice subscription increased from 30, 360,771 by 0.89% in 2014 to the end of January 2015 at 30, 629,604 National Communications Authority (NCA, 2015). ITU (2012) reported that mobile – cellular telephone subscriptions at the end of 2012 in Ghana was 25,618, 427. Mobile – cellular subscriptions per 100 inhabitants for the same period was 100.28, fixed (wired) broadband subscriptions for 2012 was 64, 436, fixed (wired) broadband subscriptions per 100 inhabitants was 0.25 as compared to 0.00 in 2001. Fixed telephone subscriptions in Ghana increased from 212,548 in 2000 to 284,981 in 2012. Ghana Telecom had exclusive monopoly over telecommunication services. The policy reforms started in the

telecommunication sector created a competitive environment that enabled mobile telecom network providers and other wireless service providers to operate. Originally, mobile entry was allowed without charge and with minimum regulation. This improvement makes provision for mobile telecommunication services in the country to bring about a revolution in the telecommunication sector (NCA, 2013).

In 1992, the first commercial mobile telecommunication network in Ghana was Millicom Ghana called mobitel. The company started operation using analogue network the first generation mobile system. The network covered few selected areas to be precise in the urban areas (ex. Accra and selected regional capitals). Due to frequency limitations, a small group of people had access to the network. While in 1993, Celtel also started operation using analogue AMPS (Advanced Mobile Phone Service) system and could serve only small number of people, specifically in Accra and its surroundings. Within the same year (1993), the country had 170 mobile subscribers. In 2003, Celtel was changed to Kasapa to give it a local identity, and has since then pursued a distinct strategy aimed at low-income subscribers.

After a few years later, the analogue networks were followed by digital networks, the global system for mobile communication (GSM), which happened to provide services in 1996. The first company to operate digital network was Scancom Ghana limited. Scancom Ghana commenced operation in 1996 using GSM 900 technology with the brand name Spacefon. The GSM technology enabled Scancom to capture relatively larger share of the market. It then became

the market leader with increasing number of subscribers. In 2005, the company was taken over by Investcom LLC and was renamed Areeba. Mobile Telecommunication Network group (MTN) acquired Investcom (Areeba) in 2006 and was renamed MTN Ghana in 2007 (NCA, 2013).

However, the booming introduction of digital network by Scancom forced other companies to migrate from analogue to digital networks. In 2000, Millicom Ghana switched from analogue to digital under the name Buzz. The company name was again changed to TIGO in March 2006 to conform to a global branding strategy (Overa, 2006). Celtel went digital in 2005 and it happens to be the only mobile service provider using the CDMA (Code Division Multiple Access) standard. In 2000, Ghana Telecom launched Onetouch that was to provide mobile services. The company was able to capture 60,000 subscribers within the first year of operation. The status of Onetouch, however, changed due to the acquisition of 70 percent shares of Ghana Telecom by Vodafone International in 2008. As a result, Ghana Telecom and Onetouch became Vodafone.

In 2008, Zain entered the mobile industry as the fifth mobile market in Ghana (Overa, 2006). Quite recently, another mobile network having to be the six operators GLO, a Nigerian-based mobile network provider, made her way into the telecom market. GLO, prior to its launch, was seen as the industry game-changer with high public goodwill. Since then expansion in mobile telecommunication networks in the country has created a competitive environment for the industry.

Competition in the industry has led to reduction in prices of mobile telecom services. This has made it possible for a wide range of people to become mobile phone subscribers. For example, both old and young, rich and poor, now depend on mobile services for communication. The benefits being enjoyed by subscribers originating from competition in the mobile industry in the country support the finding provided by a great deal of research that competition in telecommunication improves performance over monopoly (Wallsten, 2001, & Sey, 2008).

Ghana's mobile telecom industry is highly oligopolistic. The industry is made up of six main operators currently providing mobile telecom services to a wide range of subscribers. There is high competition for customers in the industry. Network providers adopt various strategies to have competitive advantage in the market. They are expanding their networks to improve service quality so as to attract more subscribers. Since firm's survival and growth are driven by customer loyalty and retentions which in turn are driven by customer satisfaction and value, delivering quality service has been important goal and pursuit for each of the six expanding mobile telecom networks. According to National Communication Authority (2013), mobile telecom service providers have universal access obligations which consist of paying 1 percent of their net revenue into a universal access fund, ensuring that their subscribers can make emergency calls, and expanding network coverage to all regions of Ghana.

The network coverage obligation has made providers to extend coverage to the remote villages. Nevertheless, it is important to understand that network

coverage is concentrated in the south which is a relatively more-developed part of the country. Mobile coverage is extensive in the southern and eastern Ghana (Greater Accra, Volta, Central, Western, Eastern, Ashanti and Brong Ahafo) and limited in the northern Ghana (Northern, Upper East and Upper West). Kasapa, Zain and GLO have limited coverage but they are expanding rapidly. TIGO, Vodafone and MTN have made significant progress in network coverage. They are roughly in all the ten regions of the country (NCA, 2013).

Table 1: The Market Share Information per Operators for Data Subscription in Ghana (2014)

Mobile Operators	November	December	Percentages
EXPRESSO	120,667	119,059	0.39%
MILLICOM TIGO	4,100,172	4,133,760	13.62%
SCANCOM MTN	13,666,766	13,852,398	45.63%
VODAFONE MOBILE	7,137,501	7,069,516	23.29%
AIRTEL	3,756,656	3,735,656	12.30%
GLO MOBILE	1,437,400	1,450,382	4.78%
TOTAL	30,219,162	30,360,771	100%

Source: National Communication Authority (2014)

Overview of Agricultural Extension Approaches Used in Ghana

Agricultural extension serves as a liaison officer between researchers and farmers. It carries to farmer's new cultural practices developed by agricultural scientists and brings back for investigation farmer problems requiring solutions. Agricultural extension is defined as the entire set of organizations that support and facilitate people engaged in agricultural production to solve problems and to obtain information, skills, and technologies to improve their livelihoods and well-being (Birner *et al*., 2009). The main aim of extension is disseminate among rural people, through educational procedure, useful and practical information on agriculture and family livelihood, and to encourage the effective application of these ideas so as to result in better living (Arokoyo, 2005).

Extension Approaches Used in Ghana

The agriculture management model/ approaches in Ghana are quite similar to that of other developing countries. The Ministry of Food and Agriculture (MOFA) through its Districts Agricultural Development Units (DADUS) carries out most of the agricultural extension delivery (Okorley, 2007). The role of the agricultural extension service is to introduce new technologies, advise farmers on various aspects of crop production, supply inputs such as chemicals, fertilizer and seed, and provide services like crop and orchard sprays against pests and diseases.

Ghana has tried several extension models including the export commodity development approach to promote food crop production, the Unified Extension System (UES) together with the World Bank's training and Visit (T&V)

extension management approach and the decentralization (Okorley, 2007). In 1997, the Government of Ghana set up reforms of Agricultural Extension ranging from the top-down commodity-based approaches to more participatory approaches like the World Bank's training and Visit (T&V), commodity participatory approaches, the Farmer Field Schools (FFSs), the innovative ICT bases approaches which offer advice to farmers on-line, and the promotion of mobile phones and community radio stations which is the more advanced form of decentralization.

According to Lodhi (2003), the decentralization of agricultural extension reforms is being implemented in many developing countries. Under this system, all extension activities are transferred at District level. All District Government are now responsible about all functioning and funding of this service. For example, in Ghana, responsibilities including service provision and administration were transferred to the agricultural unit of the District Assemblies (lowest level of government administration), while the regional and national level administration focused on policy planning, coordination, technical support, monitoring and evaluation. And at the district level, extension organization provides the best opportunity to effectively involve stakeholders to promote pluralism and it is now central to agriculture and rural development (MOFA, 2005).

Due to an increasing trend towards privatization of services, the system is, however, undergoing transformation. The inclusion of the private sector to ensure competition is gaining credence as one solution, especially with regard to

agricultural input-supply firms. It is assumed that a market-driven extension service will provide the most rational and efficient mechanism to 'get agriculture moving' and usher in a second Green Revolution. The interest of private sector in providing extension services comes mainly from their aggressive "marketing strategy" of selling the product and extension services as one package (Apantaku, Awotunde & Folorun, 2001; World Bank, 2008).

Notwithstanding, the opening up of agricultural extension has had major impacts in Ghana, not the least of which is the dismantling of the government monopoly on delivering services and extension to farmers. Public extension is now one among many extension service providers, although it remains the largest (Okorley, 2007).

Mobile Phones in Agriculture Development

Several studies have identified opportunities for using mobile phones in the agriculture sector and to promote rural development. A finding from Albu and Scott (2001), for instance, revealed that mobile phone can be an asset for development by enabling the rural poor to respond more efficiently to external economic opportunities or threats. Mobile phones can serve as a development tools to the extent that they go faster, complicate, and interact with the process of economic development in general (Donner, 2008). A report by Vodafone and Accenture (2011) notes that mobile phone-enabled solutions for food and agriculture could assist producers to access financial services, obtain agricultural

information, improve data visibility for supply chain efficiency and enhance access.

Table 2: Mobile-Enabled Solutions for Food and Agriculture

Agricultural activities	Mobile System	Outcome using mobile phone
Improving access to financial services	Mobile payment system	Increasing access and affordability of financial services tailored for agriculture purposes
	Micro-insurance system	
	Micro-lending platform	
Provision of agricultural information	Mobile information platform Farmer helpline	Delivering information relevant to farmers, such as agricultural techniques, commodity prices and weather forecast, where traditional methods of communication are limited
Improving data visibility for supply chain efficiency	Smart logistics, mobile management of distribution networks Traceability and tracking system, mobile management of supply networks	Optimising supply chain management across the sector, and delivering efficiency improvements for transportation logistics
Enhancing access to market	Agricultural trading platform Agricultural trending platform Agricultural bartering platform	Enhancing the link between commodity exchanges, traders, buyers and sellers of agricultural products, researchers and extension agents

Source: Vodafone Group and Accenture (2011)

World Bank (2009) reported four areas where mobile applications can promote agricultural and rural development. These include better access to markets, disease and climate information; better access to extension services; better market links and distribution networks (by linking buyers and sellers, and facilitating accounting and traceability); and better access to finance, including credit, insurance and payment methods. Mobile phones can empower the rural poor to lobby for and demand a higher priority for themselves through an increase in access to information which can assist in sound decision-making (Qiang, Kuek,Dymond & Esselaar, 2011). Rural dwellers, which comprise a substantial bulk of the world's poorest, use considerable amounts of valuable resources such as time and money to facilitate communication with family, business partners, health workers, and other suppliers of economic necessities (Qiang, Kuek, Dymond & Esselaar, 2011). Instead of travelling to communicate, ICTs, especially mobile phones, offer faster and cheaper means for interaction (McNamara, 2003).

Role of Mobile Phones in Agricultural Extension Approach (es)

Mobile phones can be used in every aspect of extension approaches from the farm gate to the market, just to mention few mobile phones can be used in improving market efficiency, improving access to information, reducing search costs, and farmer welfare improvement (Okello *et.al.,* 2012; Qiang,Kuek, Dymond & Esselaar, 2011).

Mobile Phones and Market Information

The most common agricultural projects related to mobile phones in developing countries today are related to providing better market information to farmers. Mobile phones have now mostly replaced the role of message boards and radio of traditional information systems (Aker & Mbiti, 2010). One example is in West Africa where a private sector innovator called TradeNet is using cellular networks to provide up-to-date market information to farmers via SMS. Similarly, in Niger, Senegal, and Ghana, farmers just type in a text code and then immediately receive price information about goods (Aker & Mbiti, 2010).

The role of mobile phones was first highlighted by Jensen (2010) in promoting development in terms of providing market information. Jensen listed some benefits farmers get through mobile phones use. First, it improve their income through better output price by reducing search cost that somewhat increases competition among buyers. Second, it could increase arbitrage. Third, it could provide direct price information in alternative markets which could force traders, even in a smaller market, to give a competitive price. Jensen supported his claims by the findings of his study, which was conducted in Kerala, India (Jensen, 2007). Jensen for five years tracked the prices of sardine and discovered that fishermen, when provided with information and communication technology like mobile phones, contact a number of landing points to canvass prices. They then decide where to sell their product based on that price information along with transportation costs. This strategy dramatically decreased the price instability and variation of fish that lead to well-being improvement of both fishermen and consumers. The average price paid to sellers increased their net profit by 8 percent

while consumer prices also declined by 4 percent. Thus, it resulted in a consumer surplus of 6 percent. Apart from that, his data also showed that these fishermen were able to increase arbitrage and were also able to eliminate wastage. The use of mobile phones leads to more efficient marketing systems that allowed them to search for information on where to sell their catch. This thus prevented fishermen from throwing away their catch as they used to do when they find no trader upon landing in the shore (Jensen, 2010). Abraham (2006) and Labonne and Chase (2009) also found positive and similar results as Jensen.

The study of Aker (2008), on the other hand, focused on the effects of mobile phones on traders, instead of farmers, in the grain market in Niger. Nevertheless, just as the other researchers, she found positive results as well. Her results showed that mobile phone service reduce grain price dispersion by at least 6.4 percent with higher effects on market pairs that are farther apart or linked by poor quality roads. The effect also gets higher as the travel time between these markets increases. This 6.4 percent dispersion she found, however, is smaller than that of Jensen (2007), but she explained this difference is due to the perish ability of the goods and the lower search costs. She further explained that with mobile telephony, grain traders were able to adjust their search and marketing behaviour that led to cheaper search costs compared to their non-mobile phone user counterparts. They were able to search and sell in more markets because they have more market contacts (Aker, 2008). Moreover, Aker's study showed that mobile phone use reduced intra-annual price variation by 10 to 16 percent, which translates into increased trader and consumer welfare. While the consumers' intra-

annual price risk decreased, increased sales price through spatial arbitrage opportunities increased traders' welfare. This resulted in a net effect of 29 percent increase in average daily profits.

Muto and Yamano (2009) also proved the importance of price information through mobile phones in increasing the income of farmers in Uganda. Both the effect of mobile phone use on banana and maize prices were observed using panel dataset on farm households from 2003 to 2005. Their findings suggest that improved access to price information reduce marketing costs and increase farm-gate prices; thereby, increasing production efficiency. They also found out that perish ability of goods, as discussed by Jensen (2007) and Aker (2008), is one factor that affects the price increase brought about by mobile telephony. Farm-gate prices of bananas increased as compared to maize because the latter is easier to transport and does not require immediate transfer and careful handling.

In contrast, however, a study by Futch and McIntosh (2009) did not find any price impact brought by mobile phones in Rwanda. Futch and McIntosh (2009) studied a village phone program which, according to their study, was not new to the farmers study, thereby, arguing that farmers already have access to market information through the existing mobile phone information service. Thus, the new program that they studied did not result in higher price for farmers' output but rather just reduced the rate of information service by providing competition to the earlier mobile phone service.

Mobile Phones and Transportation Costs

Transportation is one of the problems that hinder agricultural productivity. Overa (2006) defined transportation cost in two terms: Transporting people in order to exchange information and transporting of goods from the producer to the consumers. Agricultural market participants spend money for transportation cost to personally transact their business with other market participants. They have to go through this because, one, landlines are not very common and hard to acquire and two, other communication avenues such as letters are slow (Overa, 2006). So, before the advent of mobile phones, transportation was an inevitable part of transacting with input suppliers or output buyers, when checking market prices of goods, or when searching for farming knowledge. However, that was years ago Rafael, (2003).

A study conducted by Aker and Mbiti (2010) in Nigeria revealed that 89 percent of grain traders used to visit weekly markets and thus, spend money for transportation that increases as distance and length of poor roads increase. But since the advent of mobile phone, the costs of transportation have reduced by 50 percent. Even though they also have to spend for calling and texting, these are relatively much cheaper compared with transportation cost and the other costs incurred when travelling such as lunch and snack (Aker & Mbiti, 2010). Moreover, the cost of texting and calling in developing countries are very cheap. In fact, in Ghana, presently, a person can subscribe to one day or months of unlimited texting and calling promotion. For example, Vodafone, TIGO and MTN have a programme that allows their subscribers to get five or any amount bonus you recharge. Moreover, the bonus can be used to call and text either the same

network or others network. Overa (2006) also carried out a study in Ghana on traders and found that mobile phones eliminate distance barriers as its use reduces transportation and transaction costs. Hence, he concluded that less transportation due to mobile phone use could result in higher profits for the traders and the producers.

Bhavnani *et al*. (2008) researched on the role of mobile phones in sustainable rural poverty reduction and disclosed that mobile phone use results in reduction of buyers' transportation cost and among others. This is because mobile phones allow efficient communication between buyers and sellers without travelling. They also found that the reduction in transportation cost also leads to lower expenditure and as a result, increased surplus for the sellers. Just as Overa (2006), they argued that mobile phone is more beneficial for those who have to travel long distances just to check demand or negotiate prices. With mobile phones, they can have a deal without travelling, and in some cases, even without the middle man.

In contrast, Minten and Kyle (1999), whose study was mainly about the effect of mobile phone use on transportation costs within poor quality roads, found more specific benefits. They explained that lower transportation cost increases the availability and reduces the prices of goods and thus, should also benefit the general consumers. Higher availability, especially of perishable food stuffs, is achieved by balancing supply and demand through careful coordination by phone. This resulted in reduced spoilage of food which happens when there is over supply and a more reliable stream of goods in the market. Reduced prices, on

the other hand, should be a result of the savings on transportation cost. Though Overa (2006) also observed the benefit of higher product availability in his study, he did not observe reduced prices. He said that this was because majority of the traders during his research still did not have mobile phones. Thus, the market price was still dictated by this majority. In the end, the savings on travel cost mainly resulted in higher income and improved competitive position for the traders using mobile phones.

De Silva and Ratnadiwara (2008) showed that mobile phone result in timely market information, especially on perishable goods. With that, it significantly reduced the expenditure of Sri Lankan farmers on transaction and travel cost which constitute 11 percent of the total farming cost, from deciding what to grow until the time of selling.

Experiences from the Use of Mobile Phones Elsewhere

Mobile phones are also being used nowadays in agricultural extension services in many countries in order to overcome information failures related to technology adoption (Aker, 2011). Countries such as Kenya, India, Ghana, Bangladesh, and Uganda have projects that allow farmers to ask on farm problems or by calling or texting certain hotlines (Aker & Mbiti, 2010).

In Philippines, a government project called Farmers' Text Center (FTC) supports the information needs of farmers. It answers questions of farmers and other clients on rice and rice-based farm productions, and sends technology updates/tips that could help in improving farmers' input productivity by giving

them more and better options to effectively manage their farms from seed selection to post-harvest (Pascua, 2009). Pascua's (2009) studied the effectiveness of FTC in helping farmers get farming information instead of looking at the impact of FTC in Philippine. The finding also documented 93 percent satisfactions from its 75 surveyed clients. More notably, all of the respondents who received technology tips from FTC (84%) rated the tips as satisfactory. Overall, Pascua (2009) study basically provided information on the increasing demand for mobile phone-related extension service. He also highlighted the potential of mobile telephony in enhancing the access of farmers to efficient farming technologies despite distance barriers.

Similarly, a programme call Cocoa Link, Ghana Cocoa Board (COCOBOD), The Hershey Company (a chocolate manufacturer) and the World Cocoa Foundation (WCF) initiative uses mobile technology to connect cocoa farmers with useful information about improving farming practices, farm safety, crop disease prevention, post-harvest production and crop marketing. Through voice and SMS messages delivered in their local language or English, cocoa farmers received information at no charge. They also share information and receive answers to specific questions relating to their cocoa farming livelihoods (Ghana Statistics Service, 2013). Basically, the aim of these projects is to assist agricultural extension services in providing farmers with good farming practices that could lead to increase in productivity. However, despite the increasing number of such project, only few studies provide detail on how mobile phones, through such projects, help farmers improve productivity.

Mittal and Tripathi (2009) looked at how mobile phones are being used for agricultural purposes, particularly how it is driving agricultural productivity among farmers and fishermen in India. Data were gathered from 15 focused group discussions and 40 individual interviews. The results show that the use of mobile phones to seek farming information result in yield improvement, and among others. These improvements, however, were not observed in all respondents; only in respondents from two of the sampled states. Specifically, four of the interviewed farmers estimated 5-25 percent increase in earnings primarily because of the adoption of good planting techniques learned through different mobile phone services. Some of them were also able to prevent catastrophic losses because they were able to access professional help immediately. Moreover, results of Mittal and Tripathi (2009) showed that weather and optimal fishing zone information given through mobile phones also increased fishermen's revenue.

Apart from the study of Mittal and Tripathi (2009), Aker and Mbiti (2010) described how mobile phones reduced the risk in agriculture in Africa. Through better communication between households on potential shocks, they said that farmers were able to adjust planting and harvesting decisions and influence technology adoption which also helped counter shocks.

Summary of Literature Review

Mobile phones have been found to help improve the productivity of individuals and organizations within resource-constrained environments due to increased effectiveness, usefulness and reach. Farmers or AEAs use mobile

phones to coordinate, access to agricultural information, accessing market information, for financial transactions to seek agricultural emergency assistance and expert advice.

Conceptual Framework

The conceptual framework illustrates how the frequency of using mobile phones for extension delivery by farmers and AEAs is influenced by the following: (i) External factors such as government policies, communication infrastructure, and mobile phone networks;(ii) personal characteristics of AEA and farmers such as age, sex, marital status, years of working experience, education level, amount of money spent per week on credit, location, farm size, household size, major agricultural enterprise of farmers and source of agricultural information etc; (iii) Social factor such as relationships between farmers and AEAs, language barriers and relationships among farmers etc. (iv) Technical factors such as competency in the use of mobile applications and types of mobile phones; and (v) Outcome include reduced in transportation costs, improved communication and communication exchange, reduced risk or theft and improved productivity

According to Gómez-Barroso & Feijóo (2010) the role of government in the telecommunications sector evolved in a nonlinear way and can be described as agents promoting the information to rural people. In the same vein, the works of CIMMYT (1993) and Marra, Pannell and Abadi (2003) revealed that the focus of the adoption literatures has been on the individual farmers (e.g. the attitude or

personality of the farmers or their socio-economic characteristics, such as wealth, landholding or education) and the characteristics of the technologies, rather than the context in which technology adoption and diffusion takes place. Age of the adopter plays an important role in influencing mobile phone usage. According to Okello, Kirui, Njirani and Gitonga (2012), Williams and Agrbo (2013) and Munya (2001) young people participate in technology irrespective of their locality and that young people have a positive correlation with the use of the mobile phone. Porcari (2010) argued that young people are far more known with social networking and other recent advances in technologies use than with the older ones because new communication technologies, in many cases are strange to the older generation. Schiffman and Kanuk (2004) argued that education and income are closely related; the more educated a person is, the greater is the likelihood of a high income. Also, DiMaggio and Cohen (2004) stated that educated people are better able to learn and use new technology more and thus they are more likely to be innovative. DiMaggio and Cohen (2004) explained the positive correlation between the level of income and timing of adoption of new technology.

Furthermore, (Birke & Swann, 2006) and (Corrocher & Zirulia ,2008) argued that factors such as qualities of the mobile network and the characteristics of the mobile subscribers, choice subscribing, customer care, discount, promotion and special offers on calls influenced frequency of use of mobile phone. Therefore is it likely that mobile phone networks infrequence AEAs and farmers use of mobile phone. DiMaggio and Cohen (2004) found that availability of a technology infrastructure shapes inequality by place of location (urban verses

rural) that makes income more important. Similarly, Kalba (2008) argues that adoption of certain technology attributes or alternatives (e.g. fixed vs. mobile connection and postpaid vs. pre-paid services) depends on the level of household income over time. Demiryurek, Erdem, Ceyhan, Atasever and Mayis (2008) also argued that agricultural information disseminated by AEA has an effect on agricultural production in a number of ways. First, it can help out the farmers make informed decisions about land, labour, capital, management, and livestock. Second, agricultural production can be improved through useful, relevant, and reliable information. Therefore to realise the benefits of mobile phone use in extension delivery, government needs to provide the enabling environment for farmers and AEAs. Such environment provides reliable electricity, affordable price of mobile phone, and valuable price of agricultural products on the market.

Armstrong (2006) and Ali Hassan, Maimunah, Turiman and Abu Daud (2008) argued that job performance is related to competencies. Knowledge, attitude, skills and attributes to develop competency among the AEAs were described by Ali, Ahmad, Tanvir and Muhamad (2009) as four aspect of competency while referring to Bergevoet and Woerkum (2006) level of involvement as one contributor to competency. They describe involvement in term of four aspects. First, it can help the participants such as farmers or AEAs to think in a structured way about reality and to generate knowledge; second professional networks can be developed; third participants can create a shared understanding and lastly, it is expected that through involvement the morale of the participants is boosted. According to Chizari, Lindner and Zoghie (2009)

demography factor also influence AEAs competencies level. They argued that older AEAs possessed higher level of competency compared to the younger AEAs. Moreover, the adoption theory (Rogers, 2003) stated that it is important the innovation be compatible with existing values and practices and not too complex. Therefore it is likely that the technical factor (competency in use of mobile phone and types of mobile phone) influence AEAs and farmers frequency use of mobile phone in extension delivery.

Rogers (2003) also argued that the innovation must have some relative advantage over an existing innovation or the status. Aker and Mbiti (2010) and Aminuzzaman, Baldersheim and Jarnil (2003) argued that mobile phone adoption by farmers is predicated on the perception that it is better than most other communication means, as it is convenient to handle, provides economic advantages and enhances social status of users. Thus the likelihood of using mobile phone in agricultural extension delivery will reduce transportation costs, improved communication, increase profits and productivity.

Conceptual Framework

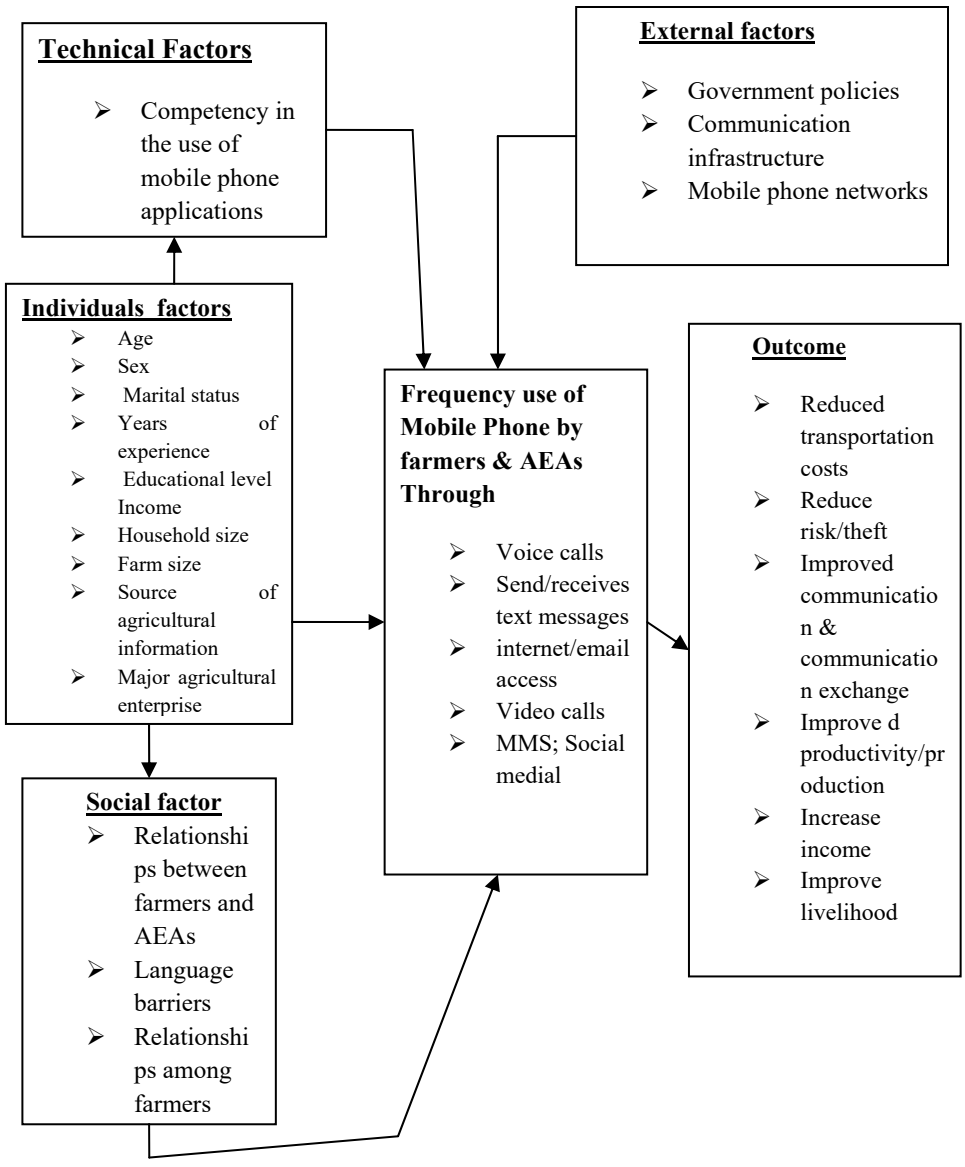


Figure 1: Author's Construct, 2014; Based on Adoption Theory (Rogers, 2003)

CHAPTER THREE

METHODOLOGY

Introduction

This chapter explains the research methodology and techniques that were used to collect and analyze data for the study. Sections of this chapter include the research design, profile of the study area, the population, the sampling procedures, the data gathering instrument, pre-testing (pilot testing), testing for reliability, data collection procedures and processing and data analysis.

Research Design

The design used for the study was a descriptive correlation survey. This design is appropriate because it investigates existing status and possible relationships among variables (dependent and independents) without trying to influence those variables. (Vanderstoep & Johnston, 2009). Best and Kahn (1998) stated that researchers who make use of survey design assess many variables, infer temporal order about past behavior, experience and examine multiple hypotheses. According to Neuman (2003), survey researches methodically ask several people the same questions about the state of a programme.) In survey research, quantitative description of trends, attitudes and opinions are usually provided by studying sample of population. According to

Babbie (1990), questionnaires or structure interviews are the techniques used for data collection and involves generalizing from a population.

Population

The target population for this study was all agricultural extension agents (AEAs) in the selected districts and their respective registered farmers in Eastern Region of Ghana. Registered farmers in this study are farmers that have been recognized by MOFA.

Sample and Sampling procedure

Two groups of respondents were used in this study. They consisted of agricultural extension agents (AEAs) and registered farmers working with the AEAs. The population of the farmers and AEAs was quite large and spread over the whole region; therefore, a sample was selected for the study. The researcher adopted a multi-stage sampling technique to select the sample. According to Agresti and Finlay (2008), multi-stage sampling technique permits larger clusters to be subdivided into smaller, more targeted groupings for the purposes of surveying. Firstly, 5 districts in the Eastern Region were selected by simple random sampling from the 26 districts of in the Region. All districts in the Eastern Region are all covered by the six telecommunication network in the country and they satisfy the same or similar socio-economic conditions and can therefore be representative of the other districts in the study. The Ministry of Food and Agriculture has AEAs working in all the twenty six (26) districts of the region.

The selected districts were: Fanteakwa, Kwahu South, Yilo Krobo, Akuapem South, and Upper Manya.

According to Best and Kahn (1998) there is no fixed percentage or number of subjects determines the size of a satisfactory sample. They argued further that a sample size may perhaps depend on either the nature of the population, the type of data to be collected, the analysis to be done or funds that will be available for the study. They also argued that when the communities are homogeneous or have the same characteristics there no need to select a large sample. In addition, Fraenkel and Wallen (2000) argued that for a descriptive research, the sample should contain a minimum of 100 elements for a correlational study and minimum of 30 elements for causal comparative study. They further stated that a minimum of 50 elements would be required to determine the existence of relationships.

Secondly, lists of all registered farmers numbering 2,393 working with the 95 AEAs in the selected districts were compiled into a sampling frame for selecting farmers. A simple random sampling technique was used to select 330 farmers from the 2,393 farmers based on using Krejcie and Morgan (1970) table for determining sample size from a given population, a sample size of 330 farmers was chosen. The population was stratified into districts. Proportionate random sampling technique was used to separately select sample farmers from each of the selected districts based on their populations. Best and Kahn (1998) explained the unbiased nature of simple random sample when they wrote that it guarantees that every sample of a given size as well as every individual in the target population has equal chance of being selected.

Pertaining to the AEAs, a list of all AEAs in the selected districts was also obtained from the District offices of MoFA. All the (95) AEAs working in the selected districts were included as sample in the study (Only 91responded to the study instrument). The nine-five AEAs were selected based on Best and Kahn (1998) suggestion that the entire population can be sample when the population is small. The breakdown of sample size per each district is shown in Table 3.

Table 3: Population and Sample size of registered farmers and AEAs in the selected districts

No.	Name of district	No. of registered farmers	Sample size of farmers	Simple size of AEAs
1.	Fanteakwa	509	70	26
2.	Kwahu South	320	44	14
3.	Yilo Krobo	343	47	27
4.	Upper Manya	453	63	14
5.	Akuapem South	768	105	14
	Total	2,393	330	95

Source: Field Survey 2014

Study Area

Eastern Region covers a land area of 19,323 kilometres and make up 8.1 percent of the total land area of Ghana. It is the sixth largest region in terms of land area. It lies between latitudes 6^{o} and 7^{o} North and between longitudes $1^{o}30'$

West and 0°30' East. Temperatures in the Region vary from 24°C to about 28°C with average rainfall between 1750mm in the low lying areas to about 1750mm per annum in the highland area of the Kwahu scarp. The Region shares common boundaries with the Ashanti Region, Greater Accra Region, Volta Regions, Central Region, and Brong Ahafo Region (Ghana Statistical Service, 2012).

The total population of the region is 2, 106, 69, representing 11.1 per cent of Ghana's population. It is the third most populous region, after the Ashanti and Greater Accra Regions. The population is made up of 49 percent males and 50 per cent females, giving a sex ratio of 97 males to 100 females. The region has four major ethnic groupings, namely Akan (52.1%), the Ga-Dangme (18.9%), the Ewes (15.9%) and the Guans (7.2%). Also in the region, the Ministry of Food and Agriculture works in all the twenty six (26) municipalities and districts, and each municipality and district is divided into four (4) zones and the zones are also divided into eight (8) operational areas. The municipality or district is headed by a director with municipal and district agricultural officers who serve as zonal heads/ supervisors and divisional heads like (Crops, Animal production, Women in Agricultural Development [WIAD], Directorate of Agricultural Extension, Veterinary services, M.I.S. office). The AEAs are in charge of operational areas within the zones in the districts. For map of Eastern Region of Ghana (see appendix F).

Instrumentation

The study employed structured questionnaires and interview schedule to collect data. Face validity was done by the researcher in order to determine whether each objective was covered. Content validity was established by my supervisors and other lectures in the department. The experts scrutinized the questionnaires to determine if the content domains, based on the objectives of the study, were adequately covered. The research questionnaire contained close-ended and open-ended questions (see appendix D &E).

The questionnaires and interview schedule consisted of five parts. Part one measured the socio-economic and background characteristics of respondents. Part two measured frequency of use of mobile phone and a five point likert scales ranging from (never to four times a week) were used. Part three measured the competencies level of respondents and five point likert scales ranging from (very low to very high) were used. Part four measured the perceive benefits and five point likert scale ranging from (strongly disagree to strongly agree) were used. While part five measured the challenges and five point likert scales ranging (Not a challenge to a very serious challenge) were used. The questionnaires were administered to the AEAs because they could read and write .While the interview schedule was administered to the farmers with the assistant of AEAs from the various districts because most of them could not read and write.

Pretesting of Instruments

The questionnaire was then pre- tested using 20 farmers and 10 AEAs from Suhum districts of Eastern Region which has similar characteristics with the

five districts. The data from the pilot study was entered into Statistical Package for Social Sciences (SPSS) data file for computer analysis to generate alpha coefficient (see appendix C)

According to George and Mallaric (2003), when the item is 0.7 and above at the alpha level, it is accepted and when it is below 0.6, it is questionable. Quality of network and challenges Cronbach's alpha for farmers were below (0.7), yet these same questions were answered by AEAs and yielded good result. This could be that the AEAs who administered the questionnaires to the farmer did not understand or explain the questions to the farmers' clearly. Therefore based on this experience from the pilot test, training was given to the enumerator who collected the main data at the level of their understanding and the questions were reconstructed and accepted alone with my supervisors for working.

Data Collection Procedure

The five districts Directors of Food and Agriculture were contracted for monthly meeting schedules date which made it possible for the researcher to meet with all the AEAs. Also the researcher trained five (5) enumerators who knew the territory, culture and could speak the language of the respondents to collect the data. The questionnaire was administered in two phases. First, AEAs in the sample questionnaire was administered at the same time and place during monthly meetings. In the second phase, farmers were contacted through AEAs who were trained in the districts to schedule a time to meet them at their house or on their farm. In all, 330 farmers were interview while 95 AEAs answer the questionnaires

(total =425). And there was 100% response rate. The data was collected from October 7, to November 5, 2014.

Data Analysis

The data collected was cleaned, decoded and analyzed using descriptive and correlational statistics, with the aid of the Statistical Package for Social Sceneries software (SPSS, Version 21).

Objective 1: Descriptive statistics such as frequency, percentages, means and standard deviation were used. Frequency and percentages were used to analysis the following variables such as locations, sex, education, marital status, major agricultural enterprise, major source of information, types of mobile phone and network subscription. While frequency, percentages, means and standard deviation were used to analysis age, household size, working experience, farm size, amount of money spend on credit per week, number of mobile owned and number of year using mobile phone.

Objective 2: A five point likert-type scale ranging from (0= ‘‘Never to 5= ‘four times a week) was used. Frequency of use of mobile phone is the dependent variable. In other to have one variable call frequency of use, the items were recoded into different variable where 0 =never was re-coded as 0=missing system while 1 and 5 remains as it is and competed to get the overall means call frequent use of mobile phone. In addition, a descriptive statistics such as frequency, percentages, means and standard deviation were used to analysis types of agricultural information search, types agricultural information send/ receive and

use of mobile phone in extension delivery. Moreover, the respondents were asked to indicate by ticking from a list of options provided, against a response option of "yes" or "no", the areas mobile phone is use for extension delivery, the types of information search and type of information send/receive using the mobile phone. Therefore the "yes" was code as one (1) and "no" as zero (0).

Objective 3, a five point likert scale range from (1= very low to 5= very high) was used. Means and standard deviation and independent t-test was also used. For objective 4, the following types of correlations (Point Biserial, Pearson, & Spearman) were first used to determine whether relationships existed between socio- economic and back ground characteristics of farmers and AEAs and frequency use of mobile phone. The point biserial was used to measured categories variables such as sex, marital status, farmers' cooperative and types of mobile phone. Also the Pearson was used to measured continuous or interval or ratio variables. For example, age and Spearmen was used to measured ordinal variable such as education. Thereafter, linear regression were used to determine the best predictors of frequency use of mobile phone and where tested at 0.05 alpha level. The Socio-economic and background characteristics variables influencing frequency use of mobile phone were computed as:

Y= Frequency Use of Mobile Phone (dependent variable)

Independents variables

Sex (1=Male, 0=Female)

Age (Years)

Education Level of Farmers (1=Non Formal Education; 2=Primary School Level; 3=Middle School/HJS; 4= Bachelor's Degree).

Education Level of AEAs (1=Certificate; 2= Diploma; 3= Bachelor degree; 4= Master degree).

Marital Status (1= Married, 0=Single,)

Household Size (Number of Person under the Care of a Farmer's & AEA's Heard)

Number of Years in Farming or working (Years)

Farm Size (Acres)

Number of Years in Using Mobile Phone (Years)

Amount of Money Spent Per Week Using Mobile Phones (Ghana Cedis)

Farmer's Cooperative (1= Members, 0= Non-Members)

Quality of network reception (Likert Scale from 1=very bad to 5=very good)

Type of mobile phones (1=Smart phone, 0=Ordinary phone).

Objectives 5 and 6, descriptive statistics such as frequency, percentages, means, and standard deviation were used.

CHAPTER FOUR

RESULTS AND DISCUSSION

Introduction

This chapter presents and discusses the results from the analyses of data according to the objectives of the study. The results are discussed under the following sub-headings: Socioeconomic and mobile phone background characteristics of farmers and AEAs, the frequency of use of mobile phone in agricultural extension delivery, competencies of AEAs and farmers, benefits, and challenges and the relationship between socioeconomic and mobile phone background characteristic and the use of mobile phones in agricultural extension delivery.

Socioeconomic and Background Characteristics of Farmers and Extension Agents

Location and Operational Area of Farmers and AEAs in the Study Area

Table 5 shows the location and operational areas of farmers and AEAs in the study. The study reveals that more of the respondents, both AEAs and farmers are located in rural communities. This implies that operational area of the AEAs largely cover with where farmers are living.

Table 5: Frequency Distribution Location and Operational Area of Farmers and AEAs in the Study Area

Area	AEAs		Farmers	
	Freq.	%	Freq.	%
Rural	56	61.5	263	83.5
Urban	35	38.5	52	16.5
Total	91	100.0	315	100.0

Source: Field Survey Data, 2014

This finding is supported by FAO (2009) and World Bank (2008), which indicated that agriculture in Ghana is rural where 70 percent of the population lives and depends directly or indirectly on agriculture. No wonder most of the AEAs are distributed in the rural areas. It is therefore expected that availability of mobile phone in the rural areas and its use by AEAs and farmers will enhance extension delivery.

Sex of Farmers and AEAs in the Study Area

The sex of the farmer plays a part in the usage of mobile phone for agriculture. The result presented in Table 6 reveals that there were more male respondents AEAs (89%) and farmers (76.8%) than female respondents AEAs (11%) and farmers (23.2). This is not surprising because, according to Ogbeide and Ele (2015), agricultural is still a male dominated sector where the head of the household often times determines what goes on in the family and their means of

livelihood. Furthermore, several studies (FAO, 2009; MOFA, 2010; World Bank, 2007) argued that males dominate extension services because they have better social capital which has a direct link with exchange of information and learning than their female counterpart.

Table 6: Sex of AEAs and Farmers

Sex	AEAs		Farmers	
	Freq.	%	Freq.	%
Male	81	89.0	242	76.8
Female	10	11.0	73	23.2
Total	**91**	**100.0**	**315**	**100.0**

Source: Field Survey Data, 2014.

MOFA (2010) indicated that despite the fact that women farmers constitute the larger agricultural labor force in Ghana, which women farmers in Eastern Region are no exception, as they produce roughly 70% of the food crops, they are least served by extension service. Women are disadvantaged in extension services because of limited access to resources-decision-making power, education, agricultural information and agricultural inputs and credits (World Bank, 2007).

Age of AEAs and Farmers in the Study Area

Studies indicated that in terms of technological packages, social and economic considerations, young farmers adopt fastest (Okello, Kirui, Njirani & Gitonga, 2012; Williams & Agrbo, 2013; Munya, 2001). The results presented in

Table 7 show that the highest number of AEAs (47.3%) and farmers (30.5%) are between 50 and 59 years. The mean ages of respondents were AEAs (49.7%) and farmers (46.33%). However, majority of AEAs (73.7%) are within the age range of 40 to 59 years. Also, about 43% will be retiring in one to ten years time which calls for a need to recruit more AEAs.

Table 7: Frequency Distribution of Age of AEAs and Farmers

Age (years)	AEAs		Farmers	
	Freq.	%	Freq.	%
Below 20	-	-	1	0.3
20-29	2	2.2	3	1.0
30-39	22	24.2	65	20.6
40-49	24	26.4	92	29.2
50-59	43	47.3	96	30.5
60-69	-	-	46	14.6
70-79	-	-	10	3.2
80-89	-	-	2	0.6
Total	91	100.0	315	100.0

Source: Field Survey Data, 2014. AEAs Mean= 46.33 years, SD=8.80; Farmers Mean =49.46, SD=11.11

Education Level of AEAs and Farmers

Almost half (49.17%) of AEAs have had Diploma to Master degree, while the rest (49.5%) also close to 50% have had a certificate from agricultural college. Furthermore, about 16% of the farmers have not had any formal education. The rest who have had (83.12%) formal education, the majority (55.8%) have obtained up to basic level (primary & JHS). Only 4 out of 315 have had some level of tertiary education.

Table 8: Frequency Distribution of Farmers and AEAs Educational Level

	AEAs		Famers	
Educational level	Freq.	%	Freq.	%
Certificate	45	49.5	-	-
Diploma	22	24.2	-	-
Bachelor degree	16	17.6	-	-
Masters degree	8	8.8	-	-
Non formal education	-	-	50	15.9
Primary school	-	-	42	13.4
Middle School/JHS	-	-	133	42.4
Secondary school	-	-	86	27.1
Bachelor degree	-	-	4	1.3
Total	91	100.0	315	100.0

Source: Field Survey Data, 2014

Education level has effect on use of mobile phone; therefore, since the entire respondents have some educational qualification, it is expected that they should be able to use mobile phone to improve their work and livelihood of others. The results is in line with Ghana Statistics Service (2010) report that roughly two-thirds (63.6%) of the population aged 15 and older in Eastern Region are literate. Therefore, since the entire respondents have some education qualification and they are expected to be able to utilize the mobile phone, the extension messages delivered must be in the medium such as voice call that both AEAs and farmer will understand.

Marital Status of Farmers and AEAs in the Study Area

The marital status of farmers and AEAs are displayed in Table 9. The result revealed that there were more married AEAs (91.2) and farmers (78.4) than single or unmarried ones. Yakubu, Abubakar, Atala, Muhammed and Abdulahi (2013) found similar result on extension agents in Nigeria where 89.8% were married and 10.2% being single.

Table 9: Frequency Distribution of Farmers and AEAs Marital Status

	AEAs		Farmers	
	Freq.	%	Freq.	%
Married	83	91.2	247	78.4
Single	8	8.8	46	20.6
Total	91	100.0	315	100.0

Source: Field Survey Data, 2014

Household Size of Farmers and AEAs in the Study Area

The study revealed that AEAs has the mean household size of (4.73) and farmers (5.89). However, 7% of farmers had between 11 and 30 per household. This is not surprising because farmers tend to use people more to assist in their farming activities. Table 10 presented the frequency distribution of farmers and AEAs household.

Table 10: Frequency Distribution of Farmers and AEAs Household Size

Household size	AEAs		Farmers	
	Freq.	%	Freq.	%
1-5	68	69.2	166	52
6-10	28	30.8	128	40.6
11-15	-	-	17	5.4
16-20	-	-	3	1.0
21-25	-	-	1	0.3
26-30	-	-	1	0.3
Total	91	100.0	315	100.0

Source: Field Survey Data, 2014. AEAs: Mean= 4.73, SD= 2.20;

Farmers: Mean= 5.89, SD= 3.13

It is expected that farmers with more members are able to use the mobile phone through the help of their children, especially the educated ones.

The study supports Ogbeide and Ele's (2015) findings that farmers with children, practically the less educated ones, are able to acquired knowledge of how to use

the mobile phone. For example, how to dial and receive calls, store and retrieve messages, send and receive messages through their children assistant.

Working Experience of AEAs and Farmers in the Study Area

Table 5 shows the frequency distribution of respondents by their working experience.

Table 11: Frequency Distribution of Work Experience of Farmers and AEAs

Working Experience (years)	AEAs		Farmers	
	Freq.	%	Freq.	%
1-5	9	9.9	17	5.3
6-10	14	15.4	67	21.3
11-15	17	18.7	59	18.7
16-20	8	8.8	61	19.4
21-25	17	18.7	42	13.3
26-30	18	19.8	27	8.6
31-35	8	8.8	20	6.3
36-40	-	-	13	4.1
41-45	-	-	7	2.2
46-50	-	-	-	-
51-55	-	-	2	0.6
Total	91	100.0	315	100.0

Source: Field Survey Data, 2014. AEAs: Mean= 18.45 years, SD= 9.36

Farmer: Mean= 18.45 years, SD= 10.31

Ibrahim, Adejoh and Edoka (2009) had argued that the more experienced AEAs and farmers are, the more they are exposed to sources and channels of information. Ibrahim, Adejoh and Edoka (2009) added that experience is required to garble and use new technology such as mobile phone faster in extension delivery.

The mean and standard deviation indicate that farmers (M=18.45, SD=10.307) and AEAs (M=18.45, SD=9.360) had very close years of working experience. However, most of the farmers (21.3%) had worked between 6 and 10 years. Also, most AEAs had worked between 26 and 30 years. Few farmers (6.9%) had worked between 36 and 55 years as farmers. It is therefore expected that farmers and AEAs should be able to use mobile phone since they are experienced in farming.

Farm Size of Farmers

Table 12 presents the frequency distribution of farmers by farm size. A greater percentage of farmers (64.7%) cultivate between one to five acres, and (35.3%) cultivate between 6 and 30 acres. This is not surprising that majority of the farmers cultivate less than six acres. According to MOFA (2010), majority of the farmers in Ghana are engaged in subsistence farming using traditional methods and low technologies which do not allow them to cultivate huge acres of land. The farmers who cultivate over 6 acres are expected to have invested resources so they are more sensitive to relevant information. They are also expected to use mobile phone more as a source of information to access market and other relevant agricultural information in other to improve their productivity.

Table 12: Frequency Distribution of Farmer by Farm Size

Farm size (acre)	Farmers	
	Freq.	%
1-5	198	64.7
6-10	68	22.2
11-15	14	4.6
16-20	15	4.9
21-25	5	1.7
26-30	6	2.0.
Total	306	100

Source: Field Survey Data, 2014. Mean: 6.34, SD=6.10

According to Williams and Agbo (2013) and Falola, Adewumi and Olaniyi (2013), farmers with large farm size are more likely to utilize ICTs in agricultural technology delivery. They further emphasize that larger-scale farmers are able to get higher benefits from mobile phone use as they are able to access resources concerned with input availability and disease control. They are also able to get technical or professional help immediately in case of plant disease. They are also privileged to benefit from the information they get on market prices and are able to overcome any possible constraints on production or market access with greater facility than small farmers.

Amount of Money Farmers and AEAs spend using Mobile Phone per Week

Table 13 shows the amount of money farmers and AEAs spend per week in using mobile phone. The amount ranged from 1.00 to 30.00 Ghana cedis.

Table 13: Amount of Money Spent per Week on Credit by Farmers and AEAs

Amount (Gh¢)	AEAs		Farmers	
	Freq.	%	Freq.	%
1.00-5.00	35	38.5	212	67.5
6.00-10.00	51	56.1	73	23.3
11.00-15.00	1	1.1	11	3.5
16.00-20.00	4	4.4	11	3.5
21.00-25.00	0	0	1	0.3
26.00-30.00	0	0	6	1.9
Total	91	100.0	314	100.0

Source: Field Survey Data, 2014. AEAs: Mean= 8.00 Gh¢, SD= 3.47, Farmers: Mean= 6.35 Gh¢, SD= 5.39

Majority (67.5%) of farmers spend between 1.00 to 5.00 Ghana cedis on mobile phone. Only less than one- quarter (23.3%) spend between 6.00 to 10.00 Ghana cedis on mobile phone every week. On the other hand, majority (56.1%) of AEAs spend 6.00 to 10.00 Ghana cedis per week, whilst (38.5) spend 1.00 to 5.00 Ghana cedis per week. The mean of (GH¢ 8.00) for AEAs and (GH¢ 5.39) for farmers indicates that AEAs spend more on mobile phone to deliver agricultural information than farmers. However, since majority of the respondents are

subscribing to MTN and Vodafone in the study areas, they should take advantage of MTN e-extension or MTN toll free- facility that demands no charge to the caller. The code number for this is 1848 (NCA, 2015).

Farmer's Cooperative in the Study Area

Farmers that belong to farming associations and other organizations, such as cooperative societies, are more likely to share information through mobile phone. The result shows that (58.7%) of the farmers in the study areas are members of a farming association. Falola, Adewumi and Olaniyi (2013) found similar results that majority of Farmers' belong to agricultural association. In addition, Pascua (2009) argued that farmer's participation in farming association can stimulate information exchange.

Major Agricultural Enterprise of Farmers

Table 14 presents the major agricultural enterprises of farmers.

Table 14: Frequency Distribution of Farmers Major Agricultural Enterprise

Enterprise	Yes	
	Freq.	%
Crop Production	311	98.7
Animal Production	112	35.6
Agricultural Marketing	14	4.4
Agro Processing	7	2.2
Fishing	11	3.5

Source: Field Survey Data, 2014 *Multiple responses

Nearly all the farmers (98.7%) in the study area are involved in crop production. Similarly, about half (35.6 %) of the farmers keep animals. However, the production of animals is low as compared to crop production. Crop production in the study area was mostly subsistence.

Major Sources of Agricultural Information of Farmers and AEAs in the Study Area

Table 15 shows the frequency distribution of sources of information of farmers and AEAs used in their activities.

Table 15: Frequency Distribution of Farmers and AEAs Major Source of Agricultural Information

Source	AEAs (N=91)		Farmers (N=315)	
	Freq	%	Freq.	%
Co-farmers	-	-	265	84.1
Extension agents	85	93.4	261	82.9
Friends	-	-	235	74.5
Co-operative society	-	-	115	36.5
Agric. Workshops	89	97.9	114	36.2
Radio	60	65.9	97	30.8
Farmer's forum	60	65.9	95	30.2
Family relations	-	-	94	29.8
Researchers	60	65.9	-	-

Source: Field Survey Data, 2014. * Multiple responses

The study reveals that co-farmers (84.1%), extension agents (82.9%), friends (74.5%), co-operative (36.5%) and radio (30.8) were found to be the main sources of information for farmers' use. In the case of AEAs workshop (97.9%), colleague's extension agents (93.4%) follow by radio, farm fora, and researchers (65.9%) in their order were found to be the main sources of information. Similar result was reported by Tologbonse, Fashola and Obadiah (2008) who found that farmers usually seek information from extension agents followed by friends/ co-farmers. In addition, Overa (2006) found that most farmers considered extension agents as their source of information, followed by fellow farmers, radio, and television.

Ownership of Mobile Phone by AEAs and Farmers in the Study Area

Table 16 presents the result on farmers' and AEAs' ownership of mobile phone. The result indicates that (95.6%) of the farmers and (78%) of AEAs use only one mobile phone. While only few, especially AEAs (21.10%) own two to three mobile phones, while (4.4%) of the farmers own two mobile phones. According to Okello, Kirui, Njirani and Gitonga **(**2012**)**, ownership of mobile phones creates the willingness or power to explore the product and its functionalities. Moreover, it increases the willingness and ability of a person to use them in diverse situations. Furthermore the ownership or use of mobile phones increases the respondent' product knowledge and symbolize high social status in the farming community. It is therefore expected that farmers in the study

area will explore the functionality of mobile phone and then in extension delivery as they attending status in the community.

Table 16: Number of Phones Owned by AEAs and Farmers in the Study Area

Number of Phones	AEAs (N=91)		Farmers (N=315)	
	Frequency	Percent	Frequency	Percent
1	71	78.0	301	95.6
2	18	19.8	14	4.4
3	2	2.2	0	0
Total	91	100.0	314	100.0

Source: Field Survey Data, 2014. AEAs: Mean=1.24, SD= .48

Farmer: Mean=1.04, SD= .21

Type of Mobile Phone Used by Farmers and AEAs

Compatibility and complexity, or the degree to which an innovation fits within the socio-cultural framework and the perceived difficulty of use, are directly related to its likelihood for adoption and use (Rogers, 2003). The study investigated farmers' and AEAs' type of mobile phone used for extension delivery as presented in table 17. The result indicates that majority of the farmers (91.1%) use an ordinary mobile phone, while (10.7%) use Smartphone. Also, (72.5%) AEAs use ordinary mobile phone, while (50.6%) use Smartphone for extension delivery. The greater percentage of the farmers and AEAs using the ordinary phones implies that the applications of ordinary phone are not too

complex as the Smartphone as stated by Rogers (2003) that when the innovation is not too complex, adoption will take place.

Table 17: Type of Mobile Phone Used by Farmers and AEAs in the Study Area

	AEAs (N=91)		Farmers (N=315)	
Source	Freq.	%	Freq.	%
Smart phone	46	50.6	33	10.7
Ordinary phone	66	72.5	287	91.1

Source: Field Survey Data, 2014. * Multiple responses

In addition, other adoption studies (Kaliba et al., 2000, Qiang, Kuek, Dymond & Esselaar, 2011) assumed that smaller holder farmers tended to adopt simple technologies first before moving on to more complex ones, while cheaper technologies may be adopted before the more expensive ones. Diffusion theory also states that an innovation will first be adopted by a small number of people and, if the innovation provides a relative advantage, more and more people will adopt; resulting in critical mass (Rogers, 2003). So with minority of the respondents using the Smartphone for extension purpose, especially the AEAs and the benefits offer such as reporting through email or browsing the internet to access relevant information will motivate other AEAs to adopt the frequent use of Smartphone.

Number of Years Farmers and AEAs have Used Mobile Phones

Mobile phone was introduced in Ghana in 1992. The long period of usage is due to the benefits derived by the respondent in terms of economic and cultural transformation of the farming environment and community communication. The study therefore sought out number of year's farmers and AEAs in Eastern Region of Ghana have been using mobile phone. The numbers of years respondents have been using mobile phones ranged from 1 to 15 years. Majority of the respondents' farmers (89.5%) and AEAs (61.6%) have used mobile phones between 6 to 10 years. Whilst (38.4%) of AEAs and (4.8%) of farmers have used mobile phone between 11 to 15 years, only (5.7) of the farmers have used mobile phone between 1 to 5 years, with the mean years and standard deviation for AEAs (Mean= 10.04, SD=2.043) years and farmers (Mean=8.08, SD=1.853) years as shown on Table 18.

Table 18: Frequency Distribution of Farmers and AEAs Number of Years Using Mobile Phone

Years	AEAs		Farmers	
	Freq.	%	Freq.	%
1-5	-	-	18	5.7
6-10	56	61.6	282	89.5
11-15	35	38.4	15	4.8
Total	91	100.0	315	100.0

Source: Field Survey Data, 2014. AEAs: Mean= 10.04 years, SD= 2.04 Farmers Mean= 8.08 years, SD= 1.85

The result presented in Table 18 also reveled that mobile phone technology is not new to farmers and AEAs of Eastern Region of Ghana as they have used it for a long time. According to Rogers (2003), at the beginning of the adoption, the adoption rate will be low but as times goes back, it will increase and then start to fall, at which we can say adoption has taken place. For example, approximately from 11-15 years, which is between 1999 and 2003, the rate of adoption was low and this is what Rogers classify as innovators, while from 6 to 10 years, that is around 2003 to 2009, the rate of adoption increases as Roger called them early adopters. Lastly, from 1 to 5 years that is from 2009 to 2014, the rate of adoption began to fall as he called them the early majority or the late majority as shown on Table 18. Therefore, from the finding, it indicates that the use of mobile phone is adopted and is used by the respondents for extension delivery in the study area.

Network Subscription by Farmers and AEAs

The results on Table 19 show the type of network subscribed to by respondents. Majority of the respondents (92.3%) for AEAs and (74.9%) for farmers subscribe to MTN. The least network subscribed to by the respondents was Glo. Only two AEAs and one farmer had subscribed. This result is in line with the finding of National Communication Authority (2014) that MTN is the leading network in Ghana followed by Vodafone and Glo is the least in the telecommunication industry.

Table 19: Frequency of Distribution of Network Subscription by Farmers and AEAs

Network	AEAs (N=91)		Farmers (N=315)	
	Freq	%	Freq	%
MTN	84	92.3	236	74.9
Vodafon	32	35.2	55	17.5
Airtel	18	19.8	30	9.5
Tigo	8	8.8	50	15.9
Expresso	4	4.4	6	1.9
Glo	2	2.2	1	0.3

Source: Field Survey Data, 2014. * Multiple responses

The study also conforms to the findings of Birke and Swann (2006), which concluded that the characteristics of the individual mobile subscriptions, social network (friends, family and partner) and income influence the choice of mobile users. Moreover, many are subscribing to MTN, because according to Kim and Kwon (2003), in order to avoid high expenditure on phone calls, mobile users try to convince friends and family to subscribe to the same network. Kim and Kwon (2003) argued that consumers consider network size before subscribing to a mobile network. Generally, the larger the mobile networks, the more advantage it has over smaller networks due to intra-network call discounts and quality-signaling effect. Furthermore, mobile network with larger subscriber base attracts more subscribers and it becomes more attractive to others.

Factors Farmers and AEAs Considered in Subscribing to a Network

The results in Table 20 present factors AEAs and farmers consider for subscription. While majority of the AEAs (97.8%) consider the coverage as the reason for choosing a network, most farmers (88.6%) indicated good reception as the major reason for selecting a network.

Table 20: Frequency Distribution of Reason Considered in Network Subscription by Farmers and AEAs

Factor	AEAs (N=91)		Farmers (N=315)	
	Freq	%	Freq	%
Wide coverage	89	97.8	206	65.4
Good reception	70	76.8	279	88.6
Promotions	34	37.4	112	35.5
Affordable services such as (Calls, SMS, MMS, Video calling)	13	14.3	15	4.7
Communicate agricultural information	8	8.8	3	1.0

Source: Field Survey Data, 2014. * Multiple responses

More than a half of the respondents AEAs (37.4) and farmers (35.5) considered promoting services provision of bonus for recharging a card or making a call as a reason for subscribing to a network. Few AEAs (8.8%) and farmers (1.0%) considered communication of agricultural information as the major reason

for choosing a network. According to Corrocher and Zirulia (2008), factors that influence the choice of subscription to a network include the qualities of the mobile network and the characteristics of the mobile subscribers; the network quality obtains from the range of mobile telecommunication services influence costumer decision making power.

Respondents Perception of the Quality of Network Reception

The AEAs perceived the quality of network reception of MTN (Mean=3.75, SD=0.77); Vodafone (Mean=3.97, SD=0.91); and Airtel (Mean=3.75, SD=0.64) to be good.

Table 21: Quality of Network Reception in the Study Area

Quality of Service	AEAs		Farmers	
	Mean	SD	Mean	SD
Vodafone	3.97	0.91	3.52	1.26
MTN	3.75	0.77	4.06	0.77
Airtel	3.75	0.65	2.83	1.16
Tigo	3.50	0.55	3.25	1.12
Glo	3.00	0.00	2.04	0.85
Expresso	2.50	0.66	2.17	0.79

Source: Field Survey Data, 2014. Means were calculated from a scale of 1= Very bad, 2= Bad, 3=Average, 4=Good, and 5= Very good.

Similarly, farmers perceived MTN (Mean=4.06, SD=0.86); Vodafone (Mean=3.52, SD=1.26) and Tigo (Mean=3.25, SD=1.12) to be good. Whilst AEAs perceived Glo (Mean=3.00, SD=0.00) to be average, farmers perceived the reception of Expresso (Mean=2.17, SD=0.67) and Glo (Mean= 2.04, SD= 0.85) as poor.

Uses of Mobile Phone in Extension Delivery

Table 22 indicates how the farmers and AEAs used the mobile phone in extension delivery. Majority of AEAs use mobile phone to schedule meetings (97.8%) with farmers, send text message information (89%) to farmers and receive text message information (54.9%). However, no farmer indicated that they use mobile phone to schedule meetings or send text message to other farmers or AEAs. However, the majority of farmers indicated that they also received text information (72.1%) and market/sales (62.2%). Compared to the (54.9%) of AEAs who also received text message information, encouragingly, few farmers (6.3%) and one out every four (40.7%) AEAs are using the internet on their mobile phone to access information on agriculture. Twenty six of farmers also indicated that they received money using money transfer facility introduced by some service provider like TIGO and MTN. Whilst one-fifth of AEAs (19.8%) indicated that they use the mobile phone to report on their work, no farmer indicated so. About half (47.8%) of farmers use radio on their mobile phone listen to agricultural programmes. Table 22 present the uses of mobile phone for extension delivery.

Table 22: Uses of Mobile Phone for Extension Delivery

Use	AEAs (N=91)		Farmers (N=315)	
	Freq	Percent	Freq	Percent
Scheduling meetings with farmers	89	97.8	-	-
Sending text message or receive message	81	89.0	-	-
Product delivery/ procurement	-	-	120	38.1
Gathering market information	50	54.9	227	72.1
Accessing Internet information	37	40.7	20	6.3
Transfer money	35	38.5	26	8.3
Reporting agric. work	18	19.8	-	-
Use radio to listen to agric programme	1	1.1	141	47.8

Source: Field Survey Data, 2014. * Multiple responses

The study supports that of Metz (2012) and Lorimer (2012) that agriculturalists and farmers tend to use the mobile phones to check weather and marketing information and access emails and internet. In addition, Ansari and Pandey (2013), Syngenta Foundation (2011) and Das, Basu and Goswami (2012)

stated that farmers use the mobile phone for accessing market information and expert advice and to seek agriculture emergency assistance.

Types of Agricultural Information AEAs and Farmers Use Mobile Phone to Access

More than one –third of AEAs indicated that they had used mobile phone on market information (3.3%), cultural practices, and new variety of crop (34.1%), weather information (31.9%), recommended fertilizer (31.9%) and post harvest (31.9%). Less than 15% of farmers had used mobile phone on the above agricultural information. On the basis of high percentage, it could be said AEAs information need is on market information and cultural practices whilst farmers are on weather information (14.6%) and weeding and thinning (12.50%).

According to Akarda and Roknuzzaman (2012), farmers will use mobile phone to access type of information that is needed most. Results in Table 23 revealed that the type of information AEAs and farmers use mobile phone to access are diverse ranging from crop production, market information, disease and pest management, fisheries and animal production, weather and animal processing (good slaughtering). This result conforms to study Elly and Silayo (2013)'s in Tanzania that farmers use mobile phone to access diverse information needs about crop and livestock husbandry, marketing, and value addition.

Table 23: Frequency Distribution of Types of Agricultural Information AEAs and Farmers use Mobile Phone to Access

Type of information	AEAs		Farmers	
	Freq.	%	Freq.	%
Market information	33	36.3	41	13.0
Cultural practices	33	36.3	41	13.0
New variety of crops	32	35.2	41	13.0
Diseases management (crops)	31	34.1	42	13.3
Weather information	29	31.9	46	14.6
Recommended fertilizers application	29	31.9	41	13.0
Post-harvest handling	29	31.9	40	12.7
Workshop / Training	26	28.6	41	13.0
Planting Materials	25	27.5	37	11.7
Poultry Management	25	27.5	10	3.2
Pest Management	24	26.4	38	12.1
Livestock Management	23	25.3	22	7.0
Disease Management (animals)	21	23.1	34	10.8
Weeding and Thinning	18	19.8	39	12.5
Animal health Management	16	17.6	29	9.2
Good Slaughtering	6	6.6	12	3.8
Fishery	2	2.2	7	2.2

Source: Field Survey Data, 2014. * Multiple responses

Type of Information Received/ Sent by AEAs and Farmers for Extension Delivery

Table 24: Frequency Distribution of AEAs and Farmers Receiving or Sending Information via Mobile Phones

Type of information	AEAs		Farmers	
	Freq	%	Freq	%
Workshop / Training	77	84.6	215	68.3
Recommended Fertilizers Application	75	82.4	243	77.1
Disease Management (crops)	75	82.4	238	75.6
Cultural Practices	75	82.4	221	70.4
New Variety of Crops	73	80.2	187	59.4
Post-Harvest Handling	70	76.9	236	74.9
Planting Materials	68	74.7	185	58.7
Pest Management	56	61.5	161	51.1
Disease Management (animals)	53	58.2	67	21.3
Poultry Management	51	56.0	46	14.6
Weather Information	50	54.9	73	23.2
Weeding and Thinning	48	52.7	91	29.0
Market Information	46	50.5	140	44.4
Livestock Management	40	44.0	45	14.3
Animal Health management	32	35.2	64	20.3
Good Slaughtering	19	20.9	16	5.1
Fishery	3	3.3	23	7.6

Source: Field Survey Data, 2014. * Multiple responses

The result reveals that majority of the farmers (79.4%) received agricultural information from (97.8%) of AEAs by mobile phones. The study shows that farmers received information on almost all (15) items listed but the top information received were: recommender fertilizers applications (77.1); diseases of crops management (75.6%), post-harvest handling cultural practices (70.4%) and workshop/training (68.3) as all the information received was similar to those sent by the AEAs.

Frequency at which Farmers and AEAs Use the Mobile Phones for Agricultural Extension Delivery

Table 25 shows how frequent farmers and AEAs use the mobile phones applications for extension delivery. In this study, frequency of service usages is measured as the number of times farmers or AEAs frequently use the mobile to obtain or send agricultural information. The result shows that AEAs (Mean=4.42, SD=0.79) and farmers (Mean=4.80, SD=0.45) do voice call more than four times a week to deliver agricultural information. In addition, the AEAs indicated that they used their mobile phone twice a week to access internet (Mean=2.32, SD=1.51); email (Mean=2.26, SD=1.52) and whatsapping (Mean=2.57, SD=1.81) to received or send information. Nevertheless, the AEAs indicated they had used it once a week to do video calling/conference (Mean=1.04, SD=0.21); receiving/sending multimedia service (Mean=1.15, SD=0.66) and chatting on twitter (Mean=1.04, SD=0.21) on their mobile phone to deliver agricultural information.

Table 25: Frequency at which Farmers and AEAs Use the Mobile Phones per Week to Deliver Agricultural Information

Service	AEAs (N=91)		Farmers (N=315)	
	Mean	SD	Mean	SD
Calling (Voice calls)	4.80	0.45	4.42	0.79
Receiving/ sending text message	3.30	1.08	1.94	0.99
Listening to radio on phone	3.09	1.75	2.15	1.63
Sending text message	2.66	0.99	1.85	0.91
Sending or receiving whatsapp	2.57	1.81	1.19	0.71
Accessing internet	2.32	1.51	1.24	0.78
Accessing email	2.26	1.52	1.19	0.64
Chatting on face book	2.14	1.43	1.21	0.73
Receiving multimedia service	1.15	0.66	1.01	0.08
Sending multimedia service	1.13	0.54	1.04	0.22
Chatting on twitter	1.04	0.21	1.02	0.25

Source: Field Survey Data, 2014. Mean calculated from a Scale of: 0= never, 1= once a week, 2= twice a week, 3= three times a week, 4= four times and above.

Farmers indicated that with the exception of voice calling, they have used their mobile phone once a week to access internet (Mean=1.24, SD=0.78); email (Mean1.19, SD=0.64); whatsapping (Mean=1.19, SD=0.71); video calling (Mean=1.02, SD=0.21); receiving/sending multimedia service (Mean=1.01, SD=SD=0.08); and chatting on twitter (Mean=1.02, SD=0.25) to search for information or receive information from AEAs. Similar result was found by

Kwakwa (2012) in Akuapem North of Eastern Region of Ghana that farmers use voice calling more than SMS and video calling. Crandall's (2011) study on use of mobile phone by Kenyan farmers revealed that calling using mobile phone was popular than sending SMS. Most farmers regardless of age, sex, or location, tend to prefer making calls to using SMS and other mobile applications.

Asharf et al. (2005) argued that lesser extent of SMS usages by farmers was due to higher rate of illiteracy. In addition, Gakuru, Winters, & Stepman (2009) argued that the challenges mobile phone users face is because the SMS carries only a limited amount of information and requires a basic level of literacy. Irafan (2005) argued that the major concerns in the agricultural technology transfer process are what technologies are appropriate and available, and how these technologies can be disseminated among farmers.

According to Rogers (2003), compatibility and complexity, or the degree to which an innovation fits within the socio-cultural framework and the perceived difficulty of use, are directly related to its likelihood for adoption and use. Therefore, the frequent use of voice call is a "snapshot" of the early stages of the diffusion process, the primary needs of mobile phone users may solely be for voice calling. As time goes back and experience with the frequent usages of the mobile phone continues to grow, the SMS, accessing internet, email whatsapp and other applications may become more compatible with the needs of the user, especially the literate ones.

Perceived Competency Levels of Farmers and AEAs in the Use of Mobile Phone

Table 26 presents the competency level of farmers and AEAs on use of mobile phone. Twelve items gather from literatures were constructed to measure both farmers and AEAs competency levels. The mean values ranged from 4.80 for calling to 1.07 chatting on twitter.

The AEAs perceived their competencies in calling (Mean=4.80, SD=0.50), receiving text message (Mean =4.38, SD=.74), sending text message (M=4.56, SD=0.65) and listening to radio (Mean= 3.76, SD=1.62) on mobile phone to be high. The farmers perceived only their competency in calling (Mean=4.52, SD=0.64) to be high also. Farmers also perceived their competency in using radio on mobile phone to be moderate (Mean 2.51, SD=1.69).

Both farmers and AEAs perceived their competencies in receiving/ sending social media services, video calling on phone, and chatting on twitter to be very low. Again, farmers and AEAs perceived their competencies in using mobile phone to access internet, email and facebooking (Mean = 1.29) to be very low and low respectively.

Table 26: Competency Level of Farmers and AEAs Mobile Phone Services Use

Competency Area	AEAs (N=91)		Farmers (N=315)	
	Mean	SD	Mean	SD
Calling (Voice calls)	4.80	0.50	4.52	0.60
Receiving text message	4.56	0.65	2.30	1.29
Sending text message	4.38	0.74	2.29	1.28
Listening to radio on phone	3.76	1.62	2.51	1.69
Accessing internet	2.60	1.70	1.29	0.94
Accessing email	2.49	1.66	1.29	0.88
Sending or receiving whatsapp	2.44	1.80	1.29	0.92
Chatting on face book	2.43	1.75	1.29	0.95
Receiving multimedia service	1.30	0.94	1.07	0.38
Sending multimedia service	1.27	0.88	1.06	0.33
Video calling on phone	1.23	0.70	1.05	0.24
Chatting on twitter	1.07	0.25	1.03	0.24

Source: Field Survey Data, 2014. Mean calculated from a Scale of: 1= Very low, 2= Low, 3= Moderate, 4= High, 5= Very high

Table 27 presents the differences in competency level between farmers' and AEAs in the use of mobile phone in extension delivery. The means and standard deviation show that farmers (Mean=1.98, SD=0.64) had low competency whilst AEAs (Mean=2.95, SD=0.69) had moderate competency in the use of mobile phone in extension delivery. The independent t-test shows that there is a statistically significant (P=0.00) difference between AEAs and farmers competency in the use of mobile phone

Table 27: Difference in Mobile Phone Use Competency between Farmers and AEAs

Group	N	Mean	SD	Mean difference	T	P-value
Farmers	315	1.98	0.64	0.97	12.03	0.00**
AEAs	91	2.95	0.69			

Sources: Field Survey, 2014 $p<0.01$ n=406

Means were calculated from a Scale: 1= Very low, 2= Low, 3= Moderate, 4= High, 5= Very high

Therefore, the null hypothesis that there is no significant difference between farmers and AEAs competency levels in the use of mobile phone is rejected and the alternative hypothesis is accepted.

Perceived Benefits Derived from Use of Mobile Phone

Rogers (2003) argued that the primary reason for adoption is the perceived relative advantage that the innovation will be better than the existing one. Table 28 presents the findings on benefits obtained from use of mobile phone by farmers and AEAs. Farmers moderately agreed (Mean =3.34, SD= 1.07) that mobile phone helps in timely acquisition of price, markets and good agricultural practices information, while AEAs (Mean=3.91, SD=0.17) agreed. Similarly, while farmers agreed (Mean=3.69, SD=0.86) that mobile phone reduce the risk of theft, AEAs moderately agreed (Mean=3.10, SD=1.03).

Table 28: Farmers and AEAs Perceived Benefits of Using Mobile Phone

Benefits	AEAs (N=91)		Farmers (N=315)	
	Mean	S. D	Mean	S. D
Reduce transportation / travelling cost	4.22	0.84	4.11	0.67
Timely acquisition of price, markets and good agricultural practices information	3.91	0.85	3.34	1.07
Improve communication skill with suppliers/customers and AEAs	3.88	0.82	3.78	0.87
Improve product/service delivery	3.86	0.81	3.73	0.97
Easy to connect with co-farmers fast as producer, traders and buyers	3.85	0.89	3.66	1.06
Increasing farmers profit	3.66	0.92	3.60	0.86
Lowering of operational cost /increased saving	3.65	1.06	3.32	0.88
Reducing risk / theft	3.10	1.03	3.69	0.86

Source: Field Survey Data, 2014. Scale: 1= Strongly Disagree, 2= Disagree, 3= Moderately Agree, 4= Agree, 5= Strongly Agree

On the other hand, whilst AEAs agreed (Mean =3.65, SD=1.06) mobile phone reduce the cost of operations or increase savings, farmers moderately agreed (Mean=3.32, SD=0.88). Both AEAs and farmers agreed that mobile phone reduce transportation/travel cost; improved communication with supplier/customers or AEAs; helped to easily connect with value chain actors

such fast as producers, traders and buyers; improved product delivery and increase farmers profit (Mean ranged from 3.66 to 4.22) as shown in (Table 28). However, in all cases, AEAs were more emphatic than farmers, since the means for AEAs were greater than farmers.

The finding supports Mittal, and Mehar, (2012); Aker (2008); Jensen (2007) and Overa's (2006) whose findings revealed that mobile phone use helped to improve communication networks between farmers and AEAs and reduce cost of travelling. However, according to Rogers (2003), one factor that influences adoption is the consequences. He classified consequences into five stages such as knowledge, persuasions, decision, implementation and confirmation. In the context of this study, confirmation is termed as the benefits. "Confirmation" is defined as where the adopter seeks information about the innovation and either continues or discontinues the use of the innovation. Based on the finding, and the confirmation provided by respondents there is no doubt that mobile phone has the potential to enhance extension delivery in Eastern Region of Ghana.

Challenges of using Mobile phone by Farmers and AEAs in Extension Delivery

The study shows AEAs (Mean= 3.31, SD=1.00) and farmers (Mean=3.09, SD= 1.16) perceived high call tariffs challenge in mobile phones use. AEAs and farmers perceived no reception, unreliable network coverage, calls ending unexpectedly and poor sound quality or breaking up of sound as somehow a challenge in mobile phone use, whilst farmers perceived their inability to send or receive text messages (Mean= 3.38, SD=1.25) was a challenge and language

barrier (Mean=2.37, SD=1.207) as somehow a change as well. The study conforms to Kwakwa's (2012) findings that challenges faced by mobile phone user are no reception/unreliable network coverage, cost of using phone, customer services and phone functionality.

Table 29: Challenges in Using Mobile Phone by AEAs and Farmers for Extension Delivery

Challenges	AEAs (N=91)		Farmers (N=315)	
	Mean	SD	Mean	SD
High call tariff	3.31	1.00	3.09	1.16
Cost of recharge card	3.12	1.07	2.78	1.13
No reception/ Unreliable network coverage	2.38	0.95	2.20	1.03
Calls end unexpectedly	2.34	0.92	1.97	0.73
Poor sound quality/breaking up of sound	2.34	0.85	2.12	0.97
Unable to send/ receive text message	1.47	0.91	3.38	1.25
Electricity for charging phone battery	1.43	0.72	1.76	1.12
Unable to send/ receive calls	1.35	0.74	1.38	1.24
Access to recharge purchasing centre	1.18	0.38	1.48	0.75
Language barrier/ Illiteracy	-	-	2.37	1.20

Source: Field Survey Data, 2014. Means calculated from a Scale of: 1 = Not a serious challenge (NSC), 2 = Somehow a challenge (SHC), 3 = Challenge (C), 4 = Serious challenge (SC), 5 = Very serious challenge (VSC)

Arokoyo (2005) reported similar findings on challenges affecting the use of ICTs in Nigeria. The challenges include erratic and unstable power supply,

difficulty in connectivity, high call tariff, high costs of telephone services, limited access to computers and high level of rural poverty and illiteracy. However, AEAs (Mean=1.43, SD=0.75) and farmers (Mean=1.76, SD=1.12) perceived that electricity for charging phone battery is not a serious challenge. This conforms to Gupta and Sullivan's (2010) finding that among other West African countries, in Ghana, access to electricity is more reliable.

The Relationship between Frequent Use of Mobile Phones, Socioeconomic and Background Characteristics of Farmers

A correlation showing the relationship between frequent use of Mobile phone and socioeconomic and background characteristics of farmers is presented in Table 30. To estimate the relationship between frequent use of mobile phone and the background characteristics, variables were estimated as follows: the overall frequent use of mobile phone was estimated as composite mean (Y) from (voice calls, short message sent/received, accessing internet and e-mails, whatsApp, facebook, multimedia service, video callings or conferencing and radio on mobile phone).

The result on Table 30 shows that out of the twelve variables that relates to frequent use of mobile phone four (4) were significant at 0.05alpha levels. Therefore the null hypothesis that there is no significant relationship between socioeconomic and mobile phone background characteristics of farmers and frequent use of mobile phone is rejected and the alternative hypothesis accepted. There was positive but significant relationship between education (r=0.12, p=0.00) and frequency of use of mobile phone. The higher the education of

farmers the more frequently they use mobile phones. This result supports findings of DiMaggio and Cohen (2004) that education positively and significantly relates to mobile phone use.

Table 30: Distribution of Relationship between Frequent Use of Mobile Phone and Socioeconomic and Background Characteristics of Farmers

Independent variables	Correlation Co-efficient	P-value	Type of correlation	Strength of relationship
Sex ($X_{1)}$	-0.05	0.43	Point Biserial	-
Age ($X_{2)}$	-0.05	0.43	Pearson	-
Education level ($X_{3)}$	0.12	0.00	Spearman	Low
Marital status X_4	0.05	0.38	Point Biserial	-
Household size X_5	-0.10	0.07	Pearson	-
Number of years farming X_6	0.04	0.48	Pearson	-
Farm size X_7	0.07	0.19	Pearson	-
Number of years in using mobile phone X_8	-0.03	0.60	Pearson	-
Amount spent per week X_9	0.16	0.00	Pearson	Low
Farmer's Cooperative X_{10}	0.18	0.00	Point Biserial	Low
Quality of network X_{11}	0.12	0.00	Pearson	Low
Types of mobile phone X_{12}	-0.00	1.04	Point Biserial	-

Source: Field Survey Data, 2014 **p<0.01 level (2-tailed) *P<0.05 level (2-tailed)

The study reveals that amount of money spent per week on mobile phones has a positive and significant ((r=0.16, P=0.00) relationship with frequent use of mobile phone. Thus the more farmers use on mobile phones the more they spent on it. The result is in agreement with common sense, and with Vishwanath and Goldhabe (2003) and Poulton, Kydd and Dorward (2006).

The study also shows that membership of farmers to cooperatives has a positive and significant ((r=0.18; P=0.00) relationship with frequent use of mobile phone in extension delivery. Farmers who belong to cooperatives use mobile phone more often than those who do not. Similar result was found by Falola, Adewumi and Olaniyi (2013) that membership positively and significantly relates to use of mobile phones. The quality of network reception has a positive and significant (r=0.12, P=0.00) relationship with frequent use of mobile phone in extension delivery.

Factors Influencing Farmers' Frequent Use of Mobile Phones in Agricultural Extension Delivery

To determine the best socioeconomic and background characteristics that determine frequent use of mobile phone by farmers, the factors that showed significant relationship (farmers' education, income, and quality of network reception) were inputted into multiple linear regression. The results of the regression analysis using the stepwise regression method presented in Table 31 revealed that amount of money spent per week on credit and quality of network reception best predict frequent use of mobile phone together accounted for (r^2= 0.04%) of all the variance. The result also indicated that for every unit (0.02)

increase in amount of money spends on credit, a (0.18) increase in frequency use of mobile phone is expected and for every unit (0.02) increase in network quality, a (0.15) increase in frequency use of mobile is expected.

Table 31: Best Predictors of Socioeconomic and Background Characteristics on the Frequent Use of Mobile Phone for Extension Delivery for Farmers

Predictors	Step to enter	Beta Standardized	R^2	Adjust. R^2	Adjust. R^2 Change	S. E.E	F	P-value
X_9	1	0.18	0.03	0.02	0.03	0.95	8.16	0.01
X_{11}	2	0.15	0.05	0.04	0.02	0.94	7.06	0.01

n=315 **P< 0.01 level (2-tailed) *P< 0.05 level (2-tailed) Source; Field survey 2014

Y= Dependent variable (frequency of use of mobile phone)

X_9=Amount of money spent on credit per week

X_{11}=Quality of network reception

Regression equation (from unstardise ßeta)

$Y=C+ß_9+ß_{11}=0$

$Y= 1.81+ 0.18\,X_9+ 0.15X_{11,}$

$Y_= 1.81$ if $ß_9=ß_{11}$

The result is consistent with Vishwanath and Goldhabe (2003) and Poulton, Kydd and Dorward's (2006) findings that low incomes hamper smallholder farmers' level of technology adoption. In addition, a recent study conducted by Dereje, Mamo and Haji (2014) reported that income positively and significantly relates to the use of ICTs in agricultural extension. This implies that farmers with more income are able to frequently use the mobile phone to seek for information in relationship to their production. Moreover, incomes empower farmers in term of decision-making. For example, a farmer who is financially endowed is able to report any emergencies on the farm without any delay. This also means that even though with the penetration of mobile phone and with the timely information delivery, the poor farmers' problem of accessing relevant agricultural information is not yet solved. That is, though the farmers may have mobile phones, they do not have money to effectively and efficiently use it in extension delivery. One may say that farmers do not need to call because AEAs will call but the question is when and how often? Therefore, farmers should be empowered financially to be able to fully use the mobile phone for extension delivery. For example, since they (farmers) are registered farmers under AEAs, the AEAs can monitor their productions and incomes generated. With this, the AEAs can link them with a reliable credit union in other to be able to access credits. Additionally, since there are more farmers in cooperative associations, MoFA can consider a policy that aims at training farmers cooperatives to establish a village saving and loans scheme which they can borrow from and pay back with small interest as a source of income to improve their use of technology

and production. Conscious effort should be made by network operators in the Eastern Region to improve their services' quality for smooth communication and operations in extension delivery.

The Relationship between Frequency of Use of Mobile Phones, Socioeconomic and Background Characteristics of AEAs

A correlation table showing the relationship between frequent use of Mobile phone and socioeconomic and background characteristics of AEAs is presented in Table 32. To estimate the relationship between frequent use of mobile phone and the background characteristics, the similar process was done for the AEAs. Y= Frequent Use of Mobile Phone.

The result presented in Table 32 shows that there were significant relationships between the ten (10) (independent) variables and frequent use of mobile phone for extension delivery expect for sex (r=0.03), number of years in using mobile phone (r=-0.10) and marital status (r= 0.44) at 0.05 Alpha level.. Therefore, the null hypothesis that there is no significant relationship between socioeconomic and mobile phone background characteristics of AEAs and frequent use of mobile phone is rejected and the alternative hypothesis accepted.

The variables that show inverse and moderate significant relationship with frequent use of mobile phone in extension delivery were: age (r= -0.54); household size (r= -0.31) and working experience (r = -0.48). The result on age indicates that young extension agents use mobile phone more frequently compared to old ones.

Table 32: Distribution of Relationship between Frequent Use of Mobile Phone and Socioeconomic and Background Characteristics of AEAs

Independent variables	Correlation Co-efficient	P-value	Type of correlation	Strength of relationship
Sex X_1	0.03	0.76	Point Biserial	-
Age X_2	-0.54	0.00	Pearson	Moderate
Education level X_3	0.26	0.00	Spearman	Low
Marital status X_4	-0.04	0. 76	Point Biserial	-
Household size X_5	-0.31	0.00	Pearson	Moderate
Number of years working X_6	-0.48	0.00	Pearson	Moderate
Number of years in using mobile phone X_7	-0.10	0.36	Pearson	-
Amount spent per week X_8	0.43	0.00	Pearson	Moderate
Quality of network X_9	0.07	0.49	Pearson	-
Types of mobile phone X_{11}	-0.71	0.00	Point Biserial	Substantial

Source: Field Survey Data, 2014 Significant ($p<0.01$ level (2-tailed) $P<0.05$ level (2-tailed).

This corroborates the finding of Okello, Kirui, Njirani and Gitonga (2012), Williams and Agrbo (2013), Munya (2001) and Porcari (2010) who concluded that young people are far more known with new media (social networking and

other recent advances in technologies) use than with the older ones. They explained that the new communication technologies, in many cases, are strange to the older generation. In terms of household size, the implication is that AEAs with smaller household size most often use the mobile phones in agricultural extension delivery than the older AEAs who have large families to carter for. The result is consistent with Dereje, Mamo and Jema's (2014) finding in Ethiopia. They found household size to be significant at ($P<0.01$) and negatively related with the use of ICTs. Additionally, Yakubu, Abubakar, Atala, Muhammed and Abdullahi (2013), in Nigeria found similar result.

Furthermore, the inverse working experience of AEAs with frequency of use of mobile phone means that AEAs with working experience below the (Mean=18.45) years frequently use the mobile phone more than AEAs with 18 years and above working experience. Similar result was found in Muhamman *et al*. (2008) findings in Pakistan that AEAs having less experience had higher computer skills than AEAs with longer job experience. They stated that the length of experience is related to the age and the year when AEAs graduated. They further argued that the younger AEAs with less job experience graduated comparatively recently when the computer subjects were included in the scheme of studies in agricultural educational institutions and as a result, junior AEAs had greater computer skills or ICTs than senior AEAs.

On the other hand, variables that show positive and significant ($P<0.05$) relationship with frequent use of mobile phone were: education ($r=0.21$); amount of money spent per week ($r=0.43$) and type of mobile phone use ($r=0.71$) which

show a substantial relationship. The positive and significant relationship of education with the frequent use of mobile phone implies that the more educated the AEAs are, the more they utilize the mobile phone in extension delivery. The finding is consistent with DiMaggio and Cohen's (2004) findings that education positively and significantly relates to mobile phone use.

In order to make maximum use of the mobile phone and obtain the benefits offered by the network providers (such as internet bonus, free SMS and free calls), one has to recharge before accessing these benefits. Therefore, is not surprising that incomes or money spent per week positively and significantly correlates with frequent use of mobile phone in extension delivery. This means AEAs with higher incomes are likely to use the mobile phone more often in extension delivery than lower incomes AEAs. The study supports (Vishwanath & Goldhaber, 2003; Poulton, Kydd & Dorward, 2006; Dereje, Yared, & Jema, 2014) findings that low incomes hinder technology adoption.

As shown on Table 33, type of mobile phone shows substantial and significant ($P<0.01$) relationship with frequent use of mobile phone. This indicates that AEAs who own Smartphone most often use the mobile phone more than AEAs with ordinary mobile phones. Moreover, those AEAs using the Smartphone can be considered as the younger AEAs with less working experience and probably with small number of children or no children who are more likely to use almost all their salary to buy a Smartphone than the older AEAs who have more children and other social responsibilities to settle. Another reason is, because of their early exposure to ICTs use in recent years; either studies in

agricultural institutions or by their peers motivated them to use Smartphone which will keep them in close contact with friends and family far away as stated by Muhamman et al. (2008) that younger AEAs with less job experience graduated comparatively recently when the computer subjects were included in the scheme of studies in agricultural institutions and as a result, junior AEAs had greater computer skills than senior.

Factors Influencing AEAs' Frequent Use of Mobile Phones in Agricultural Extension Delivery

The results presented in Table 33 show that type of mobile phone, amount of money on credit spent per week and age (independent) variables were the best predictors of frequent of use of mobile phone by AEAs. Together, these variables accounted for a total of (r^2 =0.55% of all the variance in AEAs' frequent use of mobile phone. In addition, the results signify that for every unit (0.49) increase in types of mobile phone, a 0.52 increase in frequency use of mobile is expected. Also for every unit (0.03) increase amount of money spent on credit per week, a 0.34 increase in frequency use of mobile phone is expected and for every unit (0.03) increase in age, a 0.20 increase in frequency use of mobile phone is expected.

Table 33: Best Predictors of Socioeconomic and Background Characteristics on the Use of Mobile Phone in Extension Delivery for AEAs

Predictors	Step to enter	Beta Standardize	R^2	Adj. R^2	Adj. R^2 Change	S. E.E	F	Sig.
X_{11}	1	0.52	0.50	0. 49	0.49	0.48	86.34	0.00
X_8	2	0.34	0.53	0.52	0.03	0.56	7.20	0.00
X_2	3	0.20	0.66	0.55.	0.03	0.45	6.10	0.01

n=91, **P< 0.01 level (2-tailed) * P< 0.05 level (2-tailed) Source; Field Survey 2014

Y= Dependent variable (frequency of use of mobile phone)

X_{11}= Type of Mobile Phone

X_8= Amount of Money Spent Per Week and

X_2= Age.

Regression equation (from unstandardized ßeta)

$Y=C+ß_{11}+ß_8+ß_2= 0$

$Y=0.16 + 0.52X_{11}+ 0. 34X_{8 +} 0.20X_2;$

$Y=0.16$ if $ß_{11}= ß_8=ß_3$

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

The chapter presents a summary and conclusions from the findings of the study. The recommendations and suggestions for further study are also provided.

Summary

The rapid growth and penetration of mobile phone to most remote areas and its potential in contributing to the spread of agricultural technologies to farmers prompted the Ministry of Food and Agriculture to adopt it for extension delivery. However, very little is known about the competencies and frequency at which farmers and extension agents use mobile phone in extension delivery in the Eastern Region of Ghana. This study assessed the frequent use of mobile phone in agricultural extension delivery in the Eastern Region of Ghana. Specifically, the study sought to:

1. Describe the socio-economic and mobile phone use background characteristics of farmers and extension agents.
2. Determine the frequent of mobile phone usage by farmers and extension agents for extension delivery in the study area.

3. Compare the competencies of farmers and extension agents in the use of relevant applications of mobile phones in extension delivery.
4. Determine factors that influence the use of mobile phone applications for extension purposes by extension agents and farmers.
5. Identify the benefits farmers and extension agents get from use of mobile phones.
6. Examine challenges with use of mobile phone in extension delivery.

Descriptive correlational survey was used to explore the problem. The target population consisted of agricultural extension agents (AEAs) and their respective registered farmers in Eastern Region of Ghana. A multi-stage sampling was used to select 95 AEAs and 330 farmers from five districts namely Fanteakwa, Kwahu South, Yilo Krobo, Akuapem South, and Upper Manya in Eastern Region. The main findings of the study are summed up under the following sub headings.

Summary of key findings

Socioeconomic and Background Characteristics of Farmers and Extension Agents

Majority of AEAs operate in rural setting where farmers are located. There were more male AEAs and farmers than female but the average age of farmers and AEAs are almost equal. Majority of respondents are found within 40 and 59 years. The AEAs were more formally educated than the farmers. There were more married AEAs and farmers than single or unmarried ones. There are

more people in the household of farmers than AEAs. Farmers and AEAs had very similar years of working experience. Most farmers cultivated five acres of land or less. Majority of farmers spent between 1 and 5 Ghana cedis on mobile phone per week whilst AEAs spend 6.00 to 10.00 Ghana cedis per week. MTN and Vodafone were the highly subscribed service providers. Farmers in the study areas belonged to farmer association and mainly produced crops.

While farmers mainly used information from co-farmers, extension agents and friends, AEAs use workshop, colleague extension agents, radio and researchers. Farmers and AEAs use only one ordinary mobile phone. Majority of farmers and AEAs have used mobile phones between 6 to 10 years. They considered the coverage, good reception, promoting services such as provision of bonus for recharging a card or making a call as a reason for subscribing to a network in choosing a network.

Uses of Mobile Phone in Extension Delivery

In terms of extension delivery, majority of AEAs used mobile phone to schedule meetings with farmers, send text message information to farmers and receive text message information. However, farmers used mobile phone to receive marketing and sales information. Few used of mobile phone included accessing agricultural information on internet, money transfer, reporting, listening to agricultural radio programmes. Types of agricultural information AEAs and farmers use mobile phone to access were market information, cultural practices, and new variety of crop, weather information and recommended fertilizer use and post harvest.

Frequency of Use of the Mobile Phones by Farmers and AEAs for Agricultural Extension Delivery

AEAs and farmers did voice call more than four times a week. AEAs used mobile phone twice a week to access internet, email and whatsApping. Both AEAs and farmers had never used video calling/conference or received or sent multimedia or chatted on twitter. In addition, farmers had never used mobile phone to access internet, email and whatsApping.

Perceived Competency Levels of Farmers and AEAs in the Use of Mobile Phone

Farmers were highly competent only in using mobile phone for voice calls and listening to radio. They had low competence in all other applications. AEAS were however competent in all application expect for accessing the internet, email, facebook, chatting on twitter and video calling.

Perceived Benefits Derived from Use of Mobile Phone

Farmers and extension agents agreed that mobile phone helps in timely acquisition of price, markets and good agricultural practices information and reduce the risk of theft; reduce the cost of operations and increase savings. Both agreed that mobile phone reduce transportation/travel cost; improved communication with supplier/customers or AEAs; helped to easily connect with co-farmers fast as producer, traders and buyers; improved product delivery and increase farmers profit.

Challenges of using Mobile phone by Farmers and AEAs in Extension Delivery

AEAs and farmers perceived high call tariffs, no reception, unreliable network coverage, calls ending unexpectedly and poor sound quality or breaking up of sound as challenge in the use of mobile phone. Electricity for charging phone battery is not a serious challenge in the Region.

The Relationship between Frequent Use of Mobile Phones, Socioeconomic and Background Characteristics of Farmers

There is significant relationship between socioeconomic, mobile phone background characteristics of farmers and frequent use of mobile phone. The higher the education of farmers the more frequent they use mobile phones. The more farmers spent on mobile phones the more they use it. Farmers who belong to cooperatives used mobile phone than those who do not. The amount of money spent per week and quality of network reception were the best predictors of frequent use of mobile phone by farmers.

The Relationship between Frequency of Use of Mobile Phones, Socioeconomic and Background Characteristics of AEAs

There is significant relationship between socioeconomic and mobile phone background characteristics of AEAs and frequent use of mobile phone by AEAs. Young extension agents use mobile phone more frequently compared to older ones. AEAs with smaller household size most often use the mobile phones in agricultural extension delivery than the AEAs who have large families. AEAs with less working experience frequently use the mobile phone more than AEAs

high working experience. The more educated the AEAs the more they utilized mobile phone in extension delivery. AEAs with higher incomes use mobile phone more often in extension delivery than lower incomes. AEAs who own Smartphone most often used the mobile phone more than AEAs with ordinary mobile phones. The type of mobile phone, amount of money spent per week and age were the best predictors of frequent of use of mobile phone by AEAs.

Conclusions

Based on the findings of this study, the following conclusion can be drawn:

1. Farmers use diverse sources for information in addition to information from AEAs.
2. Farmers and AEAs use mobile phone differently in extension delivery. Whilst AEAs use mobile phone to schedule meetings with farmers, send and receive text message information to farmers and receive text message information. Farmers use mobile phone to receive marketing and sales information. However both will like to use mobile phone to access market information, cultural practices and new variety of crop, weather information, recommended fertilizer use and post harvest.
3. AEAs and farmers frequency use voice call mobile phone application than others. Internet, email and whatsApping are recent mobile phone applications used by few AEAs. Farmers do not use many of recent

mobile phone applications. Because majority of them use ordinary mobile phones which do not have the feature of Smartphone.

4. There is a significant difference between AEAs and farmers' competency in the use of mobile phone. AEAs are significantly more competent than farmers in the use of mobile phones for extension delivery.
5. Farmers and extension agents consider mobile phone as help in extension delivery.
6. AEAs and farmers perceived challenges to using of mobile phone for extension delivery include high call tariffs, no reception, unreliable network coverage, calls ending unexpectedly and poor sound quality or breaking up of sound.
7. The socioeconomic and mobile phone background characteristics of farmers influence the frequency use of mobile phone for extension delivery.
8. The amount of money spent per week and quality of network reception are important factors that influence the frequent use of mobile phone by farmers.
9. The socioeconomic and mobile phone background characteristics of AEAs relate to frequent use of mobile phone by AEAs. The type of mobile phone, amount of money spent per week and age are the main factors that influence the frequent of use of mobile phone by AEAs.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. The study recommends that MOFA and Ministry of Communication in Ghana to strike a special deal that would facilitate the use of their network for inexpensive extension delivery. For example, the service provider may be given tax incentives to channel some of their profit to subsidise extension delivery.
2. Mobile phone service providers should provide short codes to AEAs and farmers to be used as a platform for extension delivery. This will help ease the problem of access to recharge credit leading to frequent use of the mobile phone for agricultural purposes.
3. The farmer associations should also be resourced to support training of farmers to use mobile phones in order to improve their communication through mobile phone use.
4. The AEAs and the farmers are literate and are able to utilize the mobile phone, especially for voice calls, therefore extension messages designed by MOFA and NGOs must be in the medium that both AEAs and farmer will understand. One example is by incorporating voice-based agricultural services into the current SMS-based agricultural services being provided by ESOKO and other actors in Ghana to further enhance the communication system in delivering extension messages to farmers in Eastern Region.

5. MOFA should recruit more young people in the extension field. During the recruitment, more females should be considered in other to fill the gap of gender disparity. This will help to avoid some gender related social problems associated with mobile phone use.
6. Again, MOFA should liaise with service providers to put Farmers and AEAs in a training workshop for training in video calling/conferencing, multimedia service, Internet and email, whatsApping and facebooking new mobile phone applications to boost their competencies, and help improve communication channels between AEAs, farmers, researchers and MOFA.
7. MOFA should consider putting in place a policy to train all farmer cooperative associations to establish savings and loans schemes from which farmers or AEAs can borrow and pay back with small interest. This will help to improve their use of technology and production.

Further Studies

The study recommends that:

1. The study is replicated in all Regions of Ghana so that a comprehensive policy for using mobile phone for extension delivery in Ghana could be developed.
2. The use of mobile phone by other actors such as researchers, input dealers in the extension delivery should be explored.

REFERENCES

Abraham, R. (2006). Mobile phones and economic development: Evidence from the dishing industry in India. *Information Technology International Development, 4* (1), 5–17.

Agresti, A. & Finlay, B. (2008). *Statistical methods for the social sciences (4th Ed.)* Hardcover: Pearson.

Akanda, A. K. M., & Roknuzzaman, M. D. (2012). Agricultural information literacy of farmers in the northern region of Bangladesh information and knowledge management. *International Journal of Education and Development using Information and Communication Technology, 2* (6), 2224-5758.

Aker, J. C. (2011). Dial "A" for agriculture: A review of information and communication technologies for agricultural extension in developing countries. *CGD Working Paper 269*. Washington, D.C.: Center for Global Development.

Aker, J. C., Mbiti, I. M. (2010). Mobile phones and economic development in Africa. *Journal of Economic Perspectives, 24* (3), 207-232.

Aker, J. C. (2008). Does digital divide or provide? The impact of cell phones on grain markets in Niger. *Center for Global Development Working Paper*, (15), 41-61.

Akpabio, I. A., Okon, D. P., & Inyang, E. B. (2007). Constrains affecting ICT utilization by agricultural extension officers in the Niger Delta, Nigeria. *Journal of Agricultural Education and Extension, 13*, (4), 263-272.

Albu, M., & Scott, A. (2001). Understanding livelihoods that involve micro-enterprise: Markets and technological capabilities in the SL framework. *Intermediate Technology Development Group (ITDG), 1* (2), 1-19.

Alemna, A. A., & Sam, J. (2006). Critical issues in information and communication technologies for rural development in Ghana. *Information Development, 22* (4), 236-241.

Alexander, B., Siderides, E., Koukouli, & Antonopoulon, A. (2010). ICT and Farmers: Lessons learned and future developments. *Journal of Agricultural Informatics, 1* (2), 35-41.

Ali Hassan, O.K., Maimunah, I., Turiman, S., & Abu Daud, S. (2008). Extension worker as a leader to farmers: Influence of extension leadership competencies and organisational commitment on extension workers' performance in Yemen. *The Journal of International Research, 2 (1),* 368-387.

Ali, S., Ahmad, M., Tanvir, A., & Muhamad, I. Z. (2009). Analysis of competencies possessed by field staff of private agricultural system in Punjab, Pakistan. *Journal of Agriculture Research, 4* (7), 101-106.

Ammani, A. A., Sani, B. M., Kura, H. N., & Hussaini, Y. (2011). An assessment of agricultural extension services in irrigation schemes under RBDAs' control in Nigeria: The case of Kano river irrigation project. *Journal of Agricultural Extension and Rural Development 3* (1), 13-18.

Aminuzzaman, S., Baldersheim, H., & Jamil, I. (2003). Talking back! Empowerment and mobile phones in rural Bangladesh: A study of the village phone scheme of Grameen Bank. *Contemporary South Asia, 1* (2), 327-348.

Annor-Frempong, F., Kwarteng, J., Agunga, R., & Zinnah, M. M. (2006). *Challenges and prospects of infusing information communication technologies (ICTs) in extension for agricultural and rural development in Ghana.* Proceedings of the 22nd Annual Conference of Association for International Agricultural and Extension Education (AIAEE), Clearwater Beach, Florida.

Ansari, M. A., & Pandey, N. (2013). Assessing the potential and use of mobile phones in agriculture, Kamantaka. *Journal of Agricultural Science, 2* (6), 388-392.

Apantaku, S. O., Awotunde., & Folorun, M. A. (2001). Target agencies, awareness and implementation of universities agricultural based research recommendation. *Asset Series, 2* (1), 41-150.

Arokoyo, T. (2005). ICTs application in agricultural extension services delivery. In S.F. Adedoyin (Ed): Agricultural extension in Nigeria (pp 245-251). Ilorin: Agricultural and rural management training institute.

Armstrong, M. (2006). *A hand book of human resource management practices* (2nd ed.) London: Kogan Page Ltd.

Asharf ,M.Y., Akhtar, K., Sarwar, G., & Ashraf, M. (2005). Role of the rooting system in salt tolerance potential of different guar accessions. *Agronomy for Sustainable Development, 25* (2), 243-249.

Avgerou, C. (2010). Discourse on ICT and development. *Information Technologies & International Development, 3* (6) 1–18.

Babbie, E. (1990). *Survey research methods* (2th ed). Belmont, CA: Wadsworth.

Best, J. W., & Kahn, J. V. (1998). *Research in education* (8th Ed.). Needham Heights: Allyn and Bacon.

Bergevoet, R. H. M., & Woerkum, C. V. (2006). Improving the entrepreneurial competencies of Dutch dairy farmers through the use of study groups. *Journal of Agricultural Education and Extension, 1* (2), 25-39.

Bhavnani, A., Chiu, R., Janakiram, W. & Silarsky, P. (2008). *The role of mobile phones in sustainable rural poverty reduction*. (ICT policy division, global information and communications Department, Washington, DC:) World Bank.

Birke, D., & Swann, G. M. P. (2006). Network effects and the choice of mobile operator. *Journal of Evolutionary Economics, 16* (1), 65-84.

Birner, R., Davis, K., Pender, D., Nkaonya, E., Anandjayasekeram, P., Ekboir, & Cohen, M. (2009). From best practice to best fit: A framework for designing and analyzing pluralistic agricultural advisory services worldwide. *Journal of Agricultural Education and Extension, 15* (4), 341-355.

Butt, S. A. (2002). *Role of television in the dissemination of agricultural technologies among the farmers of tehsil Faisalabad.* Unpublished Master's thesis, University of Agriculture, Faisalabad, Pakistan.

Chizari, M., Lindner, J. R., & Zoghie, M. (2009). Perception of extension agents regarding sustainable agriculture in the Khorasan province Iran. *Journal of International Agriculture and Extension Education, 6* (1), 3-21.

Corrocher, N., & Zirulia, L. (2008). Me and you and everyone we know: An empirical analysis of local network effects in mobile communication. *Journal Telecommunications Policy, 33*(12), 68-79.

CIMMYT (1993). The adoption of agricultural technology: *A guide for survey design*. Mexico, D. F: CIMMYT.

Crandall, A. (2011). Kenyan farmers' use of cell phones: *Calling preferred over SMS*. Third international conference on mobile communication for development, New Delhi, India.

CTA (2003). *Information for agricultural and rural development in ACP countries*: New stakeholder, new media and priority theme. Technical Centers for Agricultural & Rural Cooperation (CTA) Wageningen: CTA.

Das, A., Basu, D., & Goswami, R. (2012). Accessing agricultural information through mobile phone: Lessons of LKSL services in West Bengal. *Indian Research Journal of Extension Education 12*, (3), 102-107.

Davis, K. E., & Asenso-Okyere, K. (2010). Innovative models of agricultural extension: Dominants of e-learning acceptance *Computers in Human Behavior, 22* (5) 816-829.

De Silva, H. & Ratnadiwakara, F. (2008). *Scoping study: ICT and rural livelihoods–South Asia component (Draft), international development research centr*e, New Delhi: SDIP and Sang e-Mill.

Dedeoglu, A. (2004). The symbolic use of mobile telephone among Turkish consumers. *Journal of European Marketing, 13* (2), 143-162.

Demiryurek, K., Erdem, H., Ceyhan, V., Atasever, S., & Mayıs, O. U. O. (2008). Agricultural information systems and communication networks: The case of dairy farmers in the Samsun province of Turkey. *Information Research, 13* (2), 1-13.

Dereje, D., Yared, M., & Jema, H. (2014). Analyzing socio-economic factors affecting the use of information and communication technologies among

farmers in central highlands of Ethiopia. *African Journal of Agricultural Science and Technology, 2* (8), 163- 171.

Dillon, T. (2011). Migratory response to agricultural risk in Northern Nigeria. *American Journal of Agricultural Economics, 93* (4), 1048-1061.

DiMaggio, P., & Cohen, J. (2004). Information inequality and network externalities: A comparative study of the diffusion of television and the Internet. In V. N, R. Swedenberg, & M. Y. Abolafia (Ed.), *The economic sociology of capitalism* (pp-81) Princeton, NJ: Princeton Univeristy Press.

Donner, J. (2008). Research approaches to mobile use in the developing world: A review of the literature. *Information Society, 24* (3), 140–159.

Elly, T., & Silayo, E. E. (2013). Agricultural information needs and sources of the rural farmers in Tanzania: A case of Iringa rural district, *Library Review, 62* (89), 547 –568.

Falola, A., & Adewumi, O. M., Olaniyi, A. (2013). Impact of mobile telephony on technical efficiency of farmers in Nigeria. *Journal of Sustainable Development in Africa, 15* (6), 86-100.

Falola, A., & Adewumi, O. M., Olaniyi, A. (2012). Constraints to use of mobile telephony for agricultural production in Ondo State, Nigeria. *Journal of Research in Agricultural Extension, 2 (1), 19-27.*

FAO, (2009). *The potentials of microcomputers in support of agricultural extension, education and training*. Rome: FAO.

Farooque, S. (2004). *The present and prospective role of print media in the dissemination of agricultural information among the farmers of Tehsil Tandoallahyar, District Hyderabad*. Unpublished Master's thesis, The University of Agriculture, Faisalabad, Pakistan.

Feder, G., & Umali, D.L., (1993). The adoption of agricultural innovations: A review. *Technological Forecasting and Social Change, 43*(3), 215–239.

Folitse, B.Y. (2014). *The effect of radio peace/CSIR programme on the dissemination of agricultural information to farmers in Central Region of Ghana*. Unpublished Master's thesis, University of Cape Coast, Cape Coast, Ghana.

Fraenkel, J. R., & Wallen, N.E. (2000). *How to design and evaluate research in education (4th ed.)* Homewood, IL: Irwin.

Futch, M. & McIntosh, C. (2009). Tracking the introduction of village phone product in Rwanda. *Information Technologies and International Development, 5* (3), 54-81.

Gallup (2011). *Gallup survey: Mobile phone access varies widely in sub-Saharan Africa*, Washington D.C: Gallup.

Gakuru, M., Winters, K., & Stepman, F. (2009). *Innovative farmers' advisory*

Services using ICT. Paper presented (April 1-2) at W3C Workshop "Africa perspective on the role of mobile technologies in fostering social development", Maputo, Mozambique.

Garreau, J. (2008, February 24). *Our cells, ourselves. Planet's fastest revolution speaks to the human heart*. The Washington post. Retrieved from http//:www.washingtonpost.com/wpdyn/content/article/2008/02/22/ AR2008022202283.html.

George, D., & Mallaric, P. (2003). *Statistical package for social sciences for windows step by step: A simple guide and reference. 110 update* (4th.ed.) Boston*:* Allyn & Bacon.

Ghana Statistics Service (2013). *Ghana agricultural production survey (minor season) second round*, Accra: Ministry of Food and Agricultural /Statistics Research Information Directorate. Retrieved from http://www.statsghana.gov.gh/nada/index.php/catalog/SRID.

Ghana Statistics Service (2012). *Ministry of local government and rural development*: Report of the committee on district boundary disputes relating to the 2010 population and housing census, Accra: GSS. Retrieved from http:// www. statsghana. gov.gh/ docfiles/ 2010phc /district_boundaries_final_report_may_2012.pdf.

Ghana Statistical Service (2010). *Population & housing census: National analytical report*, Accra: GSS. Retrieved from http:// www. statsghana. gov.gh/ docfiles/ 2010phc/National_Analytical_Report.pdf.

Ghana Statistics Services (2008*). Ghana living standards survey report of the fifth round (GLSS5*), Accra: GSS. Retrieved from http:// www. statsghana.gov.gh/ /glss5_report.pdf.

Ghana Statistics Service (2003).T*he Ghana ICT for accelerated development [ICT4AD] policy*: A policy statement for the realization of the vision to transform Ghana into an information-rich knowledge based society and economy through the development, deployment and exploitation of ICTs within the economy and society, Accra: GSS. Retrieved from https: //books.google.com.gh/books/about/The_Ghana_ICT_for_accelerated_dev elopmen.html?id.

Ghosh, A., Aggarwal, T., & Marwaha, A. L. (2009). *The ICTs in Agriculture*: Making ICT accessible and affordable in rural areas. Washington DC: World Bank. Retrieved from http: // issue.com/world.bank.publications/docs/final_ book _ict_agriculture/51.

Gómez-Barroso, J. C., & Feijoo, C. (2010). Are Central and Eastern European countries managing to develop the information society? *Transformations in Business and Economics, 9* (2), 18-41.

Gorstein, L. (2003). Effective use: A community informatics strategy beyond the digital divide. *Journal of Agricultural Extension, 4* (1), 21-27.

Gupta, M. P, & Sullivan, O. (2010). Array of thermoelectric coolers for on-chip thermal management. *Journal American Society of Magazine Editors of Electronic Packaging, 1* (2), *3-4.*

Harande, Y. I. (2009). Information services for rural community development in Nigeria. *Library Philosophy and Practice, 6* (8), 152-022.

Hayrol-Azril, M. S., & Bahaman, A. S. (2009). Level of competency among JKKK members and factors affecting it. *Jurnal Ilmu-Ilmu Sosial, 1 (*2), 1-9.

Heeks, R., & Molla, A. (2009). Compendium on impact assessment of ICT for development projects, IDRC-CERD. Information technology: Toward a unified view, *Media Information System Quarterly, 27* (3), 23-40.

Houghton, D. (2009). Cell phones and cattle: *The impact of mobile telephony on agricultural productivity in developing nations.* Unpublished master's thesis, Duke University, Durham, North Carolina.

Ibrahim, M. K, Adejoh, S. O, & Edoka, M. H. (2009). *Sources and uses of agricultural information among rural farmers in ijumu local government area of Kogi State, Nigeria.* The 43rd Annual Conference of the Agricultural Society of Nigeria (ASN) Abuja, Nigeria.

IFPRI (2002). Ending hunger in Africa: *Only small farmer can do it*. Washington DC: International Food Research Policy Institutes (IFPRI).

Irafan, M. (2005). *Comparative effectiveness of mass media in the dissemination of agricultural technologies among farmers of Lahore District,* Unpublished Master's thesis, University of Agriculture, Faisalabad, Pakistan.

International Telecommunication Union (2014). *ICT facts and figures*. Geneva: Switzerland. Retrieved from https://www.itu.int/en/ITUD/statistics/ pages/facts/default.aspx.

International Telecommunication Union (2013). *Measuring the information society*. Geneva: Switzerland. Retrieved from https: // MIS2013_ without_ Annex_4.pd.

International Telecommunication Union (2012). *ICT Facts and Figures*. Geneva: Switzerland. Retrieved from http :// www.itu.int/ITU- D/ict/statistics/ /af _report07 .pdf.

Jafkin, N. J. (2003). Gender issues at the world submit on the information society, Geneva. *Journal of Information Technologies and International Development, 1* (3), 55-59.

Jagun, A., Heeks, R., & Whalley, J. (2007). *Mobile telephony and developing country micro-enterprise*: A Nigerian case study (Developing informatics Working Paper Series No. 29) IDPM, University of Manchester, Manchester.

Jain, T., & Hundal, B. S. (2007). Factors influencing mobile services adoption in rural India. *Asia Pacific Journal of Rural Development, 17* (1), 17-28.

Jensen, R. T. (2010). Information, efficiency, and welfare in agricultural markets. *Agricultural Economics, 41* (6), 203–216.

Jensen, R. T. (2007). The digital provide: Information technology, market performance and welfare in the south Indian fisheries sector. *Quarterly Journal Economics, 122* (3), 879–924.

Jirli, B. (2011). A study of social computing aspects on the students of Banaras Hindu University. *Journal of Global Communication, 4* (2), 148-161.

Kalba, K. (2008). The adoption of mobile phones in emerging markets: Global diffusion and the rural challenge. *International Journal of Communication, 2 (3),* 631-661.

Kaliba, A.R.M, Verkuijl, H., & Mwangi, W. (2000). Factors affecting adoption of improved maize seeds and use of inorganic fertilizer for maize production in the intermediate and lowland zones of Tanzania. *Journal of Agricultural and Applied Economics, 32* (1), 35-47.

Katengeza, S. P., Okello, J. J., & Jambo, N. N. (2011). Use of mobile phone technology in agricultural marketing: The case of smallholder farmers in Malawi. *ICT Research and Development in Africa, 2* (2), 221-254.

Kim, H., & Kwon, N. (2003). The advantage of network size in acquiring new subscribers: A conditional logit analysis of the Korean mobile telephony market. *Information Economics and Policy, 15* (2), 17-33.

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational Psychological Measurement, 30*, (4), 607-610.

Kwakwa, P. A. (2012). Mobile phone usage by micro and small scale enterprises in semi-rural Ghana. *International Review of Management and Marketing, 2* (3), 156-164.

Labonne, J., & Chase, R. S. (2009). The power of information: the impact of mobile phones on farmers' welfare in Philippines. *Journal of Economic Behavior & Organization, 1* (1), 1-26.

Lodhi, I. (2003). Perceived effectiveness of public sector extension under decentralized agricultural extension system in the Punjab Pakistan. *Journal of Agricultural and Social Sciences, 1* (1), 8-13.

Lorimer, S. (2012). Mobile applications- Helping agriculturalists make better decisions. Horticulture Industry Networks. *Jurnal Ilmu-Ilmu Sosial, 4* (2), 4-9.

Lwoga, E. T, Stilwell, C. & Ngulube, P. (2011). Access and use of agricultural information and knowledge in Tanzania. *Library Review, 60* (5), 3–3.

Mammo, Y. (2013). *Five ways of engaging youth in agriculture:* Young peoples' affinity with ICTs and their ability to innovate is the key to moving mAgriculture forward and attracting the youth to the agricultural sector in ACP countries. Haramaya: ICT Update. Retrieved from http://ictupdate.cta.int.

Marra, M., Pannell, D. J., & Abadi, G. A. (2003). The economics of risk, uncertainty and learning in the adoption of new agricultural technologies:

where are we on the learning curve? *Agricultural Systems, 75* (3), 215–234.

McCall, W. V., Dunn, A., & Rosenquist, P. B. **(**2004**).** *Quality of life and function after electroconvulsive therapy. British Journal of Psychiatry, 1* (85), 405-*409.*

McDaniel, M**.** A. Hartman, N.S., Whetzel, D.L., & Grubb, W.L. (2007). Situational judgment test, response instructions and validity: A meta-analysis. *Personal Psychology, 60* (3), 63-91.

McFarland, D., & Hamilton, D. (2006). Adding contextual specificity to the technology acceptance model. *Computers in Human Behavior, 22* (3), 427-447.

McNamara, P. E. (2005). Using agricultural economics to strengthen non-governmental organizations' food security programs for people living with HIV/AIDS: an example from Honduras. *American Journal of Agricultural Economics, 87*(5), 1304-1309.

Minten, B., & Kyle, S. (1999). The effect of distance and road quality on food collection, marketing margins, and traders' wages: Evidence from the former Zaire. *Journal of Development Economics, 60* (2), 467-495.

Meera, S.N, Jhamtani, A. & Rao, D.U.M. (2004). Information and communication technology in agricultural development: A comparative analysis of three

projects from India. *Agricultural Research & Extension Network, 13* (5), 85-705.

Metz, N. (2012). *SEPWA technology heads field day survey*. Melbourne: Austral. Retrieved from http://www.michaelpengilley.com/wp-content/uploads /20/12/04/SEPWA-Survey-Results-Summary.pdf.

Mittal, S. & Mehar, M. (2012). How mobile phones contribute to growth of small farmers? Evidence from India: International Maize and Wheat Improvement Center (CIMMYT), New Delhi, India. *Quarterly Journal of International Agriculture, 51* (3) 227-244.

Mittal, S., & Tripathi, G. (2009). Role of mobile phone technology in improving small farm productivity. *Agricultural Economics Research Review, 2* (2), 451- 459.

Ministry of Food and Agriculture (2013). Technology dissemination by Directorate of Agricultural Extension Services (DAES) Accra: Ghana. Retrieved September, 2014, from http :// mofa. gov.gh/ site/? page_ id=5267.

Ministry of Food and Agriculture (2010). Agriculture in Ghana Facts and figures. *Government of Ghana Publications*, 1(2), 1-41.

Ministry of Food and Agriculture (2005). *MoFA handbook on roles and responsibilities of MoFA staff under decentralization*. Accra: Buck Press.

Morrow, L., Kelly, T. & Kirley, T. (2004). ICT –Its potential as a channel for enhanced extension services. *Journal of Services Research, 23 (*3), 241-305.

Mtega, W. P. (2012). Access to and usage of information among rural communities: A Case study of Kilosa District Morogoro Region in Tanzania. *The Canadian Journal of Library and Information Practice and Research, 7* (1), 1-9.

Muhamman, Zafarullah, K. Khalid, N., Ullah, j., Ahmad, S., Habib et al. (2008). Computer skills: Assessment of the professional competencies of agriculture officers in NWFP, Pakistan. *Sarhad Journal of Agriculture, 24* (3), 542-547.

Munya, H. (2001). *Information & communication technologies for rural development & food security. Lessons from field experience in developing countries.*, Rome, Social Dimensions: FAO.

Muto, M. & Yamano, T. (2009). The impact of mobile phone coverage expansion on market participation: Panel data evidence from Uganda. *World Development, 37* (12), 1887–1896.

Musa, N. (2011). Challenges of using ICTs to disseminate agricultural information to farmers in Gezira State, Sudan. *International Journal of Sudan Research, 3* (2),117-490.

Nazim, M. (2000). *A sociological study of the factors affecting the adoption rate of modern agricultural technologies in Tehsil Chishtian* Unpublished Master's thesis, University of Agriculture, Faisalabad, Pakistan.

National Communication Authority (2015, Febuary 27). Voice subscription market trends. *News Release*. Retrieved from http: // www. nca. org.gh/40/105/Market-Share-Statistics.html.

National Communication Authority (2014, December 30). Mobile voice subscription. *News Release*. Retrieved from http:// www. nca. org.gh /downloads/Mobile_VOICE_SUB_dEC_2014.pdf.

National Communication Authority (2013, November 11). Mobile voice market share. *News Release*. Retrieved from http: //www. nca.org. gh/ 73/107 /Archives.html?item=460.

Ngathou, N., Bukenya, J. O. & Chembezi, D.M. (2006). Managing agricultural risk: Examine information sources preferred by limited resource farmers. *Journal of Research and Extension, 4* (6), 44-51.

Neuman, W.L. (2003). *Social research method: Qualitative and quantitative approaches* (5th ed.) NY: Pearson Educational.

Okello, J., Kirui, O.K., Njirani, G.W. & Gitonga, Z. M. (2012). Drivers of use of information and communication technologies by farm households: The case of smallholder farmers in Kenya. *Journal of Agricultural Science, 1* (1), 11-124.

Okello-Obura, C., Minishi-Majanja, M. K., Cloete, L. & Ikoja-Odongo, J. R. (2009). Assessment of business information access problems in Uganda. *The Canadian Journal of Library and Information Practice and Research*, *2* (2), 1-22.

Okorley, E. L. (2007). An operational framework for improving decentralized agricultural extension: A Ghanaian case study. PhD thesis, Institute of Natural Resources Agricultural /Horticultural Systems and Management, Massey University, New Zealand.

Onuzuruike , E. (2009). *Telecom infrastructure sharing as a strategy for cost optimization and revenue generation*: A Case study of MTN Nigeria/Zain Nigeria collocation. Master'theses, Blekinge institute of Telcommunication, Sekitonen for management. Retriveved from http://www.investopedia.com/terms/e/ebitda.asp.

Ogbeide, A. O. & Ele, I. (2015). Smallholder farmers and mobile phone technology in Sub-Sahara agriculture. *Mayfair Journal of Information and Technology Management in Agriculture, 1* (1), 1-19.

Overa, R., (2006). Networks, distance, and trust: Telecommunications development and changing trading practices in Ghana. *World Development, 34* (7), 1301–1315.

Pascua A. (2009). Effectiveness of FTC in helping farmers gets information in Philippine. *International Journal of Information and Communication Technology Research*, *5* (2), 37 –41.

Porcari, E. (2010). *Why communication and knowledge sharing in our megaprograms*? *New Media and Society, 2* (1), 21-45.

Poulton, C., Kydd, J. & Dorward, A. (2006). Overcoming market constraints on pro-poor agricultural growth in sub-Saharan Africa. *Development Policy Review, 24* (3), 243–277.

Qiang, C. Z, Kuek ,S. C, Dymond, A. & Esselaar, S. (2011). *Mobile applications for agriculture and rural development ICT sector unit*. Washington DC: World Bank.

Rabayah, K. S., & Qalalwi, K. (2011). The impact of mobile telephony on developing country enterprises: A Palestinian case study. *The Electronic Journal on Information Systems in Developing Countries, 46* (4), 1-20.

Rafael, V. L. (2003). The cell phone and the crowd: Messianic politics in the contemporary Philippines. *Public Culture, 15* (3), 399-425.

Rana, F. M. (2002). Role of media in promoting agricultural technology in rural areas of Tehsil Samundri. Unpublished Master's thesis, University of Agriculture, Faisalabad, Pakistan.

Richardson, D., Ramirez, R. & Haq, M. (2000). *Grameen Telecom's Village Phone Programme in rural Bangladesh: A Multi-media case study*. Ottawa: Government of Canada.

Roberts, K. & McIntosh, G. (2012). *Essential starter guide to technology making life easier on the farm, NSWDPI factsheet GRDC advisor and grower*

Update proceedings at Narrandera, Ballarat, Adelaide, Coonamble, Australia.

Rogers, E. M. (2003). *Diffusion of innovations (5th Ed.)* New York: Free Press.

Sardeshmukh, P. D. (2008). A global view of non-Gaussian SST variability. *Journal Physical Oceanography, 3* (8), 639-647.

Sey, A. (2008). *Mobile communication and development*: A study of mobile phone appropriation in Ghana. PhD thesis, Annenberg School for Communication,University of Southern California, Los Angeles. Retrieved from http: //idlbnc.idrc.ca/dspace/handle/10625/37213.

Schiffman, L.G. & Kanuk, L.L. (2004). *Consumer behavior (9_{th} Ed*) Upper Saddle River, New Jersey. Prentice Hall.

Sunding, D. & Zilberman, D. (2001). The agricultural innovation process: Research and technology adoption in a changing agricultural sector. Elsevier, *Handbook of Agricultural Economics, 1*, 207-261.

Syngenta Foundation (2011). *Mobile Applications in Agriculture*: A review by Syngenta Foundation. Basel: Switzerland. Retrieved from http://www.e-agriculture.org/content/mobile-applications-agriculture-review-syngenta-foundation.

Tologbonse, D., Fashola, O., & Obadiah, M. (2008). Policy issues in meeting rice farmers' agricultural information needs in Niger state. *Journal Agricultural Extension, 12* (2), 84-94.

Tornatzky, L.G., & Kleivn, K. D. (1982). Innovation characteristics and innovation adoption implementation: A Meta-analysis of finding IEEE. *Transactions on Engineering Management, 29* (1), 18-91.

Tschersich, K. (2010). How to enhance privacy and identity management for mobile communities: Approach and user driven concepts of the PICOS projects. *Journal of System and Software, 4* (2), 251-261.

Vanderstoep, S.W. & Johnston, D.D. (2009). *Research methods for everyday life: Blending qualitative & quantitative approaches*. San Francisco, CA: Jossey-Bass.

Verkasalo, H. (2008). Handset-based measurement of mobile service demand & value. *Information Technology, 10* (3), 51-69.

Vishwanath, A. & Goldhaber, G. M. (2003). An examination of the factors contributing to adoption decisions among late-diffused technology products. *New Media & Society, 5*, (4), 547-572.

Vodafone Group & Accenture (2011). *Connected agriculture*: The role of mobile in driving efficiency and sustainability in the food and agriculture value chain. Newbury: Vodafone Group PLC.

Wallsten, S.J. (2001). An econometric analysis of Telecom competition, privatization, and regulation in Africa and Latin America. *Journal of Industrial Economics 49*, (1), 1-19.

Williams, E. E., & Agbo, I. S. (2013). Evaluation of the use of ICT in agricultural technology delivery to farmers in Ebonyi State, Nigeria. *Journal of Information Engineering and Applications 3*, (10), 18-27.

World Bank (2009). *World Bank Annual Report-Year in Review*. Johannebury, South Africa: World Bank. Retrieved from http: //siteresources .worldbank org/ EXTAR 2009/ Resources /6223977-1252950831873 /AR09_Complete.pdf.

World Bank (2008). *The World Bank and agriculture*: Critical review of the World Bank's world development report 2008. Washington, DC: World Bank. Retrieved from http: //rajpatel.org/ wp-content /uploads /2009/ 11/ actionaid.pdf.

World Bank (2007). *Agriculture for development*. Washington, DC. World Bank. Retrieved from https:// open knowledge .world bank .org/ handle/ 10986/5990 License: CC BY 3.0 IGO.

Yakubu, D. H., BAbubakar, B.Z., Atala, T.K., & Muhammed , A. (2013). Use of information and communication technologies among extension agents in Kano State, Nigeria. *Journal of Agricultural Extension, 17* (1), 162-173.

Yasmeen, K., Abbasian, E. & Hussain, T. (2011). Impact of educated farmer on agricultural product. *Journal of Public Administration and Governance, 1* (2), 2161- 7104.

APPENDICES

Appendix A: Correlation Matrix of Farmers Frequent use of Mobile Phone

	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}
Y													
X_1	-.045												
	.426												
X_2	-.045	-.150**											
	.431	.008											
X_3	.119*	-.151**	-.471**										
	.035	.007	.000										
X_4	.050	.041	.219**	-.162**									
	.377	.472	.000	.004									
X_5	-.104	-.013	.475**	-.375**	.033								
	.068	.827	.000	.000	.561								
X_6	.040	-.197**	.718**	-.388**	.165**	.361**							
	.484	.000	.000	.000	.003	.000							
X_7	.074	-.208**	.113*	-.005	-.025	.081	.196**						
	.188	.000	.044	.930	.654	.155	.000						
X_8	-.034	-.101	.238**	.038	.091	.177**	.149*	.050					
	.604	.121	.000	.558	.163	.007	.022	.445					
X_9	.155**	-.118*	-.356**	.286**	-.100	-.196**	-.245**	.197**	-.036				
	.006	.039	.000	.000	.080	.001	.000	.001	.583				
X_{10}	.182**	.057	-.180**	.217**	.016	-.026	-.249**	.074	.125	.339**			
	.001	.314	.001	.000	.773	.655	.000	.188	.055	.000			
X_{11}	.122*	-.122*	.258**	-.046	.124*	.053	.182**	.208**	.009	-.132*	.052		
	.031	.031	.000	.421	.028	.356	.001	.000	.887	.020	.360		
X_{12}	-.004	.046	.300**	-.280**	.063	.160**	.260**	.060	.176**	-.222**	-.225**	.059	
	.946	.420	.000	.000	.266	.005	.000	.287	.007	.000	.000	.302	

n=315, *p <0.05 level (2-tailed), **p < 0.01 level (2-tailed). Source: Field survey Data, 2014

Y= Frequent Use of Mobile Phone (Likert Scale Ranging from 0= Missing System to 5=four times a week and above)

X_1=Sex (1=Male, 0=Female)

X_2= Age (Years)

X_3=Education Level (1=Non Formal Education; 2=Primary School Level; 3=Middle School/HJS; 4= Bachelor Degree).

X_4= Marital Status (1=Married, 0= Single)

X_5=Household Size (Number of Person under The Care of a Farmer's Heard)

X_6=Number of Years in Farming (Years)

X_7= Farm Size (Acres)

X_8= Number of years in using mobile phone (Years)

X_9=Amount of Money Spent per week using Mobile Phones (Ghana Cedis)

X_{10}= Farmer's Cooperative (1=Members, 0=Non-Members)

X_{11}= Quality of network reception (Likert Scale from 1=very bad to 5=very good)

X_{12}=Type of mobile phones (1=Smartphone, 0=Ordinary Phone)

Appendix B: Correlation Matrix of AEAs Frequent use of Mobile Phone

	Y	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
Y											
X1	.032										
	.761										
X2	-.448**	-.278**									
	.000	.008									
X3	.214*	.226*	-.299**								
	.042	.031	.004								
X4	-.044	.151	.018	-.077							
	.677	.153	.865	.470							
X5	-.312**	-.149	.393**	-.309**	-.247*						
	.003	.160	.000	.003	.018						
X6	-.387**	-.259*	.876**	-.250*	.028	.408**					
	.000	.013	.000	.017	.791	.000					
X7	-.100	-.109	.237*	-.037	-.013	.087	.197				
	.355	.315	.028	.730	.908	.422	.068				
X8	.434**	-.046	-.001	-.037	-.174	.071	-.058	.160			
	.000	.662	.995	.729	.098	.503	.584	.139			
X9	.073	.023	-.039	.026	-.114	.011	-.073	-.292**	.022		
	.493	.826	.715	.804	.281	.916	.490	.006	.837		
X10	.706**	.168	-.470**	.264*	-.056	-.266*	-.398**	.090	.357**	.048	
	.000	.111	.000	.011	.596	.011	.000	.409	.001	.654	

n=91, *P <0.05 level (2-tailed), **P < 0.01 level (2-tailed). Source: Field survey Data, 2014

Y= Frequent Use of Mobile Phone (Likert Scale Ranging from 0= Missing System to 5=four times a week and above)

X_1=Sex (1=Male, 0=Female)

X2= Age (Years)

X_3=Education Level (1=Non Formal Education; 2=Primary School Level; 3=Middle School/HJS; 4= Bachelor Degree).

X_4= Marital Status (1=Married, 0= Single)

X_5=Household Size (Number of Person under The Care of a Farmer's Heard)

X_6=Number of Years in Working (Years)

X_7= Number of years in using mobile phone (Years)

X_8=Amount of Money Spent per week using Mobile Phones (Ghana Cedis)

X_9= Quality of network reception (Likert Scale from 1=very bad to 5=very good)

X_{10}=Type of mobile phones (1=Smartphone, 0=Ordinary Phone)

Appendix C: Reliability Test

Question	AEA		Farmers	
	No. of items	Cronboch's alpha	No. of items	Cronboch's alpha
Quality of network	6	.973	6	.385
Frequency of Service usage	10	.894	10	.671
Competency level	10	.917	10	.724
Benefits	8	.881	8	.900
Challenges	10	.601	10	.490

Source: Field Survey, 2014

Appendix D: Questionnaire (AEAs)

THE USE OF MOBILE PHONE IN AGRICULTURAL EXTENSION DELIVERY IN THE EASTERN REGION OF GHANA

The main purpose of this study is to assess the use of mobile phone for extension delivery in Eastern region of Ghana.

It is anticipated that the results would be used by Ministry of Food and Agriculture and other stakeholders to plan training programmes for Agricultural Extension Agents and farmers and formulate policies to address the use of mobile phone for agricultural development in Ghana. The study is being conducted in partial fulfillment for award of MPhil. Agricultural Extension at the University of Cape Coast.

The information given would be used for the purpose it is provided only. Therefore, be sincere in expressing your opinions and suggestions as much as possible. Your confidentiality is assured.

THANK YOU

Section A. Demographic characteristics

1. Phone Number…….
2. District ……
3. Operational Area……
4. Rural [ ] Urban [ ]
5. Sex : a. Male [ ] b. Female [ ]
6. Age at last birthday (Years) ……..

7. Kindly indicate your formal educational level by ticking (√) the appropriate box:
    a. Certificate level [ ]
    b. Diploma level [ ]
    c. Bachelor degree level [ ]
    d. Master's degree Level [ ]
    e. Others (specify)…….
8. Marital Status: a. Married [ ] b. Single [ ]
9. Household size:……
10. Number of Years working in MoFA……
11. What are your major sources of agricultural information? Tick [√] as many as applicable
    a. Radio [ ]
    b. Farmers' Forum [ ]
    c. Workshop on Agriculture [ ]
    d. Colleague Extension Agent [ ]
    e. Researchers [ ]
    f. Any other, Please specify……..

12. How many Mobile Phones do you have?…….

13. How many SIM CARDS do you have?……

14. What type of phone do you use/ own?

    a. Ordinary phone [ ]
    b. Smartphone [ ]

15. How long have you been using mobile phone?.....

16. Which network do you subscribe to? (*tick all that apply*)
    a. MTN [ ]
    b. Vodafon [ ]
    c. Airtel [ ]

d. Tigo [ ]

e. Glo [ ]

f. Expresso [ ]

1. Why do you choose the following network (s) you tick above? (*tick all that apply*)

    a. They send agricultural information through (SMS, E-mail, internet, radio and TV) [ ]

    b. They have wide coverage [ ]

    c. They have good reception [ ]

    d. Their services such as (Calls, SMS, MMS, Video calling,) is affordable [ ]

    e. They do promotion (eg. Bonus) [ ]

2. Which of the Network are you using for agricultural purposes/ activities?

    a. MTN [ ]

    b. Vodafon [ ]

    c. Airtel [ ]

    d. Tigo [ ]

    e. Glo [ ]

    f. Expresso [ ]

3. What is the quality of the reception in your operational areas? Rank 1 to 5. 1= Very bad, 2= Bad, 3=Average, 4=Good, and 5= Very good

	Network	**Very bad (1)**	**Bad (2)**	**Average (3)**	**Good (4)**	**Very good (5)**
a	MTN					
b	VODAFON					
c	AIRTEL					
d	TIGO					
e	GLO					
f	EXPRESSO					

20. How much do you spend in a week using mobile phone?

    GH₵.....

Section B. Frequent Use of Mobile Phone for extension delivery

21. What do you use mobile phone for apart from private conservation? (*tick all that apply)*

    a. Scheduling meeting with farmers [ ]
    b. Marketing/sales [ ]
    c. Product delivery/procurement [ ]
    d. Mobile money transfer [ ]
    e. Gathering information [ ]
    f. Internet access [ ]
    g. Reporting [ ]
    h. Sending information [ ]
    i. Any others (please state)…….

22. Do you search for agricultural information using your mobile phone?

    Yes [ ]
    No [ ]

23. If yes, what type of information do you search for using your phone? (*tick all that apply)*

    a. Market information [ ]
    b. Weather information [ ]
    c. New variety of crops [ ]
    d. Recommended fertilizers application [ ]
    e. Diseases management (crops) [ ]
    f. Pest management [ ]
    g. Diseases management (animals) [ ]
    h. Weeding and thinning [ ]

i. Planting materials [ ]
j. Post-harvest handling [ ]
k. Cultural practices [ ]
l. Fishery [ ]
m. Good slaughtering [ ]
n. Animal health management [ ]
o. Livestock Management [ ]
p. Poultry management [ ]
q. Workshop / Training [ ]
r. Any others specify……..

24. Do you sent information to farmers through mobile phone?

Yes [ ]
No [ ]

25. If yes, what type of information do you sent to farmers using the mobile phone? (*tick all that apply)*

a. Market information [ ]
b. Weather information [ ]
c. New variety of crops [ ]
d. Recommended fertilizers application [ ]
e. Diseases management (crops) [ ]
f. Pest management [ ]
g. Diseases management (animals) [ ]
h. Weeding and thinning [ ]
i. Planting materials [ ]
j. Post-harvest handling [ ]
k. Cultural practices [ ]
l. Fishery [ ]
m. Good slaughtering [ ]
n. Animal health management [ ]
o. Livestock Management [ ]
p. Poultry management [ ]

q. Workshop / Training [ ]

r. Any others specify……..

26. How frequent do you use the following mobile phone applications?

Service		Never	Once a week (1x)	Twice a week (2x)	Three times a week (3x)	Four times & above a week (4x)
a	Calling (Voice calls)					
b	Sending text message					
c	Receiving text message					
d	Using the phone to access internet					
e	Using the phone access email					
f	Video calling on phone					
g	Receiving multimedia service					
H	Sending multimedia service					

I	Radio on phone					
J	charting on face book					
k	Charting on whatsap					
l	charting on twitter					
n	Any others (state and rate)					

Section C. Competency

28. Please indicate your competency level for the following mobile phone applications

Service		**Very Low (1)**	**Low (2)**	**Moderate (3)**	**High (4)**	**Very high (5)**
a	Calling (Voice calls)					
b	Sending text message					
c	Receiving text message					
d	Using the internet on phone					
e	Accessing email on phone					

f	Video calling on phone					
g	Receiving Multimedia service					
h	Sending Multimedia service					
i	Radio on phone					
j	Using phone to chart on facebook					
k	Using phone to chart on twitter					
l	Using phone to whatssup					
n	Any others (state and rate)					

Section D. Benefits for using Mobile Phone in Extension Delivery

29. What benefit do you get from using mobile phone?

	Benefit	**Strongly agree (1)**	**Agree(2)**	**Moderate agree (3)**	**Disagree(4)**	**Strongly disagree (5)**
a	Timely acquisition of price, market, and good agricultural					

	practices information					
b	Reduce transportation/travelling cost					
c	Improved communication with suppliers/customers & AEAs					
d	Improved product/service delivery					
e	Easy to connect with AEAs, co-farmers fast as producers, traders and buyers					
f	Helped to increased farmers profit					
g	Low operational cost and increase savings					
h	Update me on weather					
i	Any others (state and rate)					

Section E. Challenges Faced by farmers using Mobile Phone

30. What challenges that you face when using mobile phone? Please rate by ticking [√] as many as applicable

1 = Not a serious challenge (NC), 2 = Somehow a challenge (SHC), 3 = Challenge (C), 4 = Serious challenge [SC], 5 = Very serious challenge [VC].

	Challenges	Ratings				
		NC	SHC	C	SC	VSC
		1	2	3	4	5
	No reception/ Unreliable network coverage					
	Calls end unexpectedly					
	Poor sound quality/breaking up of sound					
	Unable to send text message					
	Unable to receive text message					
	High call tariff					
	Cost of recharge card					
	Access to recharge purchasing center					
	Charging phone battery					
	Other (State and rank)…….					

31. What suggestions do you have to help improve the use of mobile phones for extension delivery?……
……

Appendix E: Questionnaire (Farmers)

THE USE OF MOBILE PHONE IN EXTENSION DELIVERY IN THE EASTERN REGION OF GHANA

The main purpose of this study is to assess the use of mobile phone for extension delivery in Eastern region of Ghana.

It is anticipated that the results would be used by Ministry of Food and Agriculture and other stakeholders to plan training programmes for Agricultural Extension Agents and farmers and formulate policies to address the use of mobile phone for agricultural development in Ghana. The study is being conducted in partial fulfillment for award of MPhil. Agricultural Extension at the University of Cape Coast.

The information given would be used for the purpose it is provided only. Therefore, be sincere in expressing your opinions and suggestions as much as possible. Your confidentiality is assured.

THANK YOU

Section A. Demographic Characteristics

1. Phone Number…….
2. District ……
3. Town or village……
4. Rural [ ] Urban [ ]
5. Sex : a. Male [ ] b. Female [ ]
6. Age at last birthday (Years)……
7. Kindly indicate your educational level by ticking (√) the appropriate box:
   a. Non formal education [ ]

b. Primary school level [ ]

c. Middle School/JHS [ ]

d. Secondary school level [ ]

e. Bachelor degree level [ ]

f. Other (Specify)……..

8. Marital Status: a. Married [ ] b. Single [ ]
9. Household size:……
10. Number of Years in Farming……
11. Farm size: …….
12. Secondary occupation

a. Trading [ ]

b. Civil Service (retired) [ ]

c. Artisan [ ]

d. Others (specify)……..

13. Major agricultural enterprises in which you are involved

a. Crop Production [ ]

b. Animal Production [ ]

c. Agricultural marketing [ ]

d. Agro Processing [ ]

e. Fishing [ ]

f. Any other, Please specify……..

14. Do you belong to any farming cooperative in the community?

a. Yes [ ] b. No [ ]

15. What is your position in the group? ……...
16. What are your major sources of agricultural information? Tick [√] as many as applicable

a. Radio [ ]

b. Co-farmers [ ]

c. Co-operative Society [ ]

d. Farmers' Forum [ ]

e. Workshop on Agriculture [ ]

f. Extension Agent [ ]

g. Friends [ ]

h. Family Relations [ ]

i. Any other, Please specify……..

17. How many Mobile Phones do you have? …….

18. How many SIM CARDS do you have?……

19. What type of phone do you use/ own?

a. Ordinary phone [ ]

b. Smartphone [ ]

20. When did you start using first mobile phone?.....

21. Which network do you subscribe to?

a. MTN [ ]

b. Vodafon [ ]

c. Airtel [ ]

d. Tigo [ ]

e. Glo [ ]

f. Expresso [ ]

22. Why do you choose the following network you tick above? (*tick all that apply*)

a. They send agricultural information through (SMS, E-mail, internet, radio and TV) [ ]

b. They have wild coverage [ ]

c. They have good reception [ ]

d. Their services such as (Calls, SMS, MMS, Video calling,) is affordable [ ]

e. They do promotion (eg. Bonus) [ ]

23. Which of the Network are you using for agricultural purposes/ activities?

a. MTN [ ]

b. Vodafon [ ]

e. Airtel [ ]

f. Tigo [ ]

e. Glo [ ]

f. Expresso [ ]

24. What is the quality of the reception in your operational areas? Rank 1 to 5.

1= Very bad, 2= Bad, 3=Average, 4=Good, and 5= Very good

Network		Very bad (1)	Bad (2)	Average (3)	Good (4)	Very good (5)
a	MTN					
b	VODAFON					
c	AIRTEL					
d	TIGO					
e	GLO					
f	EXPRESSO					

25. How much do you spend in a week using you mobile phone? GH₵…….

Section B: Frequent Use of Mobile Phone for extension delivery

26. What do you use mobile phone for apart from private conversation? (*tick all that apply)*

a. Marketing/sales [ ]

b. Product delivery/procurement [ ]

c. Mobile money transfer [ ]

d. Gathering information for AEAs [ ]

e. Internet access [ ]

f. Any others specify----------

27. Do you search for agricultural information using your mobile phone?

Yes [ ]

No [ ]

28. If yes, what type of information do you search for using your phone? (*tick all that apply)*

a. Market information [ ]
b. Weather information [ ]
c. New variety of crops [ ]
d. Recommended fertilizers application [ ]
e. Diseases management (crops) [ ]
f. Pest management [ ]
g. Diseases management (animals) [ ]
h. Weeding and thinning [ ]
i. Planting materials [ ]
j. Post-harvest handling [ ]
k. Cultural practices [ ]
l. Fishery [ ]
m. Good slaughtering [ ]
n. Animal health management [ ]
o. Livestock Management [ ]
p. Poultry management [ ]
q. Workshop / Training [ ]
r. Any others specify……..

29. Do you receive information from AEA through your mobile phone?

Yes [ ]

No [ ]

30. If yes, what type of information do you receive form AEA through mobile phone? (*tick all that apply)*

a. Market information [ ]
b. Weather information [ ]

c. New variety of crops [ ]
d. Recommended fertilizers application [ ]
e. Diseases management (crops) [ ]
f. Pest management [ ]
g. Diseases management (animals) [ ]
h. Weeding and thinning [ ]
i. Planting materials [ ]
j. Post-harvest handling [ ]
k. Cultural practices [ ]
l. Fishery [ ]
m. Good slaughtering [ ]
n. Animal health management [ ]
o. Livestock Management [ ]
p. Poultry management [ ]
q. Workshop / Training [ ]
r. Any others specify……

31. How frequent do you use mobile phone for the following?

	Service	**Never**	**Once a week (1x)**	**Twice a week (2x)**	**Three times a week (3x)**	**Four times & above a week (4x)**
a	Calling (Voice calls)					
b	Sending text message					
c	Receiving text message					
d	Using the phone to access internet					
e	Using the phone to access email					

f	Video calling on phone					
g	Receive MMS					
h	Sending multimedia service					
i	Receiving multimedia service					
l	Radio on phone					
k	Using the phone chart on facebook					
l	Using the phone to whatssup					
m	Using the phone to chart on twitter					
n	Any others (state and rate					

Section C. Competency

32. Please indicate your competency level for the following

Service		**Very Low (1)**	**Low (2)**	**Moderate (3)**	**High (4)**	**Very high (5)**
a	Calling (Voice calls)					
b	Sending text message					

c	Receiving text message					
d	Using the phone access email					
e	Using the phone to access internet					
f	Video calling on phone					
g	Receiving multimedia service					
h	Sending multimedia					
i	Radio on phone					
j	Using the phone to chart on face book					
k	Using the phone to whatssup					
l	Using the phone to chart on twitter					
m	Any others (state and rate)					

Section D. Benefit from using Mobile phone

33. What benefit do you get from using mobile phone?

Benefit		Very low (1)	Low (2)	Moderate (3)	High (4)	Very high (5)
a	Improved timely acquisition of price, market, & good agricultural practices information					
b	Easy to connect with co-farmers, AE fast as producers, trader & buyers					
c	Improved communication with suppliers/customers & AEAs					
d	Mobile phone has help to improved product/service delivery					
e	Help to increase farmers profits					
f	Reduce transportation /travelling					
g	Lower operational cost & increase saving					
h	Update me no weather					
i	Any others (state and rate)					

Section E. Challenges faced by farmers and suggestions for improvement

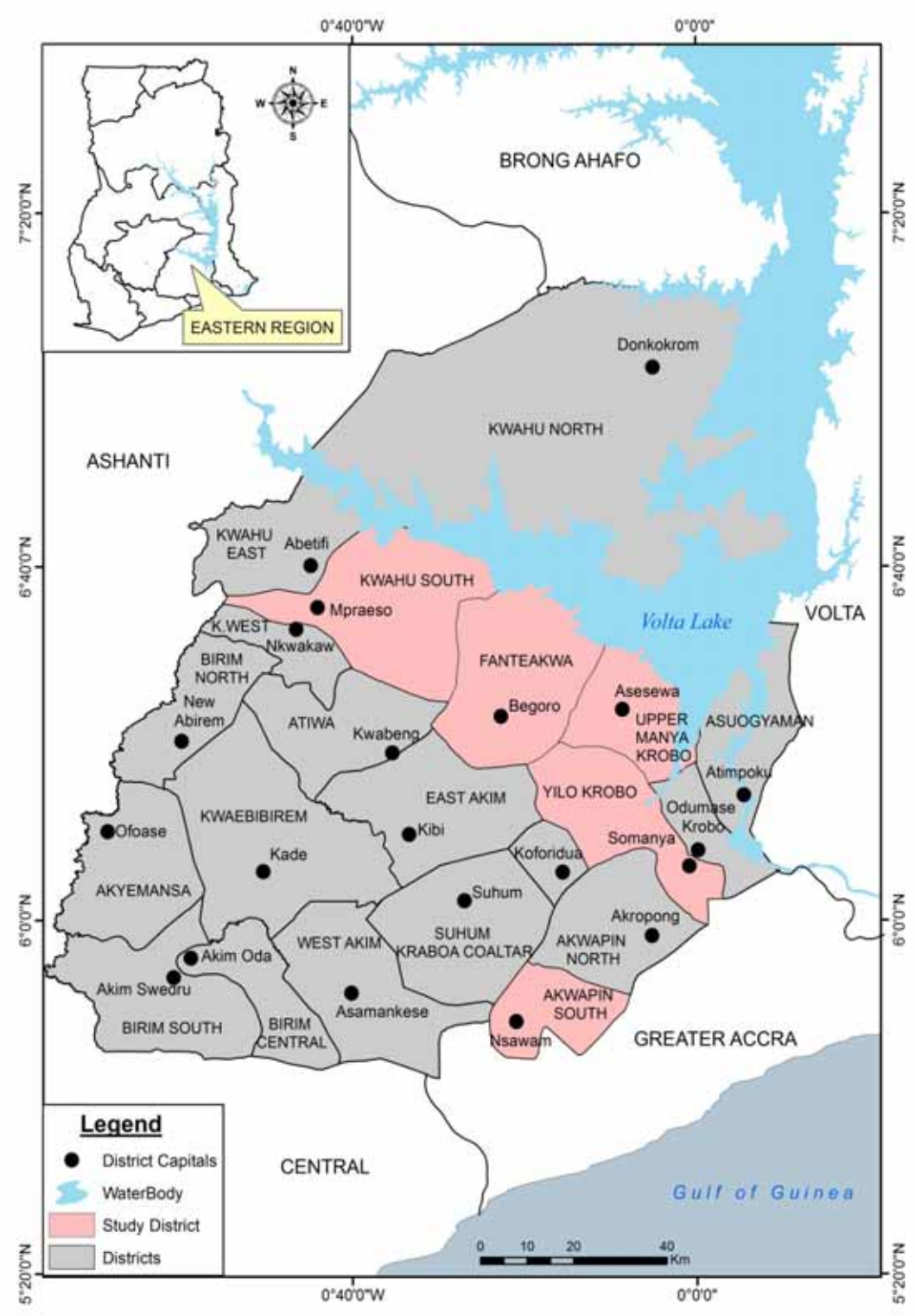
34. What are the challenges that you face when using mobile phone? Please rate by ticking [√] as many as applicable

1 = Not a serious challenge (NC), 2 = Somehow a challenge (SHC), 3 = Challenge (C), 4 = Serious challenge [SC], 5 = Very serious challenge [VC].

	Challenges	Ratings				
		NC	SHC	C	SC	VSC
		1	2	3	4	5
	No reception/ Unreliable network coverage					
	Calls end unexpectedly					
	Poor sound quality/breaking up of sound					
	Unable to send text message					
	Unable to receive text message					
	High call tariff					
	Cost of recharge card					
	Access to recharge purchasing centre					
	Language barrier/ Illiteracy					
	Charging phone battery					
	Other (State and rank)					

What suggestions do you have to help improve the use of mobile phones for extension delivery? ……

Appendix F: Map of Eastern Region of Ghana



Source: Ghana Statistical Service, 2012