THE USE OF MOBILE PHONES IN COMMUNICATING AGRICULTURAL INFORMATION IN TANZANIA: THE ROLES OF DIFFERENT STAKEHOLDERS

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ABSTRACT

The study on which this thesis is based sought to investigate roles of different stakeholders influencing the use of mobile phones in communicating agricultural information in Tanzania. The study arose from the fact that, while information is becoming an important ingredient in agriculture, farmers in Tanzania lack access to agricultural information something which greatly constrains efforts to improve agricultural development. One good thing is that, mobile phone technology which is ubiquitously being subscribed to in Tanzania is believed to have the potential to address information irregularities in various business setups including in agriculture. Therefore, the study aimed to assess roles that different stakeholders could play in order to facilitate the use of mobile phones in communicating agricultural information. Specifically, the study aimed to: understand whether or not farmers' socio-economic characteristics influence the use of mobile phones in communicating agricultural information, examine types of agricultural information that farmers require including their sources, determine roles of different stakeholders influencing the use of mobile phones to communicate agricultural information, assess existing mobile phone based interactions among stakeholders relating to communication of agricultural information, and determine institutional factors underlying actions of different stakeholders on use of mobile phones to communicate agricultural information. The study was conducted in Kilolo and Kilosa Districts in Tanzania. A cross-sectional research design was adapted; data were collected using a semi-structured questionnaire, a guide for focus group discussions and a check list for key informant interviews. Both quantitative and qualitative data were collected and analyzed. Regression analysis results indicated that socio-demographic characteristics significantly influenced the use of mobile phone to communicate agricultural information at 0.059, 0.012, 0.038, 0.265 and 0.043 coefficients for age, literacy levels, farm sizes,

distance from market and type of agricultural information needed, respectively. Similarly, the results indicated that support from other stakeholders and interactions among stakeholders affected the dependent variable at t = 1.362, $\rho = 0.009$ and t=1.362, $\rho = 0.012$, respectively. Consequently, it is recommended that planners should consider aspects like farmers' socio-economic characteristics, nature of information, interaction among stakeholders and type of support needed in order to perfectly address the use of mobile phones in communicating agricultural information.

DECLARATION

I, **Siwel Yohakim Nyamba,** do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

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This work is dedicated to my beloved father, the late YOHAKIM TEOPHILO NYAMBA, who passed away during my second year of the PhD programme.

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ANT	Actor Network Theory
AKIS	Agricultural Knowledge and Information System
AS	Application Service
ASAs	Agricultural Seed Agencies
ASLM	Agricultural Sector Lead Ministries
CAI	Communicate Agricultural Information
CLF	Converged Licensing Framework
CS	Content Services
CTA	Technical Centre for Agriculture and Cooperation
DAICO	District Agriculture, Irrigation and Cooperative Officer
DANIDA	Danish International Development Agency
DRD	Department of Research and Development
FEPU	Farmers' Education and Publicity Unit
FGDs	Focus Group Discussions
FSR-E	Farming System Research and Extension
GTZ	German Technical Corporation
IBM	International Business Machines
ICT	Information and Communication Technology
ICT4D	Information Communication for Development
IK	Indigenous Knowledge
ITU	International Tele-Communication Unit
IICD	International Institute for Communication and Development
IDU	Information and Documentation Unit

ISR	Integrated Voice Response
KDC	Kilosa District Council
KIs	Key Informants
KIIs	Key Informant Interviews
KIRSEC	Kilosa Rural Services and Electronic Communication Centre
MAFC	Ministry of Agriculture Food Security and Cooperatives
MMS	Multimedia Messaging Service
MP	Mobile Phone
MT	Mobile Phone Technology
NAIVS	National Agricultural Inputs Voucher Scheme
NARS	National Agricultural Research System
NF	Network Facility
NGOs	Non-Governmental Organizations
NORAD	Norwegian Agency for Development and Cooperation
NS	Network Service
SIDA	Swedish International Development Programme
SMS	Short Message Service
SNAL	Sokoine National Agricultural Library
SPSS	Statistical Package for Social Sciences
SRS	Simple Random Sampling
SSCI	Social Science Citation Index
TCRA	Tele-Communication Regulatory Authority
TMA	Tanzania Meteorological Agency
TNBS	Tanzania National Bureau of Statistics
TOSC	Tanzania Official Seeds Certification

TOT	Transfer of Technology Model
TTCL	Tanzania Tele-Communication Limited
TV	Television
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
URT	United Republic of Tanzania
USD	United States Dollar
USSD	Unstructured Supplementary Service Data
WB	World Bank
ZIELO	Zonal Information and Extension Liaison Officer

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Information has always been an important component of agricultural development processes. From the time when people started growing crops and keeping livestock, they tried to search for information. Irrespective of their location and type of agricultural enterprises, the most commonly searched information by farmers has been the know-how aspects which gives them fundamental agricultural facts. For instance, farmers may want to know the best cultivation practices, sources of improved seeds and or animal feeds, amount and type of inputs to use, also contextual information such as weather, as well as market information including prices, demand indicators, and other logistical information.

A number of studies have identified the importance of information for better performance of agriculture. For instance, studies by Meyer (2015) Conley and Udry (2010) and Gruber and Koutroumpis (2011) highlight that information has consistently been a significant element in the development of any farming community and has, over a long period of time shaped the way in which farmers think and act. Other studies explain that improved agricultural yields would be realized when farmers are well informed (Mchombu, 2012; Mertz *et al*., 2009; Fofana *et al*., 2010). This means that the successes of any farming activity must have a link to the proper usage of agricultural information. However, as evidenced in various studies, most farmers in developing countries, Africa in particular, lack access to accurate and relevant agricultural information. This has constrained efforts to improve agricultural development. The agricultural sector in many developing countries is characterised by low-input, small-scale and predominantly subsistence farmers (Eggleston *et al*., 2002; Ferris, 2005). Productivity is generally low due to

limited access to modern agricultural technologies including ICTs which in turn affects market participation (Barrett, 2008). Many farmers lack information about prices and demand in different markets and contacts to potential buyers. As a result, much of the produce is consumed by the households themselves while the remainder is sold to a few traders or to local markets (Barrett, 2008; Eggleston *et al*., 2002).

Essentially, poor access to agricultural information has been one potential explanation for the stagnating growth of agricultural performance in developing countries and has made farmers vulnerable to several risks, both during farming, transportation as well as during marketing of their crops (Foster and Rosenzweig, 2010; World Bank, 2008; Arokoyo, 2003 and Lwoga *et al*., 2010). Similar to other sub-Saharan countries, farmers in Tanzania suffer from poor agricultural information accessibility (Haug, 1999; URT, 2009). Equally, the Agricultural Sector Review of (2008) has identified some key challenges facing agriculture, one being failure to access marketing information in crop and livestock fields (URT, 2008).

Of the many reasons, one common explanation for farmers' failure to access agricultural information has been under-utilization of Information Communication Technologies, ICTs (Arokoyo, 2003; URT, 2006; URT, 2008; World Bank, 2008). ICT has increasingly being regarded as one of the forces for positive change in agriculture and rural development (Buncombe, 2012; World Bank, 2016; ITU, 2016). Also, studies by Prahalad (2004) and Jensen (2007) indicate that, where ICT is well utilized in agriculture, farmers have been able to access agricultural information such as weather, recommended agronomic practices and price information. Actually, this is not a physical productivity enhancement, but for the farmers it is as good as that, since the income realized per unit may definitely go up. There could be other ICT income-enhancing effects to farmers; for

example, with information, farmers become able to better plan for their operations and make concrete strategic decisions (Reddy, 2004; Meera *et al*., 2006; Mittal *et al*., 2010).

1.1.1 Why mobile phones?

Agricultural producers and other stakeholders already know that information is important and a valuable constituent in agricultural production processes; what is missing is timely access to it (Durutan, 1999; Reitz, 2010). In most developing countries, including in Tanzania, price information is gathered by the government through Ministries of Agriculture and disseminated via radio, newspaper, internet, email, mobile phones or notice boards (Ferris *et al*., 2008). In practice, however, many small-scale farmers rely on a limited number of middlemen or traders to receive price information, given that search costs for finding information elsewhere are often high (Eggleston *et al*., 2002). Various options are in place attempting to improve information accessibility to farmers through ICTs; including the use of radio, television, telephones, and print media such as newspapers. However, many of these options have their limitations; for instance, newspapers tend to be concentrated in urban areas and require literacy, internet access is low and TV and radio have limited information range and provide one-way communication (Aker, 2011; Hellstrom, 2010). Another important challenge is that the majority of farmers live in rural areas where technical and economic feasibility of fixed line infrastructure is limited.

Different studies have concluded that mobile phones have become the most important form of telecommunication in developing countries (ITU, 2010; Patel *et al*., 2012; UNCTD, 2007). According to Furuholt and Matotay (2011), mobile phone is the most widespread information technology across the world today including developing countries. Furuholt and Matotay further expose that mobile phone technology has become a subject of intense focus within the information communication technology for

development (ICT4D). Its popularity bases on the fact that, mobile phone technology is perceived as a low cost and a widely available communication tool that holds considerable promise for knowledge mobilization in the agricultural sector (Qiang *et al*., 2011). Other studies have asserted that mobile phone has the potential to address information asymmetry offering development prospects for both developed and developing countries (Aker and Mbiti, 2010; Mittal *et al*., 2010; Hellstrom, 2010; Carmody, 2012 and Siyao, 2012). In Africa, for example, mobile phone technology is becoming the most common, available and accessible ICT (Sanga *et al.,* 2013). Its penetration in rural areas of the developing countries is also growing strongly into an International Telecommunication Union (ITU, 2010).

Mobile phones are also regarded as potentially powerful and well-suited for the African communication landscape. This could be due to their relatively low cost of setting out cellular networks in low-income and rural areas, the advent of affordable prepaid services and the lower skills base required for use in comparison to other ICTs. The technology is also widely available and less inhibited by traditional access barriers such as infrastructure such as electricity and to some extent language and literacy (Muthee and Mhando, 2006; Aker, 2011; Carmody, 2012; Siyao, 2012). Other scholars (Souter *et al*., 2005; Burrell and Montoya, 2008; Baumüller, 2012; Sey, 2011; Sife *et al*., 2010; URT, 2010; Omwansa and Sullivan, 2012) noted that mobile phones have a potential to enhance the empowerment opportunity of the rural poor. However, valuable and sustainable phone applications are likely to develop within an environment that encourages collaboration between actors.

1.1.2 Multi-stakeholders engagement

Since the 1960s, agricultural extension has been solely put forth as a means of reducing information irregularities related to technology adoption in both developed and developing countries (Anderson and Feder, 2007). In Tanzania, a similar approach has been in use, whereby agricultural information has mainly been disseminated through agricultural extension officers and farmer-to-farmer extension. However, the growth of extension staff in most areas has not matched with the increasing number of farmers. The traditional extension system has thus been criticized for high costs, problems of scale and low levels of accountability which leads to ineffective and inefficient agricultural extension service delivery (Anderson and Feder, 2007). Thus, the traditional agricultural extension methods have been cited as barriers to improving the livelihood of farmers in developing countries including in Tanzania (De Silva *et al*., 2011; Rivera *et al*., 2009). Of late, however, there are many players taking part in providing agricultural information and other extension services. The extension role is now involving multiple actors such as extension agents, researchers, traders, NGOs, and other private sectors. Therefore, farmers are getting information through a wider range of stakeholders than ever before, hence the term multi-stakeholders. Essentially, the term multi-stakeholder is about joint ventures that are greater than the sum of individual parts for creating lasting and meaningful impact at all levels of actors. Also, according to Goodman (2005), in order to create socially responsible and lasting impact, any technology and or innovation must be mobilized in cooperation of varied stakeholders.

Further, Handy (2011) argues that failure of current agricultural extension services to meet the information need of farmers is due to the absence of systems that facilitate and or support interactive information sharing and transmission. Similarly, other scholars have found that facilitation positively impacts actual use of any particular technology

(GAO and Deng, 2012; Tao, 2008; Im *et al*., 2011; Yu, 2012; Chang *et al*., 2007; Venkatesh *et al*., 2003). Therefore, the study on which this thesis is based aimed at assessing the roles of interlinkage and support among different stakeholders in the use of mobile phones in communicating agricultural information.

1.1.3 Access to mobile phones in Tanzania

Mobile phone technology has been the fastest growing medium technology in Tanzania in recent years compared to other ICTs like radio, television, and newspapers (ITU, 2011; Waverman *et al.*, 2005; Chapman 2003 cited in Sanga *et al.* (2013). As indicated in Table 1, the uptake of mobile phones in Tanzania has been growing enormously and continues to grow, for instance, from 110 518 subscribers in the year 2000 to 25, 827 518 in 2011 (TCRA, 2011).

Table 1: Mobile phone subscriptions in Tanzania between 2000 to 2011 years

Year	Mobile subscribers	Changes	Percent increase
2000	110 518	-	-
2001	275 560	165 042	149.3
2002	606 859	331 309	120.2
2003	1 298 000	691 141	113.8
2004	1 942 000	644 000	49.6
2005	2 963 737	1 021 737	102.2
2006	5 608 532	2 644 795	89.2
2007	8 322 857	2 714 325	48.4
2008	13 006 793	4 683 936	56.3
2009	17 469 486	4 442 693	34.3
2010	21 158 364	3 688 878	21.2
2011	25 827 518	4 669 154	22.1

Source: Adapted from TCRA (2011)

As shown in Table 1, mobile phone ownership in Tanzania has been magnificently increasing; the highest subscription was noticed in the year 2008 while in the year 2000-2001 the highest percentage change (149.3%) was realized. Further, TCRA (2012) reported that almost three-fifths (59%) of the Tanzanians owned mobile phones by 2012.

Subscriptions are increasingly being adopted by rural people too (Sife *et al.,* 2010; Nyamba and Mlozi, 2012). Therefore, the increasing penetration of mobile phones, especially in rural areas could be a unique opportunity that could provide farmers with relevant information for their farming businesses.

1.2 Problem Statement and Research Justification

1.2.1 Problem statement

There is a plethora of literature that mobile phone technology has a wide range of applications in various business activities including in agriculture (Boadi *et al*., 2007; Wu and Wang, 2005; Frempong, 2009 and Sey, 2011). The technology has been a good medium to disseminate information to different layers of the society (May and Hearn, 2005). Obviously, mobile phone is seemingly the most valuable infrastructure which gives people access to the services they need to create a more promising future. One good thing is that the subscription of mobile phones in Tanzania is ubiquitous and its penetration in rural areas is also growing strongly (ITU, 2010).

However, many of the Tanzanian farmers are not fully utilizing the potential of the ICT (Jain *et al.*, 2014). There is an apparent disparity between mobile phone subscriptions which is increasingly being adopted on one hand and their uptake into farming practices on the other hand. Thus, smallholder farmers in Tanzania still suffer from inadequate and untimely access to agricultural information. Lack of timely access to information is one of the constraints to small scale agricultural production of Africa's population (Jensen, 2003). It seems that support is necessary for both delivery and sustainability of mobile services. According to Gollakota (2008), information alone to farmers is not sufficient and so suggested some structural and financial solutions for more support as well.

Other studies have clearly pointed out that support and shaping efforts are necessary if we are to advance technological achievements (Mittal and Kumar, 2000; Duncan, 2013). All these suggest that there is a need for sorts of support to users of mobile phones in communicating agricultural information so as to make them better off and able to purchase information services. Yet, the main challenge is the knowledge of the types of support farmers need and the specific stakeholders to help them in order that they can efficiently and effectively use mobile phones to communicate agricultural information for improved agricultural productivity. Therefore, the study sought to find out roles, resources and or activities that different stakeholders could play to support the use of mobile phones to communicate agricultural information in Tanzania. The knowledge of kinds of support needed for effective use of mobile phones to communicate agricultural information is expected to offer insights to mobile phone service providers and agricultural communicators to effectively plan and serve their clients.

1.2.2 Justification of the study

This study was justifiable by the following reasons. First, it is not clear how farmers' characteristics influence the use of mobile phone in communicating agricultural information. Second, farmers' information needs at various stages of crop production are not clearly documented. Thus understanding farmers' information needs can result in the provision of information services that better serve farmers' requirements. Also, by addressing information needs we create a society that is information rich, and thus making an essential part in tackling poverty. According to studies by Mittal and Kumar (2000), Shadrack and Shammer (2002) and Patel *et al.* (2012), information contributes to alleviating poverty through increasing opportunities, empowerment and improving economic and social security. Mason and Lee (2004), Khalil (2003) also highlight that there is a direct link between information access and poverty reduction.

Third, specific roles that different stakeholders could play to support the use of mobile phones to communicate agricultural information in Tanzania are not well known, thus the study aimed to address this. Addressing roles played by different stakeholders could enable policy makers and other development partners to see the potential that different stakeholders have in supporting the use of mobile phones to communicate agricultural information for advancement. The study also investigated the nature of interactions among stakeholders using mobile phones to communicate agricultural information, disclose the nature of interaction and or networking between various stakeholders aiming to understand strengths and or weaknesses and to suggest ways to address the identified weaknesses. Equally, the study aimed at determining institutional factors underlying actions of different stakeholders on the use of mobile phones to communicate agricultural information.

1.3 Objectives of the Study

1.3.1 Overall objective

The overall objective of the study was to establish roles and characteristics of different stakeholders influencing farmers' use of mobile phones to communicate agricultural information in Kilolo and Kilosa Districts in Tanzania.

1.3.2 Specific objectives

The specific objectives of the study were:

i. To identify relationship between farmers' characteristics and their use of mobile phones to communicate agricultural information.

ii. To examine farmers' agricultural information needs in the study area.

iii. To determine roles that different stakeholders play to enhance the use of mobile phones in communicating agricultural information.

iv. To assess the nature of interlinkages amongst stakeholders relating to the use of mobile phones in communicating agricultural information.

v. To determine institutional factors influencing the use of mobile phones in communicating agricultural information.

1.3.3 Hypotheses of the study

The following hypotheses were formulated to guide the study.

$H0_1$: Farmers' socio-economic characteristics have no statistically significant effect on their use of mobile phones to communicate agricultural information.

$H0_2$: The type of agricultural information that farmers need have no statistically significant influence on farmers' use of mobile phones to communicate agricultural information.

$H0_3$: The roles that different stakeholders play in communication have no statistically significant influence on the use of mobile phones in communicating agricultural information.

$H0_4$: Interaction between stakeholders has no statistically significant relationships with the use of mobile phones in communicating agricultural information.

$H0_5$: Institutional factors have no statistically significant association with the use of mobile phones in communicating agricultural information.

1.4 Organization of the Thesis

Chapter 1 describes the problem of information needs among farming communities and how mobile phones could bridge the gap. Chapter 2 presents a literature review related to mobile phones coverage, adoption and use in Africa. Also, there is a discourse on mobile phones usage in agricultural development and their advantages. Chapter 3 outlines the study research methodology while chapter 4 provides a detailed description of study results and discussions. Chapter 5 presents conclusion and recommendation of the study.

1.5 Limitations of the Study

This study had a number of limitations. First, the sample was purposive. Respondents were chosen based on mobile phones ownership leaving behind those people and places without mobile phones. A purposeful selection of Districts and wards was done before randomly selecting some villages and respondents for the study. Thus, our sample may not be fully representative of the entire population. This has an implication in generalizing the results to other areas. The reason is that, if for example villages without mobile phone network coverage and or farmers who did not own mobile phones could be included in the study, results could probably be different. Thus, future studies are suggested to be broader to include such components for control and generalization purposes.

CHAPTER TWO

2.0 LITERATURE REVIEW

This chapter provides a brief overview of the status of mobile technology and its use in communicating agricultural information in the world. The chapter further discusses new mobile technology development trends and their potential to promote agricultural improvement. To this end, the chapter identifies the following broad trends of the technology: 1) Dimensions of literature on mobile phone studies, 2) The contribution of mobile phones in development, 3) Mobile phone coverage, adoption and usage in the Africa, 4) The role of mobile phones in agricultural development, 5) The role of users on technology adoption and 6) The role of networking in technology adoption.

2.1 The Process of Literature Search and Review

In order to achieve a thorough literature review, two literature search techniques were involved, one being retrospective approach of literature search where by relevant materials concerning mobile phone use in communicating agricultural information were sought. The other technique was the use of social science citation index which enabled the researcher to follow up references from useful articles and other reading lists on mobile phone use. The two search techniques yielded information which was evaluated and synthesized. Generally, literature review involved searching information in journal articles, conference papers, books and other valuable materials as per research questions. The whole process of literature search and review is as shown below (Fig. 1).

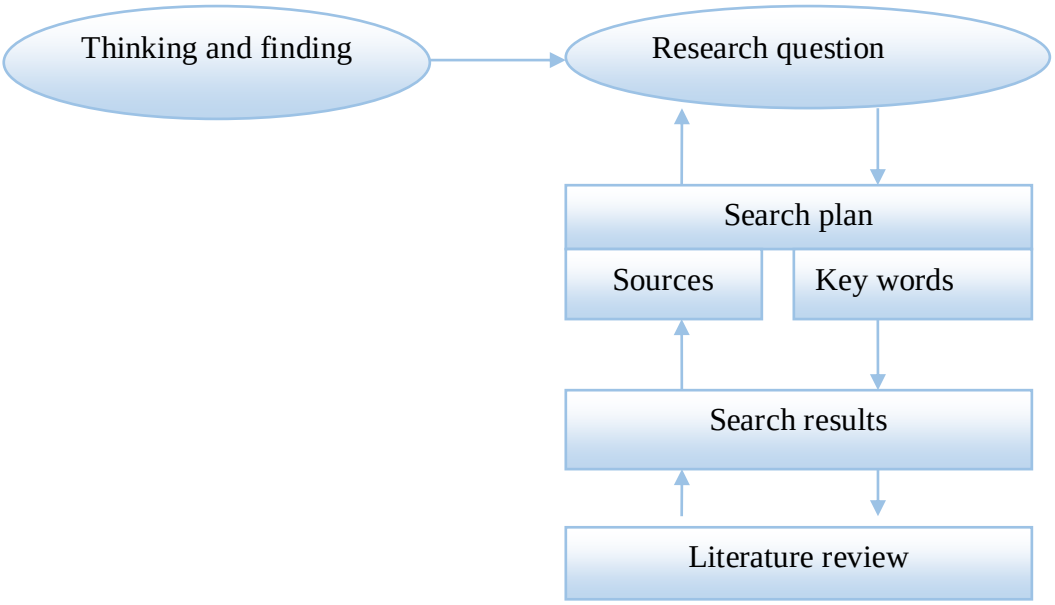

Figure 1: Literature search plan. Adapted from Ridney (2008)

2.1.1 Dimensions of literature on mobile phone studies

As depicted by Donner (2008), studies in the field of mobile phone technology, broadly speaking, can be distinguished into three main dimensions which include studies on determinants of mobile adoption, impacts of mobile phone use and interrelationships between mobile technologies and users. Mobile phone subscriptions numbered six billion worldwide in the first quarter of 2012 and have increased along with population growth (ITU, 2013). In sub-Saharan Africa, the penetration rate for mobile phone has reached 50%, with 342.6 million subscriptions (ITU, 2012). Hence, Africa is facing a mobile phone revolution, and the numbers of mobile phones are increasing exponentially (URT, 2006; World Bank, 2008). Due to this, many mobile phone companies are delivering a variety of services such as mobile-phone money transfer, information on crops and livestock prices and e-commerce applications (Venkatakrishnan and Ngilangwa, 2013).

2.1.2 The contribution of mobile phones in development

Previous studies have highlighted various contributions that mobile phone brings to individuals in a developing economy (Sridhar and Sridhar, 2006; Wyche and Steinfield, 2016; Goodman, 2005; Gruber and Koutroumpis, 2011). For instance, Goodman (2005) examined the link between mobile phone usage and "social capital" in rural South Africa and Tanzania. Goodman used the concept of social capital as a lens for examining the social impacts of mobile phones and theoretically linked the local social impacts with a broader scope of socio-economic changes. His findings showed that access to mobile phones and frequency of use was high in both communities.

Souter *et al.* (2005), a study in Tanzania, India and Mozambique found that the use of mobile phones had improved information to people's livelihood and general well-being, ranging from information about family members and information related to their livelihood strategies. The results further confirmed that the importance of interactive communication engaged people in dialogue with others, whether in social or business transactions. Particularly important are those interactions linked to social capital, conversations between members of family or within a wider social network. According to Dao (2004), government, for example, shall trigger private-sector interests to invest in facilitative initiatives that range from infrastructure to governance issues (i.e. policies and regulations). Yet, other support features for mobile phone adoption and use include expertise, availability of assistance in the event of problems, financial resources and guidance (Anandarajan, 2002). According to Sood (2006), in order to enhance rural development, mobile phones could be used at the following four levels: to provide communication, provide access to information, passive or inter-passive consumption of media and interact with systems, institutions, communities and other users.

Salia *et al.* (2011) shows how mobile phone use among fishermen has enhanced the efficiency of input and output markets for fishing and improved their business relations and livelihoods. The results indicate that use of mobile phones enabled fishermen to improve their incomes, expand their markets, feel more secure at sea and remain in closer touch with both families and other fishermen. Hellstrom (2010) discusses multiple dimensions of mobile phones as contributing to agriculture and rural development. Hellstrom claims that mobile devices and services can help create a "virtuous circle" of innovation that can benefit even the poorest farmers and increasingly integrate them into local, regional and global markets. More examples with promising avenues for improved livelihood for African fishermen are presented by Myhr and Nordstrøm (2006) from Tanzania. According to Myhr and Nordstrøm (2006), fishermen used mobile phones to find buyers and thus cut the time for bringing the fish to the consumers, which led to better quality and higher prices for their products and also made them less vulnerable to loss.

2.1.3 Mobile phone coverage, adoption and usage in Africa

While infrastructure investments still remain low in many developing countries, one of the most dramatic changes over the past decade has been an increase in mobile phone coverage and adoption. The number of mobile phones per 100 people in developing countries often exceeds access to other information technologies, such as landlines (Jensen 2010), newspapers and radios (Aker and Mbiti, 2010). In sub-Saharan Africa, for example, less than 10 percent of the population had mobile phone coverage in 1999, increasing to over 60 percent of the population in 2008 (Aker and Mbiti, 2010). Coinciding with this growth in coverage has been an increase in mobile phone adoption and usage, even in some of the world's poorest countries. Yet, due to high prices of advanced mobile equipment and poor infrastructure in rural areas of the developing

countries, the use of mobile technology is still limited. In Africa, for example, according to Ramburn and van Belle (2011), even in Mauritius which has one of the most sophisticated cellular markets in Africa, advanced mobile data services (apart from SMS) have not yet entered the lives of most mobile subscribers.

In Tanzania, the uptake of mobile phones is spontaneously growing; as by December 2011 there were 25 827 518 mobile phone subscribers, which is more than half of its total population (ITU, 2012). The rapid adoption of mobile phones has generated a great deal of speculation and optimism regarding its effect on economic development. Again, policymakers, newspapers and mobile phone companies have all hyped the poverty-eradicating potential of mobile phones (Corbett, 2008). However, as portrayed by Triandis (1980), a given behaviour cannot be well carried out if objective conditions of the environment do not facilitate the behaviour to be carried out. This study set out to investigate the contributions that different stakeholders do to support farmers' use of mobile phones to communicate agricultural information in Tanzania. A survey conducted by Souter *et al*. (2005) in Tanzania, India and Mozambique presents some empirical data relating to the use of mobile phones in these countries. The results indicate the importance of information to people's livelihood and general well-being, ranging from information about family members, information related to crops management, market prices, government and legal requirements.

2.1.4 The role of mobile phones in agricultural development

There is widespread theoretical and empirical literature identifying the determinants of agricultural performance in different contexts (Foster and Rosenzweig 2010; Conley and Udry, 2010). While the findings slightly differ based on context, numerous studies have identified the importance of information for better performance of agriculture. Different

studies have highlighted the contributions that mobile phone brings to individuals in a developing economy. For instance, according to Sridhar and Sridhar (2006), Gruber and Koutroumpis (2011), mobile phone technology is able to provide farmers with relevant and up-to-date agricultural information that positively would better influence their income. In its Mobile Development Report, Nokia recommends that, in order to enhance rural development, mobile phones could be used at the following four levels: To provide communication, provide access to information, passive or inter-passive consumption of media and interact with systems, institutions, communities and other users (Sood, 2006).

A study by Salia *et al.* (2011) in Ghana has indicated that use of mobile phones enabled fishermen to improve their incomes, expand their markets, feel more secure at sea and remain in closer touch with both families and other fishermen. More examples with promising improved livelihoods for African fishermen are presented by Myhr and Nordstrøm (2006) from Tanzania. Thus, adoption of mobile phones has generated a great deal of speculation and optimism regarding its effect on agricultural development.

For some years, "traditional" forms of ICTs have been used in advisory service provision. For example, Radio and TV programmes and rural telecentre have provided information on price and quality of agricultural produces (Goyal, 2010). With the growth of mobile phone coverage, many of these initiatives have moved away from "traditional" ICTs to mobile telephony. According to Souter *et al*. (2005), the potential of mobile phones, in reducing vulnerability to information discrepancies lies in their ability to obtain information that allows them to deal with seasonal factors (e.g. weather information), to reduce the imbalance between themselves and those they trade with (e.g. price information) and to respond more quickly and effectively to shocks. It is in this latter area

that the respondents in these countries acknowledge the beneficial impact of the mobile phones.

Different studies portray that obtaining access to any technology by users requires knowledge of the existence of the technology, the ability to assess its suitability as well as the ability to obtain and finance the technology in question (Aker, 2010; Bertolini, 2004, Ilahiane, 2007; Shin, 2012; Tapscott and William, 2006). According to Hippel (2005), users and or user communities are the key for successful implementation of any particular invention. Moreover, Fransman (2007) emphasizes the role of users of ICTs while pointing out individual difference and or variability. According to Fransman (2007), consumers of ICT services and or products assume seven different roles, some of which being sources of revenue, feed-back providers, sources of knowledge and information, content creators and conversers.

2.1.5 The role of networking in technology adoption

Butt and Raider (2000) state that people who are networked do better than those who are not because society is like a market place whereby people exchange goods and ideas to serve their own interests. Farmers operate as social networks and utilise various media and fora to exchange ideas to improve production and minimize loss. Thus, the importance of interactions in innovation processes has long been recognized. For instance, when actors interact, it becomes easy for them to identify opportunities and challenges in their routines, share information, develop better understanding of needs and capabilities of other actors (Lundvall, 1992; Nelson, 1993). Jones and Craven (2001) portrayed that diffusion of new knowledge and technology requires a networking of both formal and informal communication linkages. Networking provides actors with increased access to the experience of others. According to Perkin and Court (2005), networks are

broadly defined as formal or informal structures that link actors, individuals or organizations who share a common interest on a specific issue or who share a general set of values.

According to World Bank (2005), one of the main constraints associated with many innovation organizations results from weak links with other actors involved in the same innovation process. Other factors that are likely to affect collective action may include: characteristics of the resource, characteristics of the user groups, and institutional arrangements (Markelova and Mwangi, 2010). Other studies (Engel, 1995; Jones and Craven, 2001; World Bank, 2005) specify that interactions have always not been so easy to achieve due to the following reason: opportunistic behaviour amongst actors, lack of trust, lack of awareness, lack of incentives, lack of capacity and difficulties to enforce rules.

2.1.6 The role of institutions in mobile phone adoption

The use of the term 'institution' in social sciences and other disciplines means that much of human interactions and activities are structured in terms of implicit and or explicit rules. Basically, institutions are the structural, policy and regulatory intervention attempts to improve economic and social well-being of people (Sen, 1983). According to Trijp and Ingenbleek (2010) and Clark (2002), enhanced institutional support adds to the efficiency of technology transfer from bodies that search for and validate knowledge on the one hand, and those that use such knowledge to increase their productivity and welfare on the other hand. Institutions help societies to reap potential gains from different interactions among independent actors (Hoff and Stiglitz, 2001).

There is a debate within the new institutional economics whether institutions should be regarded essentially as balances, norms, or rules (Aoki, 2001; Crawford and Ostrom,

1995). Institutional theory considers the institutions as structures, such as schemas, rules, norms and routines established as authoritative guidelines for social behaviour. Further, according to Clark (2002), better institutional arrangements could enhance the efficiency of technology transfer from bodies that search for and validate knowledge on the one hand, and those that use such knowledge to increase their productivity and welfare on the other hand. Institutions, therefore comprise of normative and cultural cognitive elements that, together with associated activities and resources, provide stability and meaning to social life (Scott and McKemey, 2004). Conclusively, institutions are seen as a system of rules that effectively regulate the way a society embraces the manifestations in social and economic services, including information communication processes. Equally, Lopez and Scott (2000) apprehend about institutions. For Lopez and Scott, institutions are the concept of social positions and role expectations. They claim that institutions regulate actions by defining social positions agents can occupy and the behaviour that is associated with these positions. As a part of culture, knowledge about social positions is held in the individual mind, but this knowledge is shared by those who interact together. Thus, alongside norms and rules, there are social positions and roles. They also claimed that each social position defines a role in social life for its occupants. Roles are definitions of those things that people are expected to do. They are blueprints or templates for action. They specify the rights and obligations that are entailed in social positions, and tell us what is expected of us and what should we expect others to be doing.

Now, the present study perceives institutions as a set of rules that structure social interactions in particular ways. In addition, the study perceives institutions as organizations which set standards and or procedures and or regulate operations underlying the use of mobile phones in communicating agricultural information. In this regard, the

study rules, standards and structures form a basis for action in using mobile phone to communicate agricultural information.

2.1.6.1 ICT policy and regulatory development in Tanzania

The main policies guiding developments in the telecommunications sector in Tanzania are the National Telecommunications Policy (1997), the National ICT Policy (2003). The National Postal Services Policy (2003) and the National Information and Broadcasting Policy (2003). The National Telecommunications Policy of 1997 is the basic document and provides vision to 2020. The policy aims at ensuring accelerated development of telecommunications infrastructure and services so as to accelerate access to telecommunication services by all sectors of the national economy as part of the national development strategy. Tanzania's ICT Policy was approved by parliament in 2005 to provide government guidance on ICT issues.

The establishment of the TCRA marked a new era for the communications sector in Tanzania that has been characterized by growth in investments and operations including penetration. The TCRA effected a Converged Licensing Framework (CLF) in 2005. Under CLF, TCRA has issued licenses under Network Facility (NF), Network Service (NS), Application Service (AS), and Content Services (CS) categories. In a phasing out arrangement, licenses are also issued under the old regime in the areas of Public Data Operators Licenses, Internet Service Providers, Private Dedicated Data Communications, and Postal and Courier Operators.

The Ministry of Communications, Science and Technology provides policy guides. The policy guides include the National ICT Policy of 2003, and the National Telecommunications Policy of 1997. The legal framework is provided by the Tanzania

Communications Act of 1993, the Tanzania Broadcasting Services Act of 1993, the Tanzania Communications Regulatory Authority Act of 2003, and the Universal Communications Service Access Act of 2006. However, with the fast changing and the dynamic nature of the telecommunications sector, these policies, legal provisions and regulations require regular review to accommodate new services and a changing business environment.

2.1.6.2 Challenges of ICT development in Tanzania

Lack of an overall ICT Policy and poor harmonization of initiatives had previously led to random adoption of different systems and standards, unnecessary duplication of effort and waste of scarce national resources on the one hand, and lack of strategies for the utilization of ICT as a driving force for national development on the other (World Bank, 2005). The policy articulates ten main focus areas in harnessing ICT in Tanzania: strategic ICT leadership, ICT infrastructure, ICT industry, human capital, legal and regulatory framework, productive sectors, service sectors, public service, local content and universal access.

Other challenges for the development of ICT sectors as revealed in the EAC Report (2009), are that the implementation process lacks ownership, the institutional and governance structure was not articulated, and there was lack of capacity for coordination at the respective ministry, while competition for resources among ministries, departments and agencies was stiff. Hence, the need for ICT policy review to address the observed weaknesses is evident. Such a review should also build on synergies of East African regional cooperation in ICT policies, which will foster a consistent regional policy framework to achieve economies of scale and promote regional integration. Yet, there are big challenges in terms of market structure, carrier infrastructure development, network

services for fixed and mobile operations and network applications services, policies, capacity development, ICT applications and content development in local and or national language to end-users.

2.1.7 Use of mobile phones in communicating agricultural information

Regular research should be conducted on rural information needs and that local people should be considered in the design and development of agricultural technologies to increase their adaption rate (Lwoga *et al*., 2010). According to Savolainen (2008), understanding farmers' information needs and sources could result in the development and provision of information services that better serve farmer information needs. A study by Bachhav (2012) indicated different ways through which information is helping farmers improve their agricultural productivity, including obtaining information on weather trends, best practice in farming, timely access to market information, helping farmer make correct decisions about which crops to plant or where to buy inputs from and where to sell their products. According to the International Institute for Communication and Development, IICD (2009), individuals who acquire the ability to access information often find their social status improved. One regular finding in the literature has been that, choices of information sources by different users have been affected by the development of telecommunication technologies, information epidemics and the availability of a whole range of modern information technologies for efficient use of information resources (Bronstein and Baruchson 2008). Sources of agricultural information are said to be inadequate, inaccurate and untimely (Horne and Stür, 2005; Babu *et al.*, 2012).

According to Statrasts (2004), an information source could be an institution or individual who creates or brings about a message. As per Statrasts (2004) the characteristics of a good information source are aptness, accuracy, relevance, cost effectiveness,

trustworthiness, usability, exhaustiveness and aggregation level. The selection of an information source depends on a number of factors at user level, including level of income, farm size, age, geographical location, level of education (Riesenberg, and Gor, 1999). Other factors named in literature that have an influence in the selection of information sources include users' intention to minimize loss; the loss to be minimized is the cost in terms of effort which must be spent in order to gain access to an information source (Bronstein, 2010).

Other studies (Meitei and Devi, 2009; West, 2015; Daudu *et al*., 2009) have found that information sources that are easier to use are perceived as more accessible and will be used more frequently than less easy to use sources. In this context, accessibility is the perceived cost associated with the use of a source and is better related to the frequency of use than the quality of the information. This premise explains the users' preferences for easy to use and accessible sources such as informal communications and personal collections (Andreoni and Sprenger, 2012; Green, 2000). A study by Mtega and Benard (2013) reported farmers to have been using agricultural extension, posters, televisions, radio, newspapers, journals, bulletins, community leaders, and famer groups as their sources of their information.

On the other hand, Hertzum *et al.* (2012) noted that the perceived quality of any piece of information is essentially a matter of establishing to what extent one is willing to place trust in it. They defined trust as an assumption of risk and, depending on the nature of this risk trustworthiness may mean discretion, reliability, competence, integrity or empathy. Furthermore, to the user, trust involves an assessment of whether the other person possesses the required level of knowledge and skills to fulfil the user's information need

(Daudu *et al.*, 2009). Therefore, both accessibility of the information source and the quality of its information are relevant criteria when selecting information sources.

Based on Tornatzky and Fleischer Model (1990), factors influencing technology adoption could be grouped into three broad categorize: Organizational factors, which are defined in terms of several descriptive measures for instance formalization and centralization; technological factors, which include both internal and external technologies relevant to the organization; and Environmental factors, which include the arena in which an enterprise conducts its business, for example industrial structures.

Based on organizational factors, force from suppliers and business partners, customers can influence the adoption and use of technologies (Chong, 2004). Adoption and integration of technology may be necessary for firms, for example provision of mobile phone services for their customers and or business partners.

With technological factors earlier studies have rated perceived direct benefits of technological innovation as a determinant for adoption and use. This is similar to relative advantage (Kuan and Chau, 2001; Mehrtens, Cragg *et al.*, 2001; Wang, Chang *et al*., 2004), which refers to the degree to which technology is providing benefits to the organization. The technology adoption literature provides ample evidence of the benefits of technology in revenue generation, cost reduction, and improved overall efficiency. Firms that perceive there are benefits to derive from technology will more than likely adopt. Other studies have highlighted the importance of environmental factors on IT adoption decisions (Agarwal *et al.*, 1999). Pressure from suppliers and business partners can be key factors to IT adoption (Kuan and Chau, 2001). This includes industry, competition, regulations and relationships with government (Zhu and Kraemer, 2005).

2.2 Theoretical Framework

This study is informed by three theories, Actor Network theory (ANT), diffusion of innovations theory or Rogers' innovation diffusion theory and social cognitive theory which are all explained below. A combination of these theories based on the unique contribution of each theory to the objectives of the study.

2.2.1 Actor-network theory

The Actor Network Theory (ANT) is a theory by Latour (2005) and is used to explore collective processes. It recognizes infrastructure surrounding technological achievements and perceives stakeholders as a group of actors with each node and link being locally networked and dependent. ANT is interested in the ways in which networked groups overcome resistance and strengthen coherence and consistence. According to this theory, technology acceptance depends on both technical and social aspects. Technical excellence, however, does not necessarily guarantee social acceptance of the technology. For instance, with mobile phone technology, the prevalence of messages and the presence of a critical mass of users will determine its success.

2.2.2 Diffusion of innovations theory

This study adopted the innovation-diffusion model (Fig. 2), which is also referred to as Rogers' innovation diffusion theory (Rogers, 2003). The theory explains adoption process and the determinants of technology adoption. With regard to technology adoption, the underlying assumption of diffusion of innovation theory is that the technology could be both technically and culturally sound but adoption it may be hampered by one's behavioural jurisdiction (Shampine, 1998). On the other hand, adopters' perception on the perceived attributes of the technology can also largely determine adoption behaviour of an adopter unit. This means that, even with full farm household information, farmers may

subjectively evaluate the technology differently from scientists. This implies that adopters' characteristics determine the adoption behaviour of adopter unit. Remarkably, until many users adopt a new technology, it may contribute little to our well-being. Understanding the mechanisms of the diffusion process is essential as it informs us on how technology adoption actually comes about and why it may be slow at times across individuals.

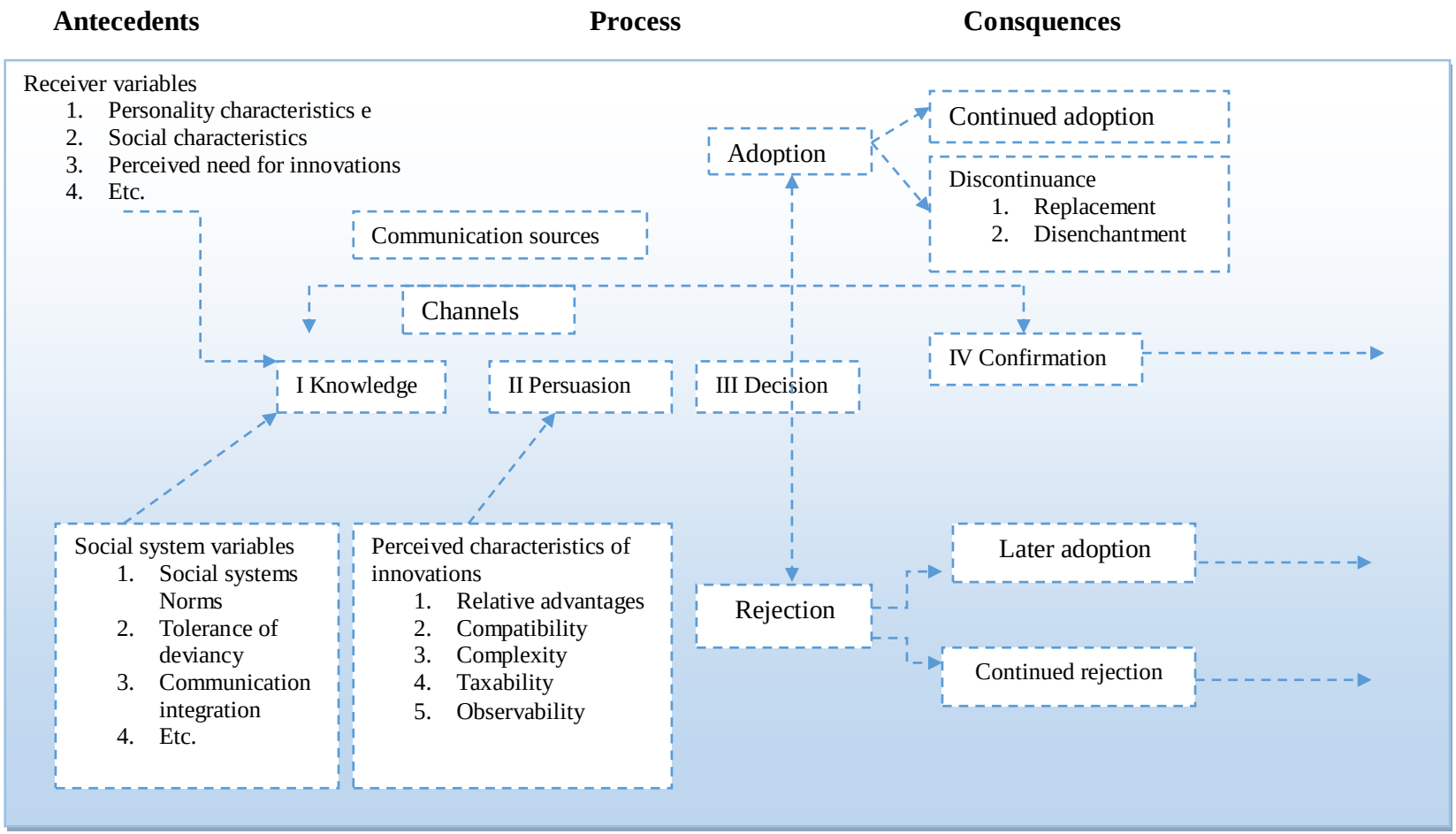

Figure 2: Diffusion of innovation model, adapted from Rogers (2003)

2.2.3 Social cognitive theory

Social cognitive theory describes the need for interventions to change the larger environment of different stakeholders in the use of any innovation Jensen (2010). The theory explains that human behaviour is guided by three kinds of considerations: beliefs about the likely consequences of the behaviour (behavioural beliefs), beliefs about the normative expectations of others (normative beliefs), and beliefs about the presence of factors that may facilitate or impede performance of the behaviour (control beliefs). Entirely, the theory purports that behavioural beliefs produce a favourable or unfavourable attitude towards the actions; normative beliefs result in perceived social pressure or subjective norms; and beliefs give rise to perceived behavioural control. Intention is thus assumed to be the immediate precursor of behaviour. However, because many behaviours pose difficulties of execution that may limit control, it is useful to consider perceived behavioural control in addition to intention (Fischbein and Ajzen, 2010), to the extent that perceived behavioural can serve as a substitute for actual control and contribute to the prediction of the behaviour in question.

The main thoughts contained by social cognitive theory include: behavioural intention, attitude, subjective norms and the perceived behavioural control**.** Behavioural intention represents a person's motivation in the sense of her or his conscious plan or decision to perform certain behaviour (Conner and Armitage, 1998). Generally, the strong the intention is, the more likely the behaviour will be performed. This means that attitude towards a particular behaviour refers to the degree to which a person has positive or negative feelings of the behaviour of interest. It entails a consideration of the outcomes of performing the behaviour. On the other hand, subjective norms are the beliefs about whether or not significantly others think we will perform the behaviour. It relates to a person’s perception of the social environment surrounding the behaviour. Lastly, another

concept is perceived behaviour control which denotes individuals' perception of the extent to which performance of the behaviour is easy or difficult. It increases when individuals perceive they have more resources and confidence (Fischbein and Ajzen, 2010; Lee and Bellemare, 2012). This theory, therefore, will contribute to explain objective one and five of the study.

2.3 Conceptual Framework

Like other ICTs, mobile phone application encompass interactive processes, meaning that, for effective mobile phone application, different stakeholders need to be involved, including mobile phone service providers, government officials, financiers, and supervisors. This means that successful mobile phone applications in agriculture need to involve interactive processes of diverse elements of the agricultural system. Consequently, a conceptual framework for this study which is presented in Fig. 3 shows the predicted nature of interactions and roles of different stakeholders in using mobile phones to communicate agricultural information.

The framework holds some elements of the Agricultural Knowledge and Information System (AKIS) model. According to Röling (1988), AKIS model illustrates a network made up of people who are linked by commercial, professional or social relationships. In our case, the framework considers service providers, researchers, traders, input suppliers and extension experts as being linked together sharing the common interest of using mobile phones to communicate agricultural information. According to Röling (1988), the effectiveness of technology transfer through AKIS depends on the existence of a system of incentives for network members to communicate with each other and develop, manage and adapt the network as technology transfer profits.

As shown in (Fig. 3), the relationship depicted could be interpreted as follows: first, the government ought to predominantly control the manner in which the programme will operate. Through its Ministries (i.e. Ministry of Agriculture, Livestock and Fisheries Development, and other Agricultural Sector Lead Ministries (ASLM), the government is expected to coordinate the manner in which the process will be, including gathering, processing and or editing information before providing it to farmers' and other beneficiaries. The government also should promote the process of mobile phone use and involve users. Tanzania government, through its departments, must work hand in hand with mobile phone companies and other private organizations to monitor and promote the use of mobile phones to communicate agricultural information.

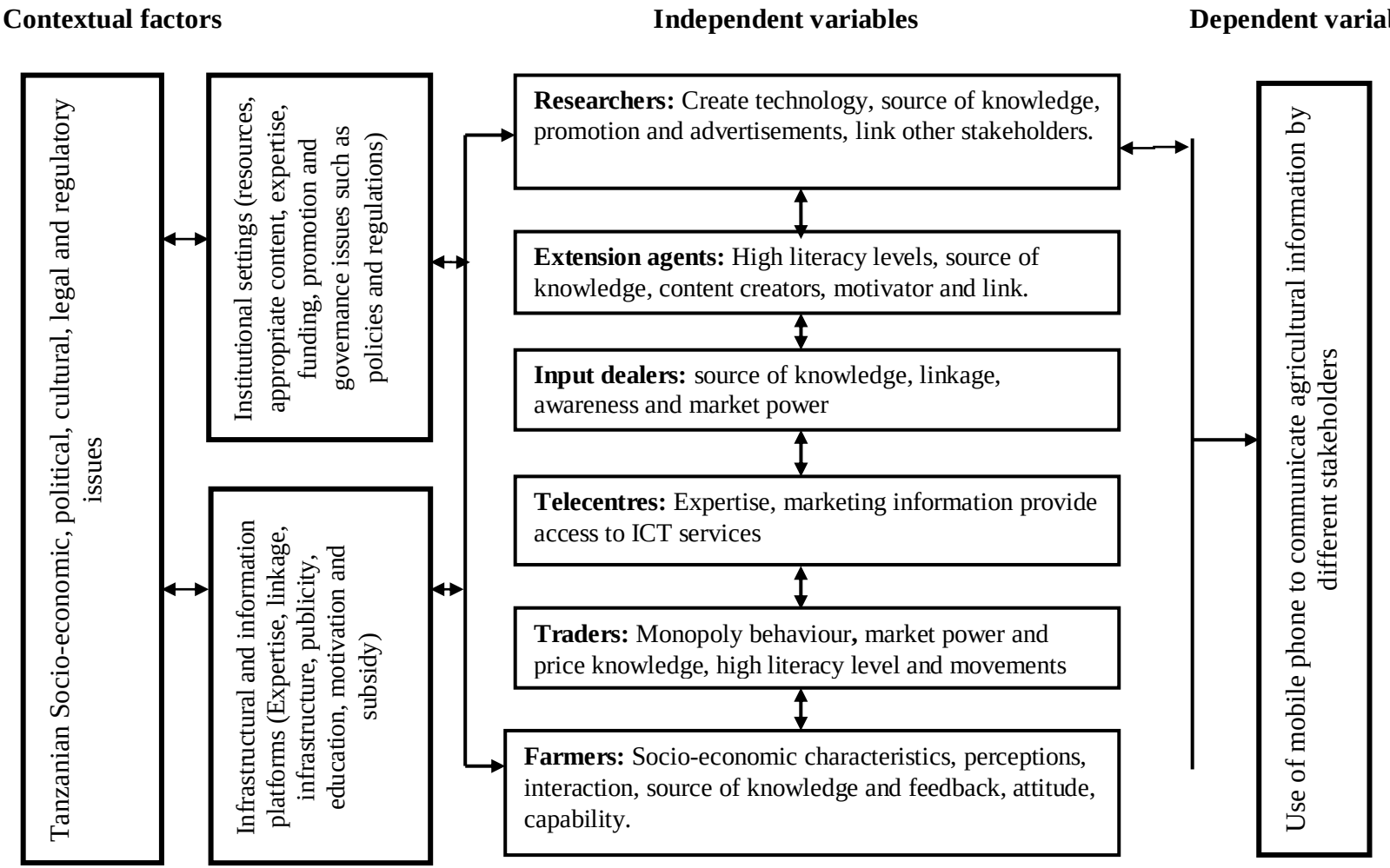

Figure 3: Conceptual framework of multi-stakeholders 'roles influencing the use of mobile phones to communicate agricultural information

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2.3.1 The role of Tanzania government

According to World Bank (2012), Tanzanian farmers have started using mobile phones to improve farming practices. Ellen (2003) portrayed that regulatory issues and policies in the telecommunication sector; including promotion of mobile phone technology usage, infrastructure, taxes and tariffs; are essential elements for the use of mobile phone for communication. Thus, public sector is expected to support smallholder farmers by offering relevant information through mobile phones, but the government should also set standards to control information and communication processes (Ellen, 2003). Currently, one of the central issues in ICT in Tanzania is the imminent stress whereby some service providers are attempting to capture business from operators while not observing business ethics including sending sub-standard and or irrelevant messages to users. In this case, it is better that, the government witness the value and relevance of the package before dissemination to the targeted audience.

In Tanzania, convergence of telecommunication, information and broadcasting technologies have been put under a single body the TCRA. At the national level, two ministries are responsible for ICT coordination and management; these are the Ministry of Infrastructure Development and the Ministry of Higher Education, Science and Technology. Similarly, a report by URT (2003) indicates that the National Information and Communications Technology Policy of 2003 which had a vision to become a hub of ICTs infrastructure and ICTs solutions truly is trying to achieve its goal to enhance sustainable socio-economic development and accelerate poverty reduction both nationally and globally. Still, the government needs to address some infrastructural and regulatory aspects to ensure equitable use of the technology. According to URT (2003), the most notable development partners supporting ICTs in Tanzania include Swedish International Development Agencies (SIDA), United Nations Development Programme (UNDP),

Norwegian Agency for Development and Cooperation (NORAD), International Institute for Communication and Development (IICD) and German Technical Corporation (GTZ).

2.3.2 The role of mobile phone companies

According to Bayes *et al.* (1999), mobile phone companies have an effect on mobile phone use. They dominate the applications network and serve as gatekeepers, deciding which applications are allowed in their systems and dictating how much to pay from the applications. According to Bayes *et al.* (1999), the probability of the presence of mobile tower base stations is positively correlated with the potential demand including population density and per capita income. This encompasses such factors as the level of technological proficiency of companies, supply of skilled labour, Research and Development linkages between companies and research institutions, and more directly the level of use of mobile phone in business.

2.3.3 The role of agricultural research institutions

In Tanzania, agricultural research stations have been recognized as being essential for effective flow of technology and scientific information between researchers, extension, and farmers (Bertolini, 2004). The research institutions have formal and informal linkages in sharing and exchanging information through their respective Information and Documentation Unit (IDU) and Farmers' Education and Publicity Unit (FEPU) which have the function of packaging research and other agricultural information for end users (Ilahiane, 2007).

2.3.4 The role of agricultural extension agents

Extension workers are at the frontline in terms of collecting and disseminating information and thus they stand a better chance in explaining the benefits of using mobile

phones to communicate information about services required by communities. Extension is considered as a link and is essential for an effective flow of technology and scientific information between researchers and farmers (Anderson and Feder, 2007). However, agricultural extension and farmer-outreach programmes in developing countries are facing major challenges (Ramamritham, 2006). Thus, the researcher imagined that mobile technologies could create new channels to communicate with others to enable cost-effective outreach and bring about solutions tailored to needs of individual farmers and an image that is farmer-friendly.

2.3.5 The role of tele-centres

Mulozi (2008) highlight on how telecentres enable communities to access information resources relating to farming practices through the Internet or offline through the telephone and through provision of opportunities for physical and virtual networking. According to Mulozi, telecentres provide an access to online market information services, access to local price information, farming tips, marketing information, and knowledge sharing amongst rural farmers. In recent years, telecentres have been thought of as an alternative bridge to the information gap created as a result of development in ICTs (Etta and Wamahiu, 2003). According to Gomez and Hunt (1999), telecentres can give solutions to developmental problems around the world because of their ability to provide desperately needed access to ICTs. Telecentre services could be a reliable and affordable way of information communication in rural Tanzania too because they have a potential for providing a range of services such as computer training, internet services, telephone and fax services and community radios (Methusela, 2007). The challenge is how to apply these approaches more widely to enable rural communities, farmers in particular and their governments, in developing countries, to manage information more effectively and develop communication strategies that make information relevant to farmers' needs.

According to Tanzania government master plan, each village should be provided with tele-communication facilities by 2020, but how and who is to put this into effect? It is true that the Rural Development Strategy (RDS) of 2001 promotes the introduction of information and communication technology in rural areas through creation of telecentres, but supervision seems to be a problem. Services by telecentres might include basic communication by telephone, fax, e-mail, internet access, etc. public and semi-public sector services such as tele-medicine, distance education, municipal governance services, etc.; and private sector services like news distribution, telecommunication services, training, access to information on markets, crops and weather conditions etc. But, is this a reality in the study area? Actually not.

2.3.6 The role of traders

Traders know prices in various markets and can enter into price arbitrage operations, whereas small producers have to limit themselves to possibly lower price realization in neighbourhood markets. Farmers, by interacting with traders through mobile phones can access price information in different markets (Prahalad, 2004; Jensen, 2007). According Aker (2010) and Jensen (2010), traders have an influence on the use of mobile phones as they reduce search costs and inter-market price dispersion. For instance, Jensen (2010) pointed out that traders' characteristics such as strong market power, high literacy level and their monopoly behaviour could contribute to lowering farm-gate prices of farmers' products.

2.3.7 Farmers as consumers of agricultural information

To be able to use a particular technology, consumers need to have the necessary knowledge of how to use and manage any associated risks. Likewise, obtaining access to these technologies requires knowledge of first, the existence of the technology, second,

ability to assess its suitability as well as the potential risks, and third the ability to obtain and finance such technologies (Aker, 2010). A large number of personal, situational and social characteristics of farmers as consumers of agricultural information have been found to be related to adoption behaviour (Ray, 2001). Furthermore, URT (2010) indicated that socio-economic status, network availability and language to have an effect on the use of the mobile phone in communicating agricultural information to farmers in Tanzania. Yet, Sisay (2007) argues that many African rural areas are frequently without electricity or not wired for electricity at all, or if they have access to electricity in their homes it is often expensive.

2.4 Definitions of Concepts

2.4.1 Data, information, and knowledge

Defining data, information and knowledge can help to understand the relationship between them. According to Baumann (1999), the three terms are differentiated as follows: Data is defined as the raw material such as facts and figures that could be collected by an information system while information refers to the analyzed data, often presented in a form that is specifically designed for a given decision-making task, and transmitted to decision makers. According to Chailla (2001), information can also be defined as meaningful message transmitted from sources to users for the purpose to bring in knowledge to the users. On the other hand, knowledge refers to the subsequent absorption, assimilation, understanding and appreciation of information.

2.4.2 Information and communication technology (ICTs)

Michiels and Crowder (2001) defined ICTs as a range of electronic technologies which when converged in new configurations are flexible, adaptable, enabling and capable of transforming organizations and redefining social relations. ICTs, therefore, are an

expanding assembly of technologies that can be used to collect, store and share information between people using multiple devices and multiple media (Chapman and Slaymaker, 2002). According to Gerster and Zimmermann (2009), ICTs are characterized by interactivity, permanent availability, global reach and reduced per unit cost for more than a few.

2.4.3 Information exchange networking

Information exchange networking in this context refers to a collaborative process of information interchange, around a central theme carried out by actively interested parties. It can be contacted through several media, such as face-face, telephone, film, Television and Radio (Aker and Mbiti, 2010). The key characteristic of networking is that it is a process of exchange, ruling out the traditional one-way information flow from one centre, such as an agricultural research centre which simply sought to inform audience about its activities.

2.4.4 Information as a factor of production

Demiryürek (2008) states that agricultural information is a critical factor in agricultural production since the productivity of the other four factors of production namely land, labour, capital and managerial ability are anchored on the reliability and authenticity of agricultural information. According to Chowdhury and Wolt (2003), information and communication technologies are becoming inputs in the production process. They see information as going forward before other factors of production, which are land, labour, capital and management.

2.4.5 Agricultural information

Agricultural information has been defined as all published and unpublished knowledge on all aspects of agriculture (Bello and Obinne, 2012). Aina (1995) categorizes agricultural information into scientific, socio-cultural, commercial and legal. Technical information is a result of research and development; commercial information relates to the marketing of produce; socio-cultural information is made up of famers' traditional practices, also called indigenous knowledge; and legal information is concerned with legislation regarding taxes, sale of produce, land distribution and tenure. Rolling (1988) uses a systems approach to describe an agricultural information as a system in which agricultural information is generated, transformed, consolidated, received and fed back to underpin knowledge utilization by agricultural producers.

2.4.6 Stakeholders

Stakeholders are individuals or institutions who should be participants of a particular process (Burger and Mayer, 2003). Multi-stakeholder processes can be seriously risked if the partners are not well balanced in terms of participation in the process. The identification of relevant or important stakeholders is an important step in the generation of a multi-stakeholder initiative.

2.4.7 Technology adoption

Technology refers to productivity tools, functional business processes and e-business (Chong, 2004). Technology adoption, therefore, refers to the choice to acquire and use a technology (new invention or innovation). It may also refer to decision by an organization or individual, to utilize and or implement a particular technology (Zhu and Kraemer, 2005; Srivastava and Teo, 2006). Other literature describes the term as the extent to

which a given technology becomes accepted and incorporated into approved social practices.

2.4.8 Diffusion of innovation

Diffusion of innovation is the process by which something new spreads throughout a population. Diffusion can be defined as the process by which a new innovation is communicated through mass media as well as word-of-mouth in a specific context (Forlani and Parthasarathy, 2003; Deffuant *et al.*, 2005; Hafeez *et al*., 2006).

2.4.9 Communication

Communication is a metaphoric pipeline through which messages and information are transferred from the source to the receiver (Canary *et al*., 2008). Yet, Frey *et al*. (2000) define communication as the management of messages for the purpose of creating meaning.

2.5 Embracing Gaps in Literature

By and large, studies in the field of mobile phone technology have been distinguished into three main dimensions which are studies on determinants of mobile adoption, impacts of mobile phone use and interrelationships between mobile technologies and users. A number of research gaps cut across the empirical literature on mobile phone usage in farming business. For instance, while several studies provide evidence on the key role that mobile phones are playing in improving information transmission, less or little has been documented about the roles that different stakeholders could play to enhance the use of mobile phones in agriculture. Equally, limited research has examined how farmers' characteristics influence effective usage of mobile phone to communicate agricultural information. This study, therefore, fills in an evident gap of little knowledge on types of

support which different stakeholders have and could avail to advance the use of mobile phones for communicating agricultural information.

2.6 Chapter Summary

Literature has shown that mobile phone technology is becoming an important tool that greatly affects social operations. The technology has quickly become the world's most common way of transmitting information. As a result, mobile phone applications hold significant potential for advancing development both in agriculture and in other developmental sectors. Several studies provide evidence on the key role that mobile phones are playing in improving information transmission between farmers and research institutions, government, private input companies, input-dealers, and other agrarians. However, there is lack of studies on roles that different stakeholders could play to enhance the use of mobile phones in agriculture. Largely, previous studies in the field of mobile phone technology have been distinguished into three main dimensions which include studies on determinants of mobile adoption; impacts of mobile phone use and the interrelationships between mobile technologies and users. This study, therefore, fills an evident gap of little knowledge on types of support which different stakeholders have and can avail to advance the use of mobile phones for communicating agricultural services.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Description of the Study Areas

The study was conducted in two districts namely Kilolo and Kilosa in Iringa and Morogoro Regions, respectively. The two districts were purposively selected because ownership of mobile phone in these districts has been growing over time (Nyamba and Mlozi, 2012; Sife *et al*., 2010). Another reason for selecting the two districts was the presence of agricultural research centres and telecentres. Another consideration was that, the two districts are well dispersed, Kilolo in the southern highlands and Kilosa in the Eastern part of Tanzania.

Kilolo district is one of the three districts in Iringa region of Tanzania. Its geographical coordinates are 8°S and 35^0 51'E, and borders with Morogoro region to the North and East, Mufindi district is to the South and Iringa Rural district is to the West (Fig. 4). According to the 2012 census, Kilolo district is administratively divided into three divisions (Kilolo, Mazombe, Mahenge), 12 wards, 83 villages, 415 hamlets and has 42 002 households (NBS, 2012). The twelve wards are: Bomalang'ombe, Idete, Ilula, Image, Irole, Lugalo, Mahenge, Mtitu, Udekwa, Uhambingeto, Ukwega, and Ukumbi.

Kilosa district is located in Morogoro region in Tanzania. Its geographical coordinates are 6° 50' 0" South, 36° 59' 0" East. The district is located approximately 300 km inland from the coast of the Indian Ocean and Dar es Salaam, along the old East African caravan routes stretching from Bagamoyo to the Eastern part of the Democratic Republic of Congo (URT, 2009). Today, Kilosa is one of six districts within Morogoro region; it is 14 245 km^2 wide making up about 20 per cent of the region (KDC, 2010). As shown in

Fig. 5, the district borders Tanga region to the North and Morogoro District to the east. In the south, it is bordered by Kilombero district and part of Iringa Region (KDC, 2010). According to the 2012 census, there were 489 513 people living in Kilosa. Over 80% of the people in Kilosa depend on agriculture (Maganga *et al*., 2007).

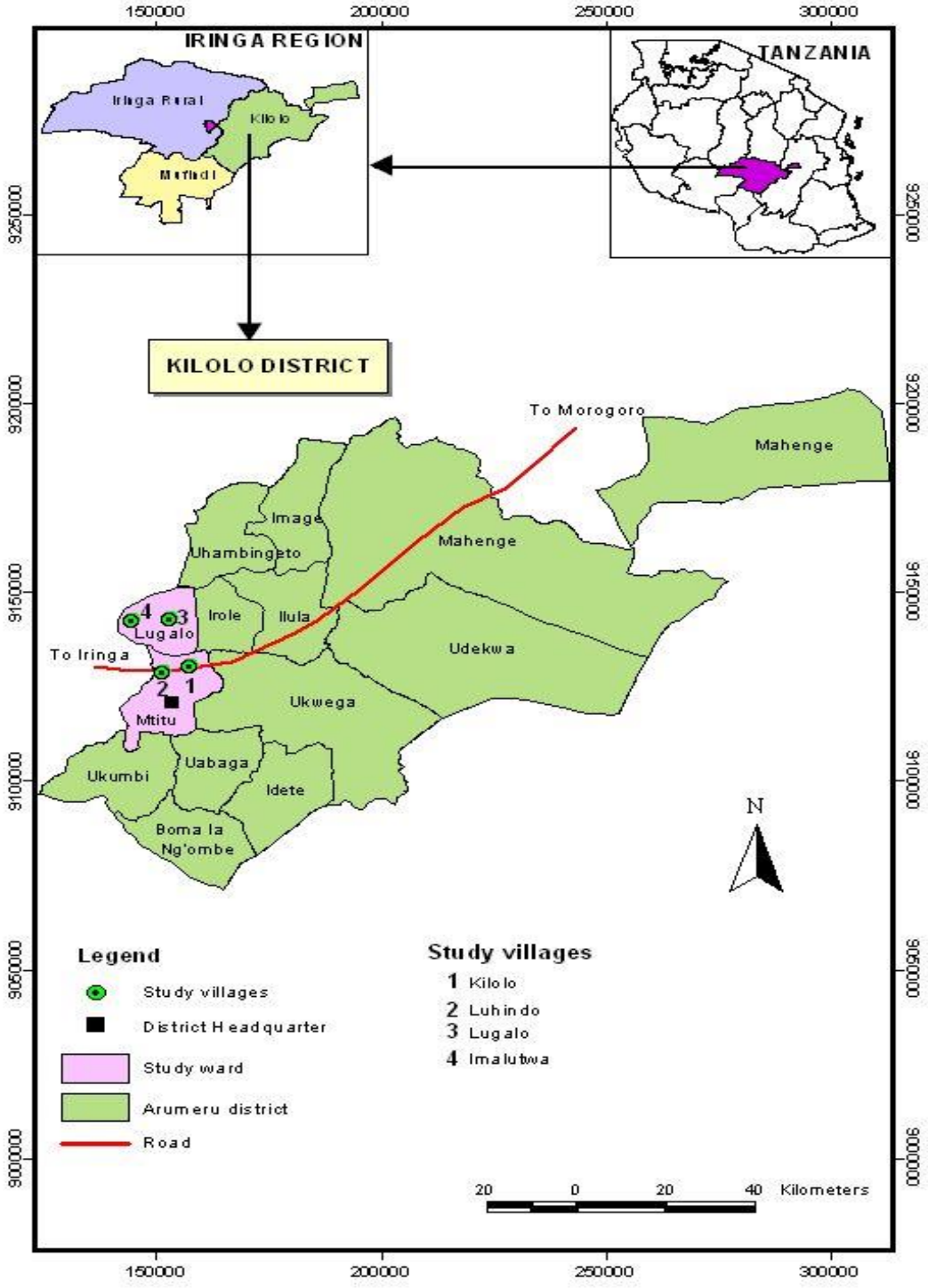

Figure 4: Map of Kilolo District showing study villages

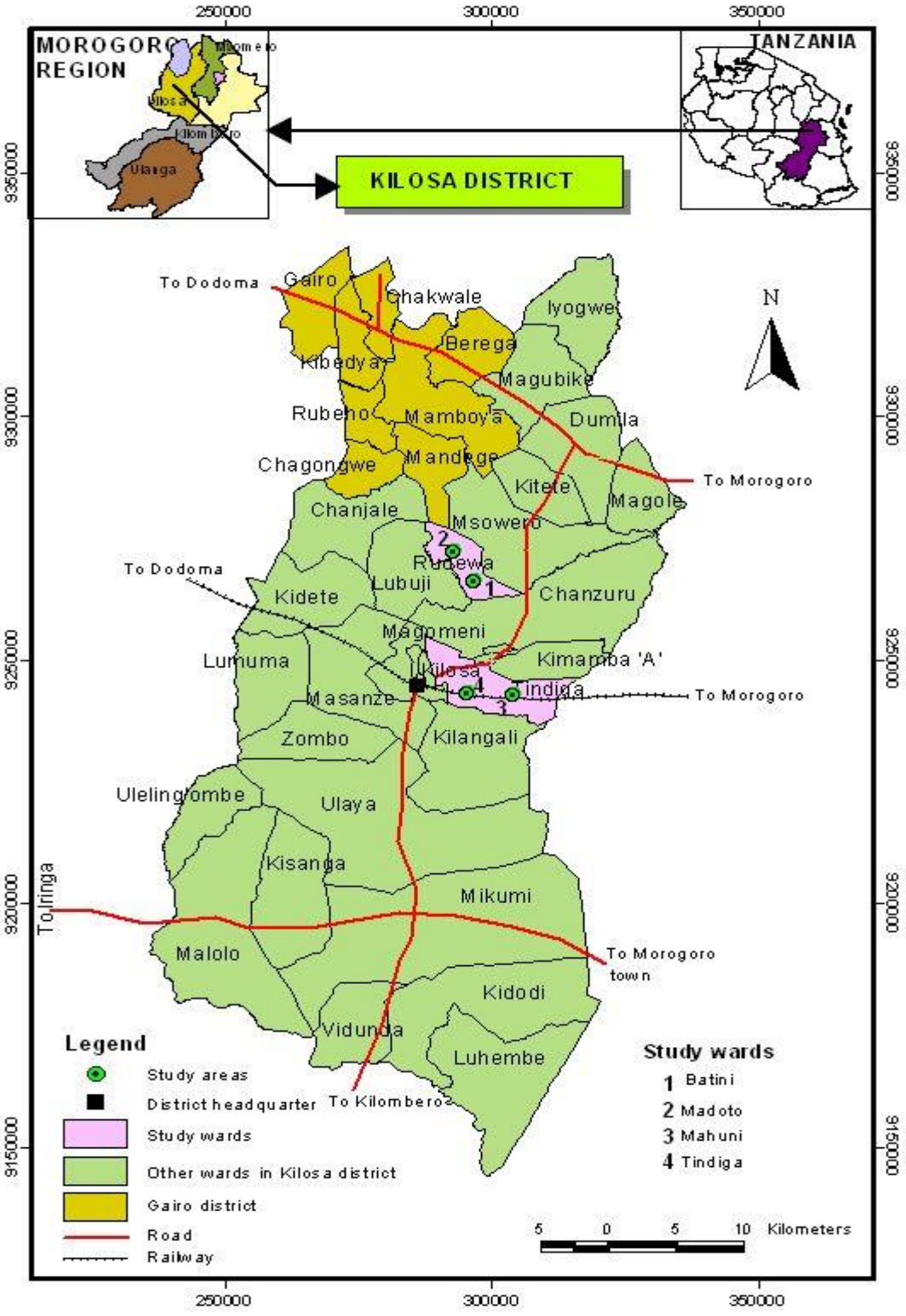

Figure 5: Map of Kilosa District showing study villages

3.2 Research Design

According to Bryman and Bell (2011), research design represents the structure that finds way to the collection and analysis of data to solve given research questions. Babbie and Mouton (2002) define research design as a plan of how a researcher conducts his research. The basis for selecting a particular research design greatly depends on the kind of information that is to be collected. Thus, based on the nature of the research questions of a study (being descriptive), a cross sectional research design was adopted. According to Bailey (1994) and Casley and Kumar (1987), cross- sectional research design allows data to be collected at a single point in time to capture important aspects. The design is also considered appropriate for descriptive analyses and for generalization.

3.3 Sampling Procedure, Sampling Frame and Sample Size

3.3.1 Sampling procedure

The study adapted a multi-stage sampling technique. First, the two districts were purposively selected. Purposive selection of the district was based on several reasons, including the fact that: the rural areas of these districts have gradually become active in the use of mobile phones related services and that mobile phone ownership in these districts has been growing over time. Equally, the main economic activity in both districts is agriculture; so the majority of its people are farmers (Sife *et al.*, 2010; Nyamba and Mlozi, 2012). Also, both districts have community telecentres and agricultural research stations (i.e. Dabaga and Msimba seed farms) for Kilolo and Kilosa, respectively. Purposive sampling was also used to select four wards which were included in the study based on mobile phone network availability. The four wards were: Mtitu and Lugalo in Kilolo district, while in Kilosa district Tindiga and Rudewa wards were selected. Then, in each ward, two villages were selected based on similar criteria making a total of eight

study villages, which were, Luhindo, Kilolo, Imalutwa and Lugalo in Kilolo District, while those of Kilosa were Madoto, Rudewa, Malui and Tindiga.

3.3.2 Sampling frame and sample size

The sampling frame included all farmers in the study areas. An individual farmer formed a sampling unit of the study. From each participating village, the National Agriculture Input Voucher Scheme (NAIVS) register was used to obtain sampling frames. The register(s) had names for all farmers in a particular village, hence individual farmers were sorted out and randomly selected to form a group of respondents. Then, Simple random sampling (SRS) technique was used to obtain a sample size of 30 respondents in each village making a total of 240 respondents for interview. A sample of 30 or more is believed to result in a sampling distribution that is very close to the normal distribution (Saunders *et al*., 2007). Other scholars (Agresti and Franklin, 2012; Louangrath, 2014; Abranovic, 1997) advocate that in post facto, descriptive, correlational and or causal research, 30 subjects per group is often cited as the minimum sample. SRS was adopted in order to ensure that the estimated parameters in relation to the dependent variable represent the population as adequately as possible (de Vaus, 2002).

The researcher also interviewed other stakeholders who were likely to interact with farmers in the process of using mobile phones to communicate agricultural information. This included representatives from agricultural research institutions, extension agents, traders, input suppliers, mobile phone service providers, Tanzania Communication Regulatory Authority (TCRA), Tanzania Meteorological Agents (TMA) and the Ministries of Agriculture, Livestock and Fisheries Development. Finally, the sampling plan was as illustrated in Table 2.

Table 2: Summary of Sampling Plan for the Study

Districts	Divisions	Wards	Villages	Farmers	Government officials	Researchers	Extension agents	Traders	DAICOs	TMA	TCRA	Input dealers	Phone companies	Telecentres
Kilolo	Kilolo	Mtitu	Kilolo	30	1	2	1	1	1	1		1	3	1
			Luhindo	30								1		
	Mazombe	Lugalo	Lugalo	30			1	1				1		
			Imalutwa	30								1		
Kilosa	Kimamba	Rudewa	Madoto	30	1	2	1	1	1	1	1	1		1
			Rudewa	30								1		
	Masanze	Tindiga	Malui	30			1	1				1		
			Tindiga	30								1		
Total				**240**	**2**	**4**	**4**	**4**	**2**	**2**	**1**	**8**	**3**	**2**

3.4 Research Approach

To address the research objectives, a pragmatism view point was found ideal, whereby both qualitative and quantitative research approaches were involved. According to Teddlie and Tashakkori (2010), pragmatism view point allows the researcher to use multiple perspectives in seeing and understanding a phenomenon. With pragmatism paradigm, the researcher is free from the need to adhere solely to either quantitative or qualitative methods; instead he/she can focus on research questions and select whichever methods deem appropriate to respond to the research questions (Creswell, 2014). With this view point, the researcher neither aligns him/her self with objectivist view point of a reality which exists distinctly to human experience nor does he/she position wholly within a world centered on the subjective perspective of the researcher's mind (Creswell, 2014).

As such, the study adopted a mixed methods research approach, which, according to Teddlie and Tashakkori (2010) and Clark *et al.* (2008) entails collection and analysis of both qualitative and quantitative data. The idea put forward is that considering both qualitative and quantitative data can result into a better understanding of the phenomena being studied as it provides opportunity to exploit advantages of each approach (Cowger and Menon, 2001). For example, the researcher becomes able to examine both statistical results and the overall trends along with in-depth individual perspectives and the context in which they occur. The advantages of mixed research approach, which is arguably a major methodological approach (Clark *et al*., 2008) compared to the other two main approaches, is that it is effective in addressing many of the research questions of interest today that seek to both understand and generalize findings. Mixed research approach is also termed as hybrid approach (Krotz, 2006), Multi-methods (Hartmann, 2006; Irwin, 2008; Oksman, 2006) combined research, convergence and or integrated approach (Creswell, 2003). The whole process of the research approach is summarized in Fig. 6.

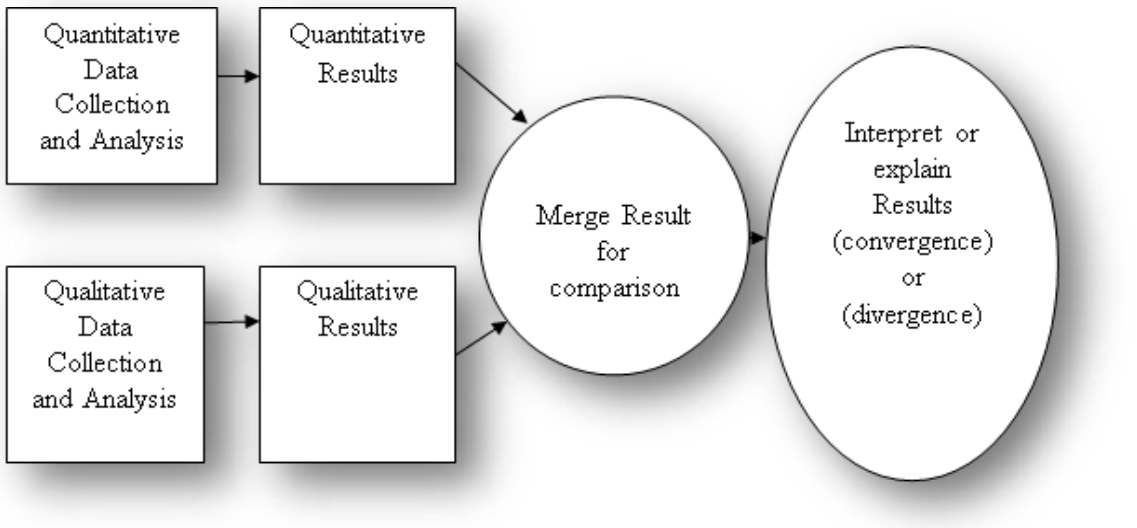

Figure 6: The research approach, adapted from Creswell 2003.

3.5 Data Collection Methods and Tools

3.5.1 Methods of data collection

The study used three main data collection methods, namely interviews with farmer respondents, key informants interviews, and focus group discussions. These methods were designed such that they complemented each other in terms of analysis, and verification. Interview guide was the main tool for the survey process of the study. To come up with a worthy interview tool, the researcher adhered to the rules and guides for interview guide formulation. According to Bryman and Bell (2011), interview guide consists of a range of detailed questions that the researcher asks in an interview setting. Punch (2006) said that, there is a direct relationship between the specific research questions and questions for data collection through an interview guide. Bryman and Bell (2011) concluded that the interview guide is, therefore, the primary tool the researcher has in the interview setting to investigate a research question of a particular study. Bryman and Bell further suggested a way a researcher can follow to formulate questions in his/her research guide (Fig. 7).

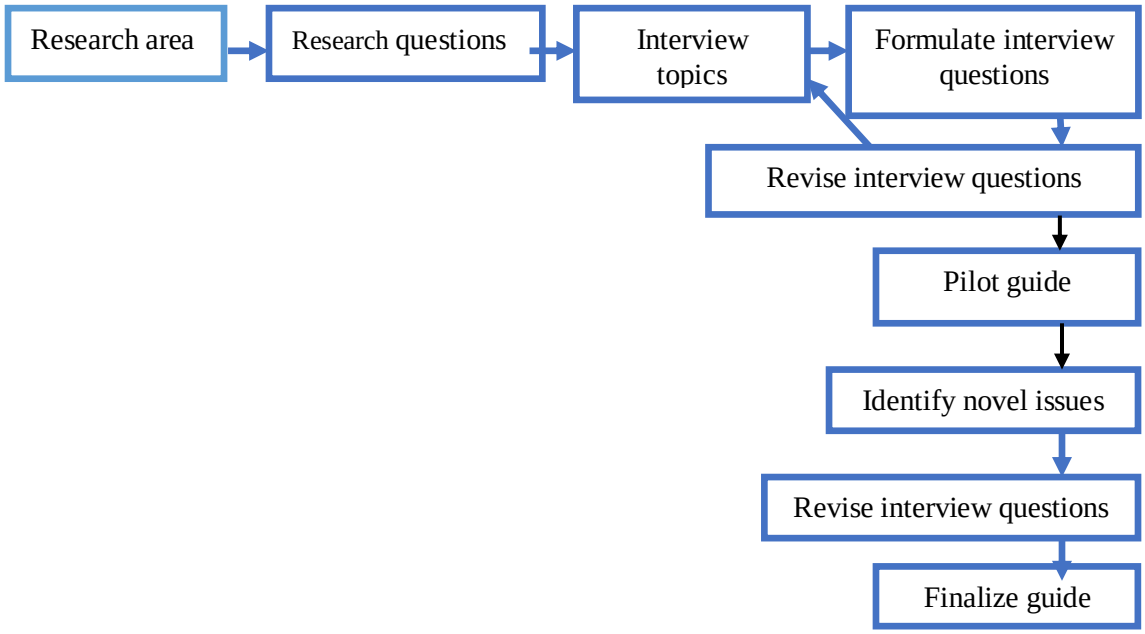

Figure 7: Steps in formulating interview questions, adapted from Bryman and Bell, 2011

Survey method is known to be a very appropriate method of collecting data for descriptive or exploratory studies, and suitable where individuals are the unit of analysis for measuring attitude, perceptions and personal qualitative skills (Rossie and Freeman, 1993; Kerlinger, 1986). Also, it is considered suitable to gain responses from a large sample size and set of questions in a short period of time and gives room for researchers to generalize findings to a wide population (Bryman, 2008; Neuman, 2006). Responses from survey are often analyzed in statistical format (Crotty, 2003). Both quantitative and qualitative methods were carried out, though quantitative survey had a dominant status. Different scholars (Creswell and Clack, 2007 and Carney *et al*., 1999) have shown the differing strengths of mixed-methods design, one being ability to counteract weaknesses of individual methods.

According to Tacchi *et al*. (2003), when survey method is used in conjunction with other methods they complement data collected from each. The selection of respondents

considered gender alarm whereby a balance of male and female interviewees was observed as shown in Table 3.

Table 3: Composition of respondents by their village and sex (n =240)

Respondent's village	Respondent's Sex		Total
	Male	Female	
Kilolo	25	5	30
Luhindo	23	7	30
Batini	20	10	30
Madoto	22	8	30
Tindiga	18	12	30
Malui	20	10	30
Imalutwa	25	5	30
Lugalo	23	7	30
Total	**176**	**64**	**240**

Four FGDs were also conducted with an average number of 12 participants in each group. In each team gender sensitivity and coverage from various sub-villages was considered. Important considerations to involve a member in a focus group interview included group homogeneity in terms of their socioeconomic characteristics and experience. FGD interviews were recorded and transcribed into practical themes for analysis and discussion. Participants for FGDs were purposively picked amongst sample frame based on group homogeneity in terms of their socioeconomic characteristics and experience as suggested by Malhorta (2002).

The researcher also conducted Key informants Interviews (KIIs) with 30 purposively chosen representatives who included officials from the Ministry of Livestock Development and Fisheries (1), Ministry of Agriculture Food Security and Cooperatives (1) District Agriculture, Irrigation and Cooperative Officers (DAICO) (2) Agricultural Research Stations Officers (2), Input dealers (8), TMA Officials (2), TCRA Officials (1),

Mobile phone companies' representative (3), Telecentres (2), Extension agents (4) and Traders (4). Table 3 summarizes the sampling plan for the study.

Key informants were selected based not only on being active members of the community but also having adequate information and knowledge on the subject matter. The focus of the interviews was more on institutional issues, including policies, regulations and laws and prevailing opportunities and constraints of using mobile phone to communicate agricultural information. Key informant interviews were also designed to provide data about the interviewees' perceptions of the mobile phone use in farming practices, linkages, interactions and competencies of farmers required to manage smooth use of mobile phones technology to communicate agricultural information. Generally, the interviews yielded in-depth opinions and perceptions, which were combined with the outlines from FGDs and used as a basis for further inquiry in the survey process.

3.5.2 Testing of the instrument

The worthiness of a questionnaire is judged in the course of the pretest. Based on this understanding the instrument was pretested to verify its validity and reliability. According to Synodinos (2003), question construction is a highly developed art from within the practice of scientific enquiry and even small changes in wording may have a considerable effect on the resultant data. As depicted by Synodinos (2003), a questionnaire must go through several stages before its final version is utilized in the actual processes of data collection. Synodinos (2003) summarizes steps to follow during the questionnaire construction process (Fig. 8).

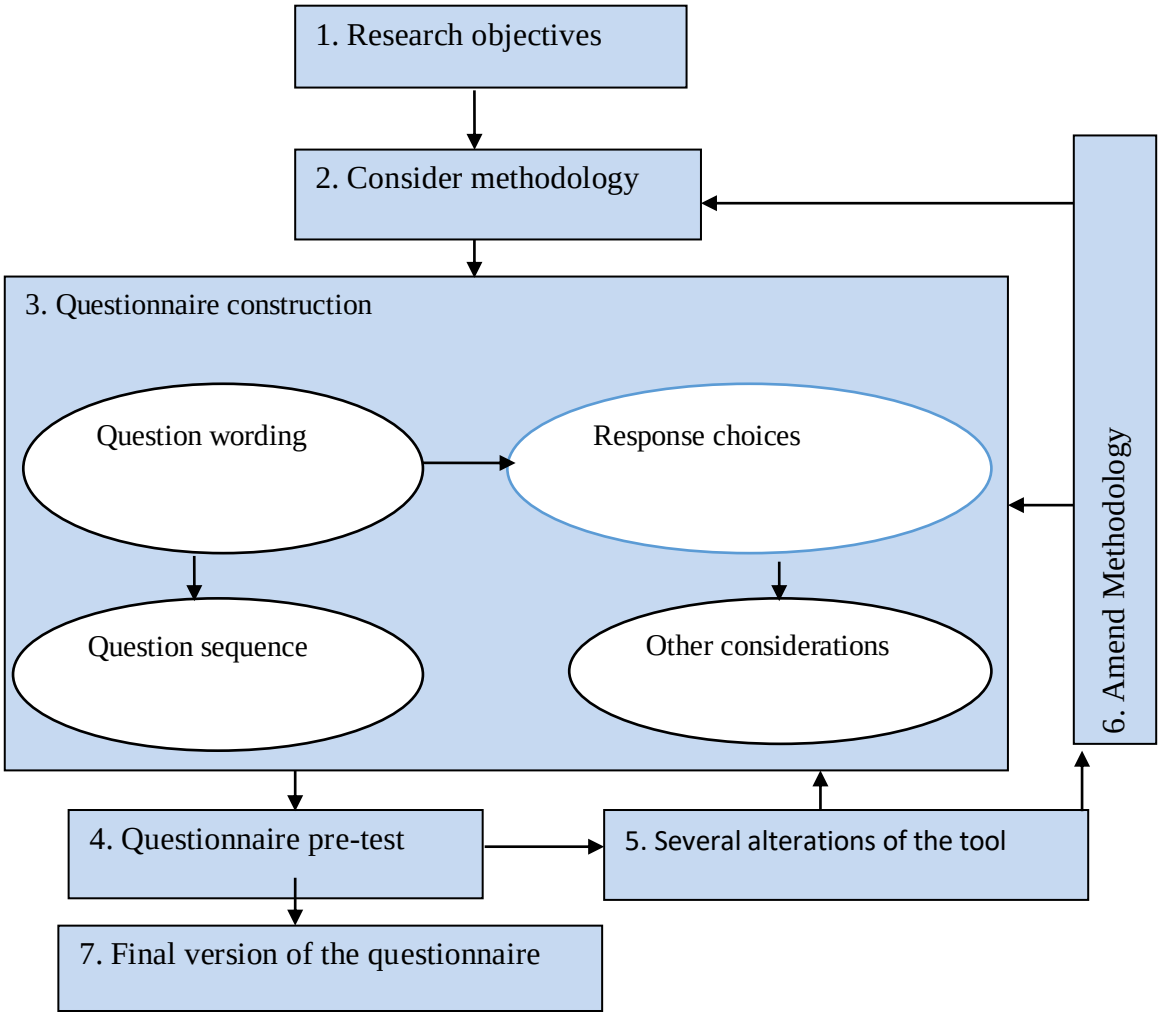

Figure 8: Questionnaire construction process, Adapted from Synodinos (2003)

3.5.2.1 Validity and reliability of the instrument

Validity is defined as the extent to which accurate and meaningful inferences can be drawn based on the results obtained from an instrument. Mainly, two types of validity (content and construct) are used to evaluate the inferences based on the results from an instrument. Content validity is the degree to which an instrument accurately measures the variable it claims to measure (Kathuri and Pals, 1993).

That is to ensure that the items in the questionnaire represent the context area. On the other hand, construct validity is a measure of the degree to which data obtained from the instrument meaningfully and accurately reflect theoretical concepts (Mugenda and Mugenda, 2003). Therefore, to ensure both content and construct validity, items in the instrument were checked and revised against objectives while at the same time the researcher sought expert opinion concerning the worthiness of the instrument. Two general approaches were involved in assessing construct validity: first, through the whole process of questionnaire construction the researcher kept on examining the content of the measure whether it made sense or not then adjusting accordingly. Secondly, reliability test enabled to spot relationships among variables.

3.5.2.2 Reliability of the instrument

Joppe (2006) defines reliability as the extent to which results are consistent over time under similar methodology and accurate representation of the total population under study. According to Kombo and Tromp (2006), pretesting of an instrument is compulsory to ensure its reliability. Reliability was tested using Spearman-Brown Coefficient, which, according to Mugenda and Mugenda (2003), is also known as Spearman-Brown Prophecy Coefficient. The researcher pre-tested the reliability of the instrument using a random sample of 20 respondents, 10 in each of the purposively selected villages (Lulanzi and Mbigili) in Kilolo District. The two localities were selected because they had similar characteristics as those found in the study villages. The 20 respondents were chosen based on the suggestion by Kathuri and Pals (1993) that 20 cases is the smallest number for meaningful results in data analysis. The pretest data were subjected to split half analysis technique to yield Spearman-Brown reliability coefficient $2r_{sb}$.The actual equation for Spearman-Brown reliability coefficient is:

$$2r_{sb} = 2r_{xy}/1 + r_{xy} \quad \text{..... (1)}$$

Whereby, r_{sb} is the split half reliability coefficient and $\mathbf{r_{xy}}$ is the average of inter- item correlation. Spearman infers that if an instrument is reliable, then the two halves would have a split half reliability coefficient between 0.7-1.0 and that a range between 0.7-8.0 is regarded as appropriate. The key idea is that if different measures are measuring the same construct, they should be positively correlated with each other. The result of the split half test yielded a correlation coefficient (r_{sb}) of 0.79, which is within the recommended threshold as inferred by spearman. Thus, it assisted the researcher in revising the instrument before using it for actual data collection.

3.6 Data Collection

3.6.1 Primary data

Primary data were collected from 240 respondents using face-to-face interviews. In order to avoid the possibilities of low response rates caused by low levels of literacy as the case with self-administered questionnaire (Laws *et al*., 2013), face to face interviews were carried out verbally with individual respondents. Checklists for FGDs and key informant interviews were also used to discuss with various stakeholders on aspects of mobile phone use in agriculture. Data collected included socio-demographic data, informational needs, access to mobile phone and use, access to agricultural information and challenges faced. Primary data were complemented by secondary data obtained from various sources, including documents such as government reports, journal articles, books, and websites.

3.6.2 Secondary data

Primary data were complemented by secondary data which were obtained from various sources including the Department of Research and Development (DRD) of the Ministry

of Agriculture, Food Security and Cooperatives, Ministry of Livestock Development and Fisheries, Tanzania Communication Regulatory Authority, (TCRA) and the SUA National Agricultural Library (SNAL). The documents reviewed comprised government reports, publications, journals, books, and website. The aim was to gain insights into type(s) of support given to mobile phone users by different stakeholders, mobile phone programmes documented so far, challenges and or factors influencing the use of mobile phones to communicate agricultural information.

3.7 Data Analysis

3.7.1 Quantitative data analysis

Quantitative data which were collected through interviews were summarized, coded and entered in the International Business Machines (IBM SPSS) Statistics Version 20 for analysis. Descriptive statistics including frequencies, means, percentages and standard deviations were determined. The essence was to determine level of mobile phone use among respondents, nature of interaction, accessibility to agricultural information, nature of linkage and type of help between and amongst identified stakeholders. Chi-square tests and regression analyses were also performed to test for relationship between variables and rule out which variables and identify the best predictors, respectively. Thus, the best predictors of effective use of mobile phone to communicate agricultural information were identified from the list of potential independent variables of the study.

3.7.1.1 Model specifications

With the aim of addressing the third objective as well as hypothesis number three that meant to establish roles of different stakeholders influencing the use of mobile phones to communicate agricultural information, the appropriate model specifications is as illustrated below.

Binary Logistic regression model

Data were analyzed using a binary logistic regression model as described below:

$$Pi = E\ (Y = \frac{1}{X}) \frac{1}{e^{-zi(\beta 0+\beta 1+x1)}} \quad \text{..... (2)}$$

For the case of explanation, Equation 1 is further interpreted as follows:

$$\text{Pi} = \frac{1}{1+e^{-zi}} \quad \text{..... (3)}$$

Therefore, the probability that a given individual used mobile phones to communicate agricultural information is expressed by Equation 2 while the probability of not using ICTs is expressed by Equation 3.

$$\text{1-Pi} = \frac{1}{1+e^{-zi}} \quad \text{..... (4)}$$

As a result, Equation 3 can further be expressed as shown below

$$\left(\frac{Pi}{1-Pi}\right) = \frac{1+e^{zi}}{1+e^{-zi}} \quad \text{..... (5)}$$

Thus, $Pi/(1-Pi)$ simply expresses chances that an individual is likely to use mobile phones to communicate agricultural information. This is the ratio of the probability that an individual will use mobile phones to communicate agricultural information to the probability that he will not use it. Finally, taking the natural log of Equation 4,m we obtain:

$$L_i = \ln\left(\frac{Pi}{1-Pi}\right) = Z_i = \beta_0 + \beta_1 X1 + \beta_2 X_2 + \beta_n X_n \quad \text{..... (6)}$$

Where, P*i* is the probability of using mobile phone in communicating agricultural information ranging from 0 to 1, Z_i is a function of n explanatory variables (x), β_0 is an intercept, *β1, β2 …βn* are slopes of the equation in the model, Li is the natural log of the

odds ratio, which is linear in the parameters, X_i is a vector of a particular individual characteristics. But, if the disturbance term (U_i) is introduced, the logit model becomes:

$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_n X_n + U_i$ ..... (7)

Therefore, this study used the above model in Equation 6 to analyse data. The procedure yields unbiased, efficient and constant parameter estimation.

The assumptions of the model

Basically, as far as the study is about communication between information sources and receivers, the model presupposed that correspondents have the role to facilitate a smooth communication of information. Logically, such a model runs as follows:

- Socio-demographic characteristics of farmers relate to their use of mobile phones to communicate agricultural information;
- Ownership and access to mobile phones as a precondition for use;
- Skills (mobile phone-literacy) as a precondition for use;
- There must be need for agricultural information as a precondition for receiving agric information;
- There must be mobile phone applications for agricultural information as a precondition for users to go for; and
- Farmers' capabilities as a precondition to using mobile phones in farming.

This is when we looked, as one way information communication from facilitators to users. Then, the researcher turned around and similarly presumed conditions for effective communications when facilitators interact with farmers. The study hypothesized that planners needed to have communication capabilities of (a) selecting the right message, (b) formulate it in the right way and (c) send it the right way and through proper channels.

3.7.2 Qualitative data Analysis

Qualitative information collected from the FGDs and key informant interviews were conceptualized, summarized, coded and categorized using content analysis. Both FGDs and key informant interviews were recorded and transcribed into practical themes by the researcher for discussion. The researcher sorted phrases and issues that recurred during discussion and established themes. According to Braun and Clarke (2006), a theme captures something important about the data in relation to the research question and represents some level of patterned response or meaning within the data set. According to the present study, arrangements of commonly recurring themes revealed some patterns and processes related to mobile phone use and support availed to smallholder farmers in the study area. Largely, the results are concurrently presented with quantitative findings in chapter four in a way that the qualitative results elaborate and complement quantitative findings.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

This chapter presents the findings of the study according to the specific objectives. The first section discusses the first objective which is about socio-demographic characteristics of individual respondents. It covers farmers' characteristics such as age, sex, marital status and literacy level. Other socio-demographic variables discussed include off-farm activities, income and farming systems. Also, it discusses farm contextual characteristics such farm sizes, scale of production and market locations and their effect on the use of mobile phones in communicating agricultural information.

Subsequent sections describe the remaining four objectives, first it describes about farmers' agricultural information needs and their liable sources. It further highlight the limitations of using mobile phones to communicate agricultural information and the ways to improve its use. Second, it describes the role of different stakeholders influencing the use of mobile phones in communicating agricultural information. This is followed by a section which illustrates the significance of interactions amongst stakeholders on acquisition and use of agricultural information through Mobile Phone. Thereafter, a discussion is given on institutional factors governing actions of different stakeholders on the use mobile phones to communicate agricultural information. Finally, chapter five presents the study conclusions and presented recommendations of the study.

4.1 Respondents' Socio-Economic Characteristics

Of the 240 respondents, 38.3% indicated that their ages were between 46 and 60 years, 35.4% were aged 36 and 45 years; 21.3% were aged between 25 and 35 years; and 3.3% were above 60 years, while a few, 1.7% were below 25 years old. This implies that over

half of the respondents were youth, aged 45 years old or less (Table 4). The majority of the respondents, 73.3% were males and 88.7% were married. Regarding their literacy level, most of the respondents, 82.9%, had attained primary school education; 10.8% had secondary school education; a few 3.8% had no formal schooling; and only two respondents, 0.8%, indicated having college and or university education.

Further, a chi-square test of independence was performed with the aim of examining the association between respondents' socio-economic characteristics and the use of mobile phones in communicating agricultural information. For instance, Table 4 shows cross-tabulation between the use of mobile phones with the five age groups with the largest percentage of use in the 46 to 60 age category (38.3%), followed by the 36–45 age group (35.4%), then the 25–35 age group (21.3%) while very few users, 3.3% were in age groups above 60. The results support the idea that mobile phone use differs along age groups. Table 4 shows that the Pearson's chi-square test was significant at χ^2 =12.804, $\rho \leq 0.01$. This implies that age had a statistically significant association with the use of mobile phones to communicate agricultural information.

Moreover, Table 4 shows cross-tabulation between respondents' literacy levels and the use of mobile phones in communicating agricultural information whereby the largest percent (82.9%) of mobile phone users indicated to have attained primary education, followed by those with secondary education (10.8%). A chi-square test confirmed that respondents' literacy levels significantly associated with the use of mobile phones to communicate agricultural information at $\chi^2 = 22.394$, and $\rho \leq 0.001$. Similar findings were reported by Alampay (2003) and Onwuemele (2011) who found that education determines the level of both access and use of ICTs. Therefore, based on age and literacy, we partly reject the null hypothesis that, demographic variables had no statistical

significant influence on farmers' use of mobile phones to communicate agricultural information. However, other variables, such as sex and marital status had no statistically significant influence on the dependent variable.

Association between sex category and mobile phone use in communicating agricultural information was determined. However, it was found that there were no statistically significant association between sexual categories on mobile phone use to communicate agricultural information at $\rho > 0.05$. The findings are different from the conclusions arrived at by other scholars (Bigne *et al*., 2005; Frempong, 2009 and Singh, 2012) who established that on average women and men do not exhibit important differences in ICT adoption and usage. These findings also contradict those of Souter *et al*. (2005) which established that normally women tend to be more marginalized than men in technology adoption. The study is also not in line with the conclusion made by Kiiza and Pederson (2012) who highlighted that the likelihood of access to ICT-based market information among farmers declines with female-headed households. Marital status was another variable which was found to be not significantly related to the use of MPs to CAI.

Table 4: Respondents' socio-economic characteristics association with the use of mobile phones to communicate agricultural information

Variables	Frequent	percent	Use mobile phones to CAI		χ^2	ρ -value
			Yes	No		
Age						
Less or equal 45	140	58.4	129	11	12.804	0.012*
46-60 years	92	38.3	90	2		
Above 60 years	8	3.3	8	0		
Sex						
Male	176	73.3	166	10	0.091	0.763*
Female	64	26.7	61	3		
Marital status						
Single	27	11.3	26	1	0.174	0.676*
Married	213	88.8	201	12		
Literacy levels						
No schooling	9	3.8	7	2	22.394	0.000*
Primary education	199	82.9	190	9		
Secondary educatn	26	10.8	26	0		
College/University	2	0.8	2	0		
Adult education	4	1.7	2	2		

*Significant at $\rho \leq 0.05$; ^{ns} Not significant at $\rho \leq 0.05$

4.2 Other Socio-Economic Characteristics Associated with the Use of Mobile Phones

4.2.1 Off-farm activities, income levels and farming systems

The study results in Table 5 indicate other respondents' characteristics that affected use of mobile phones to communicate agricultural information, including their involvement in off-farm activities, their income levels and farming system involved. For instance, of the 240 respondents, 15.75% mentioned that apart from being directly involved in farming activities, they were also engaged in off-farm activities which included tailoring (5%), buying and selling agricultural products 3.8%, formal employment (1.4%), local brewering (2.9%), and food vending (0.4%). The results indicated that off-farm activities had a statistically significant associated with the use of mobile phones to communicate agricultural information at $\chi^2 = 89.88$, $\rho \leq 0.001$. Respondents explained that off-farm incomes provided them with extra money which they used to buy air time for mobile phone use.

Moreover, as seen in Table 5, the study revealed a disparity in mobile phone usage among respondents due to their differing income levels. A chi-square test showed that income levels were associated with the use of mobile phone to communicate agricultural information at $\chi^2 = 6.493$, $\rho \leq 0.039$. Similar conclusions were established by Chowdhury and Wolt (2003) who found a positive correlation between incomes and the use of mobile phones. However, the results differed with those of Mwombe *et al*. (2013) who found that incomes had no effect on the use of mobile phones as a source of information for banana production and marketing among farmers in Gatanga District, Kenya. On the other hand, a chi-square test indicated that farming system was related with the use of mobile phones to communicate agricultural information and was found to be statistically significant at $\chi^2 = 8.062$, $\rho \leq 0.018$.

Table 5: Association among Off-farm activities, income levels, and farming systems with use of mobile phones to communicate agricultural information

Variable	Use mobile phones to CAI		Chi-square test	
	Yes (%)	No (%)	χ^2	ρ -value
Off-farm activities				
Tailoring	12 (5)	0 (0)	89.878	0.000*
Buy-sale agro-products	9 (3.8)	10 (4.2)		
Local brewing	7 (2.9)	0 (0)		
Formal employment	4 (1.7)	0 (0)		
Food vending	1 (0.4)	0 (0)		
Income levels				
Less than Tshs 1700	169 (70.4)	7 (2.9)	6.493	0.039*
Tshs 1700-3400	28 (11.7)	0 (0)		
Beyond Tshs 3400	30 (12.5)	6 (2.5)		
Farming system				
Crop production	168 (70)	7 (2.9)	8.062	0.018*
Livestock production	22 (9.2)	0 (0)		
Mixed farming	37 (15.4)	6 (2.5)		

*Significant at $\rho \leq 0.05$; ^{ns} Not significant at $\rho \leq 0.05$

4.2.2 Farm size, scale of production and market location

Moreover, statistical analysis results (Table 6) indicate other variables that had a statistically significant effect on the use of mobile phones to communicate agricultural information, including respondents' farm sizes, scale of production and market locations. With reference to farm sizes, the results showed that, of the 240 respondents, 69.17% were small-scale farmers with land sizes up to two and half acres most of whom (92.8% owned mobile phones, which perhaps they used to communicate agricultural information. A chi-square test revealed that farm size had a statistically significant association with the use of mobile phones to communicate agricultural information at $\chi^2 = 6.488$, $\rho \leq 0.011$. The findings are similar to that by Khanna and Zilberman (1997) who acknowledged that heterogeneity among farms and farm sizes can often explain why not all farmers adopt an innovation in the short-or long-run terms. However, other studies (Rodgers, 2003; Feder and Umali, 1993) went further by differentiating that farm size may be significant for early adopters than in later stages.

Conversely, there are some contradicting agreements between various scholars about the effect of farm size in technology adoption and use. In some studies (Parvan, 2011; Shively, 1999) farm size has been considered an important attribute influencing technology adoption and use (Parvan, 2011; Shively, 1999). Studies show that farmers with larger farms are more likely to adopt new technologies because they can spread costs over a wide range of outputs than it is possible with small-scale farmers. Other studies (Ziggers, 2010; Khanna *et al.*, 2012) show that technology adoption results from a complex combination of several variables that cannot be captured by one or a few variables. The value of information technology in farming is affected by goals and competences of the farmers, and other characteristics of the farm, one being size of the farm (Rougoor *et al.*, 1998).

Another aspect that played a significant role as a determinant of mobile phone use to communicate agricultural information was scale of production. The study hypothesized that farmers with large scale farm could generate more incomes, which partly could be used to buy mobile phones and use them. The study findings showed that there was a statistically significant association between scales of production and respondents' use of mobile phones to communicate agricultural information at $\rho \leq 0.05$. Similar findings were found by Khanna *et al.* (1999) in the Midwest, USA, who indicated that adopters of ICTs, among other things, also had higher crop yields and that adoption tended to skew positively to large famers than to small-scale farmers. However, they noted that higher adoption rates by large-scale farmers could not have been solely due to high production, but more to their ability to hire professional services, access to credit and technical information and more contacts with extension agents and consultants.

Market location was another important aspect that affected the use of mobile phones to communicate agricultural information. Statistics indicate that, of the 240 respondents, 59.2% sold their agricultural products in local markets within their villages (Table 6). Since over half of the respondents sold their products in local markets, many farmers had limited contacts with outside consumers. According to Rogers (2003), selling in distant markets exposes farmers to ideas and opportunities beyond their local social systems. Furthermore, Rowan-Campbell and Tandon (2009) acknowledged that the use of mobile phones could improve the economic opportunities among farmers and traders by allowing them to access consumers who were not previously accessible due to boundaries imposed by traditional social network linkages and geographic constraints. Other studies (Katengeza *et al.*, 2011; Lwasa *et al.*, 2011) demonstrate that greater distance of farmers from the markets implied greater intensity of mobile phone use. Likewise, Hansen *et al.* (1990) indicated that benefits derived from telecommunications were related to distances

and were high in rural areas. Principally, if farmers are unable to secure price information from various markets in which they could sell their products, this could result into income losses.

Table 6: Associations between farm sizes, scale of production and market location with use of mobile phones to communicate agricultural information

Variable	Use mobile phones to CAI		Chi- square test	
	Yes (%)	No (%)	χ^2	ρ -value
Farm size				
≤ 2.5 acres	155 (64.6)	13 (1.2)	6.488	0.011**
2.5-5 Acres	44 (18.3)	0 (0)		
Above 5 Acres	28 (11.7)	0 (0)		
Scale of production				
Only for home use	69 (28.8)	(0)	5.546	0.019**
Some surplus for sale	158 (65.8)	13 (5.4)		
Market location				
Market within my village	170 (70.8)	13 (5.4)	7.537	0.023**
Markets outside my village	57 (23.8)	(0)		

**Significant at 0.05

4.3 Hypotheses Testing

H_{01}: *Farmers' socio-economic characteristics have no statistically significant effect on their use of mobile phones to communicate agricultural information.*

To ascertain the effect of selected independent variables, a binary logistic regression analysis was conducted (Table 7). Regression analysis was run essentially to rule out variables that significantly influenced the use of mobile phones in communicating agricultural information. The age of respondents was found to be one of the variables influencing the use of mobile phones in communicating agriculture. The influence of age had a coefficient with negative sign of -0.059 and was found statistically significant at $t = -1.977$, $\rho \leq 0.05$. The negative sign of age meant that an increase of one unit of age caused a 5.9% decrease in use of mobile phone to communicate agricultural information. In other words, the negative sign coefficient implied that given equal proportion of young

and old people in a population, a greater percent of mobile phone users will be of the young people. The reason could be similar to what Uvasara *et al.* (2012) noted that nowadays young farmers want to study agricultural business information and they want to be familiar with advanced mobile based agricultural technology than the elderly. On the other hand, Byron *et al.* (2005) reports that elderly farmers seem to be somewhat less inclined to adopt new practices than younger farmers.

Another socio-economic variable that had a statistically significant influence on the use of mobile phone to communicate agricultural information was literacy levels. The influence of literacy levels had a positive coefficient of 0.012 and was found statistically significant at $t = 1.131$, $\rho \leq 0.01$. The positive coefficient sign of literacy levels meant that increase of one unit of literacy level caused a 1.2% increase in use of mobile phone to communicate agricultural information. The study findings contradict those of Jenkins *et al.* (2011) who found literacy level to have a negative coefficient implying that, with an increased literacy levels, people move closer to markets hence little need for ICTs. This conclusion is similar to conclusions of other studies which portrayed that people with high level of education had higher access to and use of mobile phones (Alampay *et al.*, 2003; Onwuemele, 2011; Rice and Katz, 2003).

Other variables found to have an influence on use of mobile phones to communicate agricultural information were farm physical characteristics, such as farm size and market location. Farm size, for example, had a positive coefficient sign of 0.038, meaning that an increase of one unit of farm size caused an increase of 3.8% in use of mobile phone to communicate agricultural information and was found statistically significant at $t = 1.362$, $\rho \leq 0.011$. This implies that, given similar grounds, a large farmers in a population would use mobile phone to communicate agricultural information than small scale farmers.

This is because farmers with large farms normally have surplus produces which they would want to sell, hence the need to call more buyers. Similarly, literature indicates that adoption of a technology tends to skew more positively to large famers than to small-scale farmers (Katengeza *et al*., 2011; Lwasa *et al*., 2011).

The other farm contextual characteristic which had an influence on the use of mobile phone to communicate agricultural information was distance from market with a positive coefficient sign of 0.265 and was found statistically significant at t =5.20, $\rho \leq 0.03$. Thus, greater distance from markets implied greater intensity of mobile phone use to communicate agricultural information. Generally, the above factors led to reject hypothesis I which stated that, farmers' socio-economic characteristics have no statistically significant effect on their use of mobile phones to communicate agricultural information is rejected.

Another variable that had an influence on use of mobile phones to communicate agricultural information was farmers' interaction with other stakeholders. The co-efficient of farmer interaction with other stakeholders had a positive coefficient of 0.275 and was statistically significant at $\rho \leq 0.012$ (Table 7). The positive sign of farmers' interaction with other stakeholders meant that more interactions between stakeholders caused an increased use of mobile phones to communicate agricultural information. The results are in agreement with Butt and Raider (2000) who states that people who are networked do better than those who are not because society is like a market place where people exchange goods and ideas to serve their own interests. Further, Butt and Raider (2000) portray that, networking enables beneficiaries to utilise various media and fora to exchange ideas to improve production and minimize loss.

H_{02}: *The type of agricultural information that farmers need have no statistically significant influence on farmers' use of mobile phones to communicate agricultural information.*

The type of agricultural information that respondents needed had an influence on the use of mobile phones to communicate agricultural information. Agricultural information requirement differed among respondents and varied overtime. One key explanation for their differences information needs and sources was the type of farming systems that farmers undertake. These were found to have statistically significant influence on the use of mobile phones to communicate agricultural information at $t = 1.435$, $\rho \leq 0.02$. Therefore, the results give evidence to reject the third null hypothesis which stated that type of agricultural information that farmers need have no statistical significant influence on farmers' use of mobile phones to communicate agricultural information. Moreover, sources of agricultural information had an influence on their use of mobile phones to communicate agricultural information. Sources of agricultural information were found statistically significant influencing the use of mobile phones to communicate agricultural information at $t = 2.200$, $\rho \leq 0.029$. Therefore, the results gives enough evidence to reject the second null hypothesis which stated that the type of agricultural information that farmers need have no statistically significant influence on use of mobile phones to communicate agricultural information.

H_{03}: *The role that different stakeholders play in communication have no statistically significant influence on the use of mobile phones in communicating agricultural information.*

Support from other stakeholders also had an influence on farmers' use of mobile phones to communicate agricultural information. Support from others was found statistically significant influencing the use of mobile phones to communicate agricultural information at $t = 0.616$, $\rho \leq 0.009$. Therefore, the results give evidence to reject the third null

hypothesis which stated that roles that different stakeholders play have no statistically significant effect on the use of mobile phones to communicate agricultural information.

H_{04}: *Interaction between stakeholders has no statistically significant influence on the use of mobile phones in communicating agricultural information.*

According to Jones and Craven (2001), diffusion of new knowledge and technology requires a networking of both formal and informal communication linkages. As seen in Table 7, interactions between stakeholders was found statistically significant influencing the use of mobile phones to communicate agricultural information at $t = 4.289$, $\rho \leq 0.012$. Therefore, the results give evidence to reject the fourth null hypothesis which stated that, interaction between stakeholders has no statistically significant influence on the use of mobile phones in communicating agricultural information. The role of interaction as a factor to enhance the use of mobile phone to communicate agricultural information is further discussed in section 4.7.

Table 7: Regression estimates of factors influencing the use of mobile phones to communicate agricultural information

Variables (χ)	Unstandardized Coefficients		*Beta*	t-value	ρ-value
	B	Std Error			
Age	-0.015	0.008	-0.059	-1.977	0.050**
Literacy levels	0.005	0.031	0.012	1.131	0.010**
Sex	-0.009	0.010	-0.032	1.042	0.320ns
Marital	0.036	0.021	0.050	1.666	0.098^{ns}
Farm size	0.009	0.007	0.038	1.362	0.011**
Scale of production	-0.006	0.004	-0.050	1.689^{ns}	0.070 ^{ns}
Distance from Market	0.126	0.024	0.265	5.200	0.030**
Interaction with others	0.039	0.009	0.275	4.289	0.012**
Source of information	0.008	0.004	0.069	2.200	0.029**
Type of information needed	0.016	0.011	0.043	1.435	0.020**
Support from others	0.002	0.004	0.018	0.616	0.009**
Type of mobile phone owned	0.028	0.035	0.023	0.807	0.210 ^{ns}
Awareness about applications	0.029	0.016	0.055	1.776	0.040**
Skills in using mobile to CAI	0.003	0.006	0.017	0.406	0.010**
Daily income	0.008	0.008	0.030	0.976	0.090^{ns}
Member in farmer organizations	-0.015	0.024	-0.030	-0.604	0.390^{ns}

$R^2 = 0.71$, ** statistically significant at 5%; ^{ns} statistically not significant at 5%

4.4 Other Factors Associated with Respondents' Ability to Use Mobile Phones to Communicate Agricultural Information

Further, the study identified other factors affecting respondents' ability of using mobile phones to communicate agricultural information. For instance, as shown in Table 8, of the 240 respondents, the majority (84.2%) indicated that limited awareness about the availability of mobile phone applications for communicating agricultural information such as Tigo Kilimo, Kilimo-klub and m-farming affected them, awareness was found statistically significant at $\rho \leq 0.01$. This means that, the potential utility of mobile phone must be known in order to associate its value with agricultural practices. However, of all the respondents, 84.2 % indicated that they lacked awareness about mobile phone application to use in agriculture. A study by Tologbonse *et al.* (2008) reported similar findings that lack of awareness on existence of information sources is a challenge facing farmers in accessing agricultural information.

The study also considered whether respondents had basic (simple) or featured (smartphones) phones. The majority (99.6%) owned simple phones which lacked some important application features, hence using mobile phones with much more basic functionality. This tallies with views by different scholars, for instance, Hatt *et al*. (2013) portrayed that, basic phones are still dominant in developing countries where less than 10% of people are estimated to own a smartphone. Other scholars (Ericsson, 2013; Qiang *et al*., 2011) showed that most mobile applications for agriculture in developing countries are designed for low-tech mobile phones and delivery technologies such as SMS or voice services. According to Ericsson (2013) subscriptions for lower-tech phones will remain high, declining only relatively little to 4 billion by 2018 compared to 5 billion in 2012. Thus, the prevalence of basic and feature phones is expected to continue in many developing countries in the short and medium terms, in particular among lower-income

groups (Hatt *et al.*, 2013). However, entrepreneurs in several businesses including in agriculture are now making use of smartphones to offer services for the poor. Thus, smartphones have capabilities to enable far greater information sharing but are out of the reach of most farmers. Nevertheless, this study found the type of mobile phone owned not statistically insignificant relating to the use of mobile phone to communicate agricultural information.

Moreover, preferred way(s) of communication affected farmers' ability to use mobile phones in communicating agricultural information. Of all the respondents, 57.1% reported to have been using mobile phone to receive voice calls. Yet, 24.6% of the respondents indicated that they made outgoing voice calls, while 8.3% used text messaging. Few, 3.3% reported to use mobile phones to take pictures and video. The preferred way of communication was found to be significantly associated with the use of mobile to communicate agricultural information at $\rho \leq 0.046$.

Also, Table 8 show that, membership in organization such as FFs and One Acre Fund was significantly associated with the ability to communicate agricultural information. Membership in associations was significantly related with mobile usage for agricultural production activities in the study area at $p \leq 0.024$. From the findings of this study it means that, working in team offers a room to learn new ideas including the use of mobile phones in communicating agricultural information. This tallies with the conclusions made by several studies which concluded that farmers who are part of a group are more likely to use and benefit from information services (Ferris and Robbins, 2004; Kiiza and Pederson, 2012; Kirui *et al.*, 2010). However, only few respondents indicated that they were members in farmers' organizations, for instance, 19.2% and 8.3% for FFs and One Acre fund, respectively. A one acre fund is an NGO based in Kenya working with

smallholder farmers in Tanzania. During the FGDs in Kilolo village, one speaker mentioned that:

> *"As members in One Acre Fund, we are regularly receiving price information from higher authorities and markets via mobile phones"*

Yet, another FGDs participant in Luhindo village in Kilolo District who had membership in One Acre Fund was quoted saying that:

> *"I have mobile phone numbers of traders in more than three markets in other regions which I use to call and ask them about crop produce and input prices at particular times."*

Moreover, during FGDs, all discussants who were members in Farmer Field School (FFS) groups acknowledged to have been using mobile phones to communicate agricultural information. The belief is that collective action offers more significant benefits in allowing smallholders to use the technology by enabling them reach one another.

Also, lack of skills of using mobile phones was significantly associated with the use of mobile phones in communicating agricultural information at $\rho \leq 0.016$. Of all the respondents, 77.9% perceived themselves as poor in using mobile phones in communicating agricultural information. According to Vinding (2000), skillful individuals are more receptive to innovations and can easily translate new information into changes and adaptations. Further, few (3.8%) of the respondents reported that they had attended training on mobile phone use. This also was associated with respondents' ability to use mobile phones to communicate agricultural information.

Table 8: Other factors influencing respondents' ability to use mobile phones to CAI (n = 240)

Variable	Use mobile phones to CAI Frequency	Percent	χ^2	Significance
Aware of types of Mp applications				
Yes	38	15.8	18.03	0.043**
No	202	84.2		
Type of phone owned				
Simple	239	99.6	12.32	0.211^{ns}
Featured	1	0.4		
Trained on mobile phone use				
Yes	9	3.8	11.37	0.091 ^{ns}
No	231	96.2		
Skills in using mobile phones				
Poor	187	77.9	21.25	0.016**
Good	53	22.1		
Preferred mobile applications				
Receive voice calls	137	57.1	23.64	0.046**
Outgoing voice calls	58	24.2		
SMS	20	8.3		
Internet	17	7.1		
Membership in organization				
Farmer Field Schools	46	19.2	10.05	0.024**
One acre fund	20	8.3		
None members	174	72.5		

**Statistically significant at $p \leq 0.05$; ^{ns} not statistically significant at $p \leq 0.05$

4.5 Farmers' Agricultural Information Needs

Despite some slight differences, farmers in the two study districts had a number of similarities based on types of agricultural information that they needed. One of the similarities is that in both districts the need for information on inputs stood first. Also, similar problems were itemized in the two Districts. Of all the 240 respondents, 50.8% showed that they needed to communicate issues pertaining to agricultural inputs (Table 9). Other crop-related information that respondents' needed to communicate included information about improved farming techniques (12.5%), weather forecasts

(10%), find transport (9.6%), seeking better-off prices (9.2%) and the need for high yielding crop varieties (7.5%). This means that providers of agricultural information in this area should focus their priority on best agronomic practices, weather trends, market information, and better crop varieties if they aspire for improving farm productivity.

Table 9: Crop related information needed by respondents (N=240)

Crop related information	Respondents' District		Total n (%)
	Kilolo	Kilosa	
Sources of agricultural inputs	49	73	122 (50.8)
Improved farming practices	10	20	30 (12.5)
Weather forecasts	14	10	24 (10)
Find transportation	12	11	23 (9.6)
Seek better prices	18	4	22 (9.2)
High yielding crop varieties	17	1	18 (7.5)

Similar findings were revealed during FGDs; one participant was quoted saying:

> *"I have been calling extension agents and input dealers to ask about types of inputs (i.e. seeds, fertilizers and insecticides) that I could use at particular occasions".*

Similarly, when asked whom have been helping them to get agricultural information, their responses varied. One FGD participant said:

> *"I have been calling extension agents asking them about the correct ratio of water and chemicals during mixing of herbicides and pesticides. Other participants also have been doing so."*

Another participant was quote saying:

> *"Whenever I get any agricultural problem, my first decision has been first to ask my friends if ever they experienced the same and how they solved it. If not satisfied I seek help from other sources such as extension agents, traders or input suppliers."*

4.5.1 Livestock-related information

Table 10 indicates that, of the 65 respondents who kept livestock, they reported four varieties of information that they communicated using mobile phones. For instance, 47.7% reported that they sought information related to livestock and livestock product prices. Other livestock related information that respondents reported to communicate using mobile phones included issues like livestock diseases and their control (33.8%) and feeds and regime of feeding (12.3%). Yet, few (6.2%) said that they used mobile phones to communicate about availability of good quality animal breeds (Table 10).

Table 10: Livestock related information needed by respondents (n=65)

Livestock related information	Number of respondents		Percentage
	Kilolo	Kilosa	
Best price for livestock and products	5	26	47.7
Livestock diseases and their control	3	19	33.8
Livestock feeds and regime of feeding	2	6	12.3
Availability of good breeds	1	3	6.2
Total	**11**	**54**	**100.0**

Again, livestock keepers agreed that the information in Table 10 above was relevant for their farming practice. Further, during the FGDs, one participant said:

> *"One day when my animal fell sick I had a plan to consult an extension agent, but I had hard time trusting him because in my mind I believed that extension agents are just after money. So, after I asked a fellow farmer and he gave me the details of an extension agent he knew I called and indeed he helped me to solve the problem".*

Also, another FGD member was quoted saying that:

> *"I have been calling extension agents asking them about the types of drugs I can use to treat my local chicken. Other farmers have also been calling extension agents to ask for help on poultry diseases and control."*

4.5.2 Crop related information

Further, during FGDs, respondents indicated to communicate different types of agricultural information at various stages of crop production (Table 11). For instance, at planning and decision making stages, respondents reported to demand knowledge on what and how to produce, how much to produce, where to sell and the required resources. Unfortunately, this kind of information was found not to be commonly communicated through mobile phones; instead respondents indicated that farmers obtained that information through a word of mouth from extension agents, input dealers, traders and fellow farmers.

At land preparation, planting and weeding stages, farmers are interested in information pertaining to labour availability, weather forecasts and the aavailability of inputs i.e. seeds, fertilizers and herbicides. The study found that information on availability of agricultural inputs was available, but that on weather and labour was partly available. Common sources of this information included meteorological agents, input suppliers, extension agents and other farmers. Again, during harvesting and post-harvest periods, information commonly needed included that on transportation, storage, product quality, preservation methods, money transfer and storage. In general, the study identified information needed at various stages of crop husbandry including information necessary during land preparation, planting, weather forecasts, new seeds for new varieties, storage methods, diseases and pest control. Key sources of information to farmer were also identified which included fellow farmers, extension officers, researchers, input suppliers, traders, meteorological agents, and telecentres.

Table 11: Respondents' agricultural information need and sources

Stage of farming	Information need	Information Sources
Farm planning and Decision making	Information on what to produce, how much to produce, needed resources	Fellow farmers, extension agents, researchers, input suppliers and traders
Land preparation and sowing	Availability of inputs i.e. seeds, fertilizers, herbicides, weather forecasts	Fellow farmers, input suppliers, extension agents, meteorological agents
Weeding	Labour availability for cultivation, expert/extension advice	Fellow farmers, input suppliers, extension agents and researchers
Harvesting	Information about the availability of transportation methods to markets,	Traders and fellow farmers
	information about storage, warehousing and preservation methods	Traders and fellow farmers
Post-harvesting	Information about market opportunities and price information	Traders, extension agents, fellow farmers
	Availability of buyers and product quality	Researchers, Traders, extension agents, fellow farmers
	Money transfer, payment methods	Tele-canters, traders, Mobile phone companies, fellow farmers

4.5.3 Source of agricultural information

Results in Table 1 point out information sources that farmers in the study area depended on. The findings revealed six groups of information sources that farmers relied on, including fellow farmers, extension agents, input suppliers, traders, researchers and telecentres. Of all these sources, three featured prominently: input suppliers, agricultural extension agents and fellow farmers. Of the 240 respondents, the majority (50.8%) indicated that they relied on input suppliers as their immediate source of agricultural information. Yet, few (18.8%) mentioned that they relied on extension agents for

agricultural information. Other important information sources were fellow farmers (10.4%). Similar findings were reported in a study by (Masinde et al., 2012) who found that farmers are commonly still depending on exchange advice informally with friends and neighbours. Other sources identified are traders 9.6%, researchers (8.8%) and tele-centres (1.6%).

Table 12: Distribution of respondents' based on their information sources

Information sources	Frequency	Percent
Input dealers	122	50.8
Extension agent	45	18.8
Fellow farmers	25	10.4
Traders	23	9.6
Researchers	21	8.8
Telecentre	4	1.6

On the other hand, qualitative data analysis documented other sources of agricultural information which are broadly classified in four main sets as outlined hereunder and further illustrated in Table 13:

- Information resource centres: these included information sources in electronic form at internet cafes and telecentres.
- People in the cycle of farming business: this included fellow farmers, village leaders, traders, middlemen and agricultural input suppliers.
- Written sources: these included all types of information sources in print form such as books, posters, newspapers and magazines.
- Professional sources: these included people who had clear knowledge such as extension agents and researchers.

Table 13: Other agricultural information sources revealed during the FGDs

Sources	Components
Information resource centres	Internet cafes and telecentres
People in the cycle of farming business	Farmers, village leaders, middlemen, traders and input suppliers
Written sources	Books, posters, newspapers, and magazines
Professional sources	For instance, extension agents and researchers

4.5.4 Advantages of using mobile phones to communicate agricultural information

It was found that mobile phones would bring benefits such as greater time efficiency which in turn increases income. Extension agents, for example, argued that, with mobile phones, they experienced increase in consultation with farmers, something which they said was attributed to increased accessibility to farmers. Framers also witnessed that mobile phones enhanced increased extension agents' accessibility through the use of mobile phones and that it also allowed them to easily contact extension agents.

Extension agents, traders and input suppliers also showed that mobile phones saved time by eliminating unnecessary visits to farmers' house or farms, thus improving the efficiency of extension agents' schedules. For example, they said that, instead of making several trips to the clients' house, the agent can control farmers' situations using a mobile phone.

During FGDs, extension agents claimed that mobile phones helped them to easily contact fellow extension agents and other agricultural experts for advice and information, particularly during emergencies. For instance, an extension agent at Madoto village was quote saying that:

> *"With a phone I have been able to call colleagues for advice about complicated cases. For instance, I once called an extension agent*

> *who was a classmate who is now working in Tanga, and he really helped me to solve the problem."*

Another extension agent at Rudewa village was quoted saying that:

> *"It is easier to communicate with farmers using mobile phones than other wise. Mobile phone makes communication easier."*

Another advantage of the application of mobile phone to communicate agricultural information is found in a story by a farmer in Batini Village in Kilosa District who was cited saying that:

> *"In the past, I sold cowpeas to middlemen and I accepted whatever prices they offered, because I had no idea about other profitable prices of the produce. Nowadays it is different. Whatever price middle men come up with, it is checked by asking other reliable sources through mobile phones before agreeing to sell to them."*

Another FGD member was quoted saying that:

> *"One time I was about to sell my tomatoes at a very big loss (TZS 15 000 per Crate) to an untruthful middleman, but due to this precious mobile phone I made a price assessment at other markets and finally called a trader in Iringa town who bought 30 000 TZS per crate at farm get price. You can imagine how information can change things."*

Furthermore, Fig. 9 presents respondents' opinions about the advantages of using mobile phones to communicate agricultural information. Of the 240 respondents, 29.6% mentioned that the use of mobile phones had helped them to contact extension agents, while 21.3% indicated that the technology enabled timely sale of their agricultural products by calling buyers. On the other hand, 18.3% said that they had increased production due to improved access to inputs. Similarly, other (18.3%) respondents mentioned that mobile phones had enabled respondents to get current information about the prices of their products from different markets, hence reducing chances of being

cheated. Yet, few (5.4%) reported that mobile phones had enabled them to communicate with other different sources of agricultural information in and outside their districts.

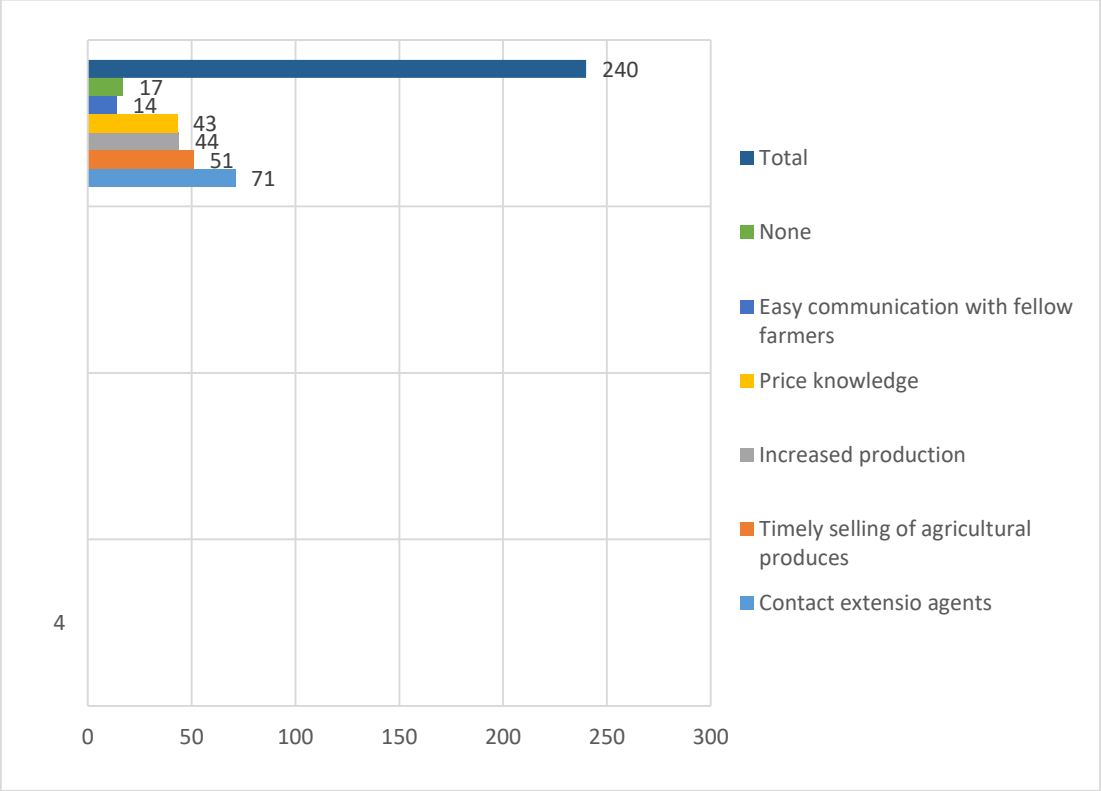

Figure 9: Advantages of using mobile phones to communicate agricultural information

Similarly, during both KIIs and FGDs, participants reported that the use of mobile phones to communicate agricultural information was helpful to farmers in several ways. For example, during FGDs it was revealed that some farmers called traders in distant markets, as far as Kariakoo market in Dar es Salaam and markets in Mwanza and Arusha located more than 500 kilometres away. For instance, in Malui village in Kilosa District, one FGD participant reported that he called an extension agent from a nearby village.

One key informant in Madoto village, in Kilosa District, reported to have been receiving phone calls from agricultural extension agents on the type of seeds to plant and other agro-inputs to use. Yet, one discussant in an FGD in Luhindo village, in Kilolo District, reported incidences of livestock thefts and that, through mobile phones, thieves were caught. For instance, he mentioned that, in 2009, 50 cattle were stolen in Luhindo village, in Kilolo District where through mobile phones, farmers informed one another and immediately organized follow ups in which all 50 cattle were saved and sent back to the owners.

Also, one respondent in Kilolo, explaining benefits of using mobile phone to communicate agricultural information, said:

> *"In the past when mobile phones were not there we suffered, but nowadays mobile phones help us a lot. For example, sometimes we work in the field and find problems, we just call for help immediately. Mobile phones are thus very useful; they enable us to communicate with others around us."*

Further, an extension agent at Rudewa village in Kilosa District said that:

> *"Mobile phone helps me a lot to communicate with my clients, colleagues and supervisors and our relationships have improved than ever."*

4.5.5 Limitations of using mobile phones to communicate agricultural information

Table 14 shows a number of constraints facing farmers in the study area in their quest for agricultural information necessary for crop and livestock husbandry. Such constraints include poor linkages among knowledge intermediaries, financial constraints to purchase information, lack of awareness, inappropriate subject content, and lack of access to information sources, lack of trust on SMSs, illiteracy, poor network signals, and poor rural electrification.

Table 14: Constraints of using mobile phones to communicate agricultural information

Response	Frequency	Percent
Poor linkages among knowledge intermediaries	230	95.8
High mobile phone purchase and running cost	195	81.3
Lack of awareness	80	33.5
Inappropriate subject content	45	18.8
lack of access to information sources	44	18.3
Low digital literacy among mobile phone users	43	17.9
Lack of trust on SMSs	35	14.6
Poor network signals	26	10.8
Poor rural electrification	13	5.4

Percents not adding to 100 because it was a multiple response question

Of the 240 respondents, 95.8% said that poor connections between stakeholders limited the use of mobile phones to communicate agricultural information. The findings are in line with those reported previously by Shaffril *et al*. (2010) and Samah *et al*. (2011) that lack of linkage among stakeholders has made farmers reluctant to use advanced technology in accessing agricultural information. Similarly, during FGDs, participants reported that poor linkage between famers and other stakeholders had negative effect on the use of mobile phones in agriculture.

Another limitation identified was cost; of the 240 respondents, 81.3% mentioned cost as a limiting factor to the use of mobile phones to communicate agricultural information. Farmers required spending lots of money to buy information something which effects agricultural productivity. Other studies (Bolarinwa and Oyeyinka, 2011; Singh, 2012) had similar conclusions that unaffordable cost is largely blamed and that governments and mobile companies are to be held responsible for the cost and service failure. Furthermore, cost is recognised as having one of the most significant negative impacts on behavioural intention to use (Chong *et al*., 2011; Luarn and Lin, 2005; Wei *et al*., 2009; Yu, 2012).

Likewise, Wolf (2001) reported that cost of accessing ICTs in poor countries was often too high.

Further, during the FGDs at Rudewa village in Kilosa District, one participant described cost as a limiting factor in using mobile phones to communicate agricultural information; she emphasized as follows:

> *"It is relatively cheaper to buy a phone than getting agricultural information through mobile phone. To us, a charge of Tshs 150 equivalent to (US$ 0.1) for a single SMS is too expensive and uneconomical."*

Another concern associated with the ineffective use of mobile phone in communicating agricultural information is lack of awareness of the potential value that mobile phones offer in agriculture. In fact, the potential utility of the technology must be known in order to associate its value with the practice. As seen in Table 14, users' awareness of a technology was the third most serious hindrance, which implies that farmers, as potential users of mobile phone technology, were significantly unfamiliar with the availability and or utility of these devices in agriculture. About one third of the respondents indicated that they lacked awareness about the usefulness of the technology to communicate agricultural information. The findings are in line with the findings by Tologbonse *et al*. (2008) who reported that lack of awareness was a challenge facing farmers in accessing agricultural information.

Yet, few (14.6%) of the respondents indicated lack of trust on SMS as a limiting factor to using mobile phones to communicate agricultural information. This implies that communications through SMS require trust amongst actors. Mobile phone service can be unsuccessful because it fails to present its content, for example weather forecasts, in a

way that is either reliable, understandable and/or acceptable for the target users. According to Khodamoradi and Abedi (2011), adoption of any innovation is associated with an individual's perception of the trust-worthiness to the innovation. As evidenced during FGDs, one participant was quoted saying:

> *"I sometimes got a text messages asking me to respond, but because of not knowing the sender, I just ignored it".*

Another limitation reported was irrelevant subject content; of the 240 respondents, 18.8% reported that they were not happy with the information they got through mobile phones as in most cases it was outdated and or irrelevant. Similar findings were also reported (Jain *et al*., 2014) that farmers need localized news and information which meets their daily needs in their own language.

Other limitations reported included complexity of the technology (18.3%); low digital literacy, each being mentioned by about 18% and lack of skilled technicians (10.8%). Few respondents (5.4%) mentioned infrastructural aspects such as poor network signals and poor rural electrification as limiting factors to their use of mobile phones to communicate agricultural information (Table 14). According to Fox and Porca (2001), infrastructure is one of the big challenges to develop ICT solution in developing countries.

4.5.6 Ways of improving the use of mobile phones for communicate agricultural information

Table 15 indicates ways of improving use of mobile phones in communicating agricultural information. These include enhancing farmers' capability on use of mobile phones (53.3%), provide cheap or free SMS services and voice calls (21.7%), provision of locally based content to ensure relevance (9.2%), provision of call centers for agricultural

information (6.7%), provide low cost mobile phones (5%), offer crop specific mobile phone programmes (2.5%), integrate mobile phone technology use with other ICT tools i.e. radio (1.7%). The integration of ICT can help to improve the performance of agricultural development (Woodburn *et al*., 1994). This is in line with what the social cognitive theory emphasizes, the need for interventions to change the larger environment of different stakeholders in the use of any innovation (Jensen, 2010).

4.5.6.1 Enhancing farmers' capability

This could be about gaining knowledge and skills. One way to effect this could be through training farmers on ways to use mobile phones in communicating agricultural information. According to Gunasekara *et al.* (2011), the rate and speed of adoption of a technology is found to be higher where farmers received training in use of particular technology than otherwise.

4.5.6.2 Provision of cheap or free SMS services and voice calls

SMS services have been hyped to be the best way of communicating agricultural information between stakeholders. However, in practice, the value of SMS to consumers is ambiguous. For example, based on this study, the usefulness of an SMS can only if the nature of textual message, its compatibility with different devices, requirements for the recipient's mobile subscription and rate of getting through are well considered. Equally important, the cost of SMSs and calls have a great implication for farmers use. Thus, respondents suggested that, where possible, provision of either cheap or free SMSs or calls related to agricultural information should be done. However, according to Fitzgerald *et al*. (2010), there is a need to develop a simple system, keeping in mind the farmers skills and educational level.

4.5.6.3 Provision of locally based content to ensure relevance

A mobile service can be unsuccessful when the challenge that the mobile service aims to address and context in which the challenge is situated are not thoroughly analysed before creation and implementation of the service. The reliability of the content of a mobile service should at all times be ensured. It is important to include all stakeholders in the iterative process of creating and shaping the content. For example, a representative sample of the target users together with the government and research institutes can validate content to ensure its reliability Thus, for effective communication, information must be provided based on local condition (Muthiah *et al*., 2013; Knoche *et al*., 2010).

4.5.6.4 Integrate mobile phone technology use with other ICT tools

Based on good attributes mobile phone services contribute to bridging the knowledge gap and thereby increasing agricultural production and profitability. Integration and coordination of such services with other ICT tools are vital, provided they are formalised to ensure agencies work together in a structured and planned manner (Keast 2011; Leigh, 2008; Sullivan *et al*., 2002).

Table 15: Ways for improving the use of mobile phones in communicating agricultural information

Ways to improve use of mobile phones	Frequency	Percent
Capacity building on use of mobile phones	128	53.3
Free calls and text messages on agriculture issues	52	21.7
Provision of locally based content to ensure relevance	22	9.2
Provision of call centers for agricultural information	16	6.7
Provide low cost mobile phones	12	5.0
Offer crop specific mobile phone programs	6	2.5
Integrate MP with other ICT tools i.e. Radio	4	1.7
Total	**240**	**100.0**

4.5.7 Other uses of mobile phones

The results in Table 16 show five common uses of mobile phones by respondents in the study area apart from using them in communicating agricultural information. Respondents in both Kilolo and Kilosa Districts indicated that they used mobile phones for: first, to receive and send money, solve emergencies such as sickness, arrange for social functions like weddings, contact relatives and or friends and making follow ups on business. The findings indicate that sending and or receiving money ranked first (37.9%) while the need for solving emergencies stood second (33.3%).

Table 16: Other uses of mobile phones in the study area

Other uses of obile phone	District		Total	(%)
	Kilolo	Kilosa		
Send or receive money	56	35	91	37.9
Help in case of emergencies	37	43	80	33.3
Arranging for social functions	19	21	40	16.7
Contact relatives and or friends	8	15	23	9.6
knowing status of my business	0	6	6	2.5
Total	**120**	**120**	**240**	**100**

4.6 Roles of different stakeholders influencing the Use of Mobile Phones in Communicating Agricultural Information

Stakeholders who influenced the use of mobile phones ranged from governments, mobile private companies i.e mobile phone companies, input dealer, traders differs, telecentres, Telecommunication Regulatory Authorities and Tanzania Meteorological Agencies.

4.6.1 Roles of the government

Figure 10 indicates respondents' opinion based on what they thought the government should do as an enabler of farmers' use of mobile phone to communicate agricultural information. Almost two-fifths (39.2%) thought that, the government has a responsibility to expand mobile phone access to underserved communities. Other important aspects

farmers mentioned included government subsidy on both buying and operation cost of mobile phones to enable access (17.5%) and the government getting involved with content creation through agricultural experts (16.7%). Other roles that the government needs to play included provision of digital literacy, provision of laws and policy regulation and motivation through promotions.

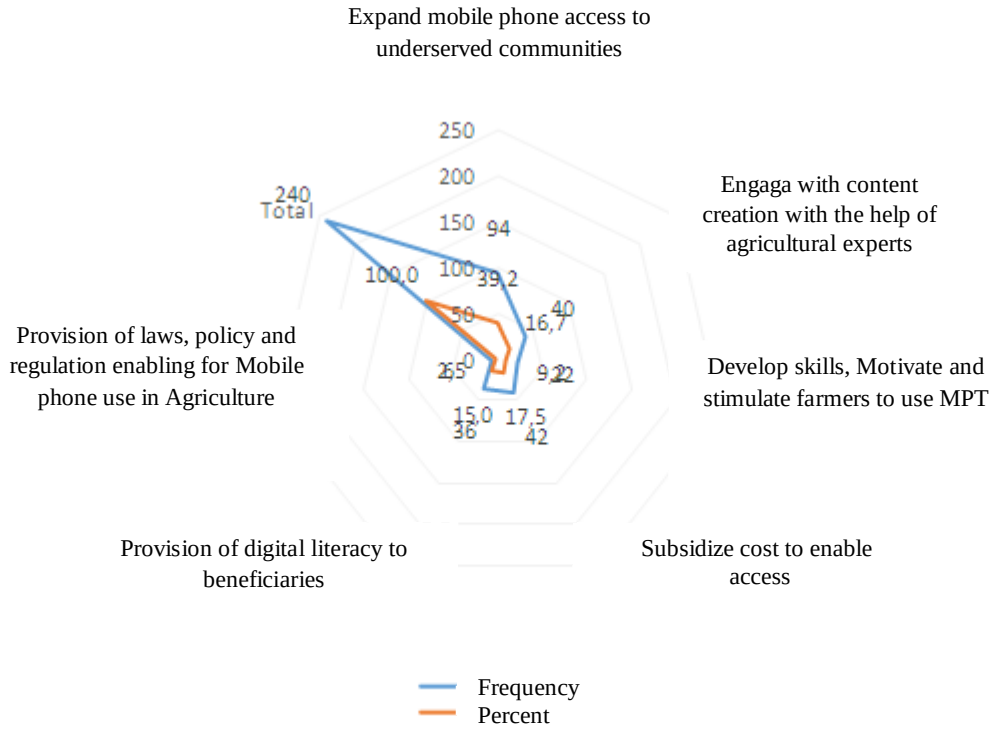

Figure 10: Respondents' opinion about the role of government

Further, a discussion with two key informants, one from the Ministry of Agriculture, Food Security and Cooperatives and the other one from the Ministry of Livestock and Fisheries Development, indicated that the government of Tanzania had already taken some initiatives to address information asymmetry in agriculture through mobile phones; one official said:

> *"The Government of Tanzania and the private company (Sibesonke) from South Africa have a Memorandum of Understanding (MoU) for provision of agricultural information to farmers using mobile phones. It is necessary that some refresher courses are carried out to extension agents to improve their coordination and interpersonal communication skills."*

According to him, the rationale for providing extension agents with a refresher course will help them transform smallholder farmers' productivity by creating a sense of being self-motivated to working and promote the use of mobile phones. Another ministry official said that training of extension staff is meant to provide them with adequate communication skills for promotion of information exchange among farmers. He further pointed that:

> *"There are other efforts by the government to push forward the use of mobile phones to communicate agricultural information including welcoming investors for prospective agricultural mobile phone applications or programmes."*

On the other hand, another key informant a representative of a private company (Sibesonke-Tanzania), said:

> *"The government of Tanzania is placing control to enhance use of mobile phones to communicate agricultural information."*

4.6.2 The role of mobile phone companies

Mobile phone companies play an important role in realizing the effectiveness of mobile phones in communicating agricultural information. Each company has a role to play if we are to maximise successful use of mobile phones to communicate agricultural information. For instance, one Tigo company representative asserted that:

> *"Stakeholders should collaborate with the line ministries to ensure that relevant contents are developed, packaged and disseminated to farmers. Already Tigo company has three applications: (1) Unstructured Supplementary Service Data (USSD) SMS, (2) Integrated voice response*

> *(ISR) and (3) Call centres, and the USSD-SMS application has been commonly used by farmers to exchange agricultural information. The role of content processing section was piloted by the Techno-Serve, an NGO that control the Tigo Kilimo Programme."*

In addition, the Tigo officer said:

> *"Policy makers should recognize the challenges of using mobile phones and formulate policies and regulations that stimulate both supply of and demand for mobile phone services by users".*

Similarly, during key informant interviews, a representative from Vodacom Tanzania was quoted saying that:

> *"Investing in mobile phone networks in areas with low usage makes the technology more expensive."*

Talking of a situation where mobile phone network is placed in an area where citizens are not motivated enough to adopt the technology, he further highlighted that:

> *"Low usage of mobile phones has a root in one's motivation and that people themselves are the driving force of their own development, so, he said, unless people have an internal motivation they will not fully exploit the potentials of a particular technology."*

According to him, investing in mobile phone networks in areas with low usage makes the technology more expensive due to costs of building networks. The government of Tanzania and other institutions can invest money in building these mobile phone programmes, but the investments in mobile phone could be a waste of time if people do not understand and are not able, or are not willing to use the services.

He further clarified that:

> *"The problem is not just building more networks, but to consider issues like cost and quality of service. The company thus requires some support from the government that encourages the demand for*

> *mobile phone services to people in rural areas because the private sector cannot do it alone."*

He also said that:

> *"The company has introduced an SMS based mobile phone service through the Ministry of Industry, Trade and Marketing for dissemination of agricultural market information. Here, agricultural experts (market monitors) under District Executive Directors (DED) collect information three times a week and send it to the Ministry's Marketing Department which is entered into Vodacom server and disseminated to enable accessibility of market prices to farmers."*

On the other hand, one trader who bought and sold paddy and maize in Kilosa town said:

> *"Mobile phone has help me a lot in my business activities. I am using it in making bank transactions, price negotiations with farmers and fellow traders; hence I save time and money. However, sometime the agricultural information obtained through mobile phones is not realistic. I can remember sometimes I got an SMS via my mobile phone showing that the price of one kilogram of maize in the market was Tshs 300, while the actual price in the National Grain Reserve was Tshs 500."*

Further, an officer at the Zonal Information and Extension Liaison Office (ZIELO) at ARI-Ilonga said:

> *"The institute does sell seeds, but it sends them to Tanzania Official Seed Certification Centre (TOSC) for approval before they are distributed to other agencies in the country including the Agricultural Seed Agencies (ASA). Because of this, farmers do not call directly to ARI-Ilonga, except few progressive farmers who called to ask for help, especially about a rice disease locally termed as "Kimianga" or broadly called rice streak. I have commonly been communicating with farmers and other agricultural officers in the Eastern Ecological zone using mobile phones."*

The DAICO of Kilosa district argued as follows:

> *"The role of mobile phones in the district is to make follow ups on agricultural issues. Mobile phone has reduced the need for travel*

> *long to villages, we use SIM banking to pay workshop participants, which has eliminated carrying large sums of money. However, it is not common for district based officers to directly call farmers in fields, rather farmers are reached through their close technical staff, the village or ward agricultural extension officers."*

Further, a marketing officer at AS revealed that mobile phones are the basic tools for contacting their customers. He said that they had a list of registered farmers of which when there is any new product, are sent text messages or individual calls to sensitize them on the availability of a product. He further said:

> *"Farmers have been calling and or sending text messages asking for availability of other crop varieties and or about problems they face in their fields."*

4.6.3 The roles of tele-centres

Figure 11 indicates respondents' opinions on what they believed telecentres could help them in using mobile phones to communicate agricultural information. Of the 240 respondents, over one-third 88 (36.7%), perceived that telecentres have a responsibility to create awareness about mobile phone apps to under-served communities. Other important aspects respondents mentioned included the need for telecentres to train people on the use of mobile phones to communicate agricultural information 64 (26.7%). Also, they thought that tele-centres could get involved with content creation and adoption to local context through agricultural experts 52 (21.7%). Other aspects named by the respondents included the anticipation that telecentres could connect farmers to traders and input dealers. Another strength with telecentres was the availability of expertise to assist farmers on technical aspects pertaining the mobile phones and other technologies as well.

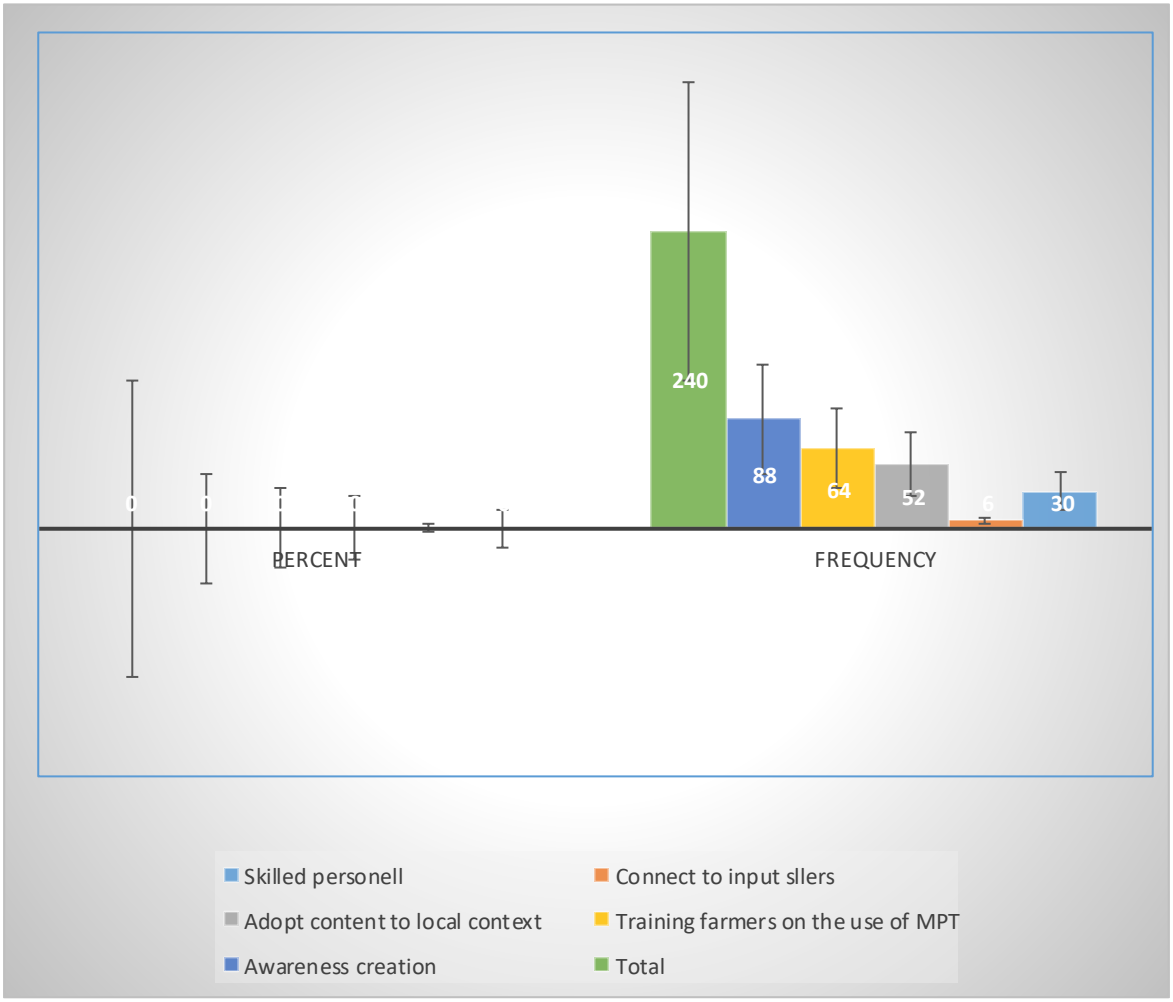

Figure 11: Opinions about the role of tele-centres

Again, a discussion with the representatives of the two telecentres visited indicated that a telecentre in Kilosa (KIRSEC) was active in helping farmers use mobile phones to communicate agricultural information as compared with Kilolo tele-centre. KIRSEC reported to have been using two approaches to reach farmers: first, the centre had computers through which farmers registered their mobile phones numbers for receiving SMS for new agricultural inputs arrivals. Secondly, KIRSEC aired its programmes through the Kilosa Farmer Voice Radio (KFVR) owned by the Kilosa District Council.

Further, the owner of KIRSEC reported that the centre responded to farmers' questions through the KFVR. But, the in-charge of the Kilolo telecentre revealed that the centre was not well-known to the communities, as it covered a small area of the District and was mainly used as a training centre for farmers and business people on computer use. He contended that only few people used the centre, particularly those with Internet and SIM banking.

4.6.4 The role of other stakeholders

Input suppliers, traders and researchers together had the responsibility to design mobile phone applications, campaign for the use of the designed mobile phone applications and enhance interactions (Table 17). Other stakeholders who were found to have an influence on mobile phones use to communicate agricultural information included Tanzania Communication Regulatory Authority (TCRA) and Tanzania Meteorological Agencies (TMA).

For instance, a representative from TMA acknowledged that, jointly with agricultural researchers and extension agents, farmer organizations, private sectors and mobile phone service providers were struggling to enable the use of mobile phones in providing weather information for various purposes including in agriculture. He further explained that, Tanzania Meteorological Agencies has the role to monitor how content production could be monitored, the effective way to deliver weather information to end users and selecting the best feedback mechanism by end users.

On the other hand, a representative from TCRA contended that the main role of TCRA is to enhance provision of communication services in the country through licensing and control. The representative from TCRA further said that the department is also

responsible to monitor the operation of various communication bodies, so that they observe rules and regulation

Table 17 illustrates roles different stakeholders have a responsibility to undertake in order to enhance the use of mobile phones to communicate agricultural information, including provision of subsidy, devising policies, knowledge creation, digital literacy support, promotion of mobile phone use in agriculture, enhancing interactions amongst stakeholders, enabling connectivity and network coverage, technical support and control over arbitrary charges. Legends used include (++), (+) and (-) which represent fully, partly and not involved, respectively. Thus, if labelled (++) it implies that the stakeholder is completely responsible and accountable for such a role, while the other two legends agree that a particular stakeholder is somewhat responsible (+) or absolutely not responsible (-).

Table 17: Roles of different stakeholders in using mobile phones to communicate agricultural information

Stakeholders	Roles										
	Financial subsidy	Policy devising	Knowledge creation	Digital literacy provision	Campaign for MP use	Enhance interactions	Enable connectivity	Skilled personnel	Set price and payments	Design mobile Apps	Develop technology
Fellow Farmers	+	-	+	+	-	+	-	-	-	+	+
Extension Agents	-	+	+	++	++	++	+	-	-	+	-
Agricultural Researchers	+	++	++	-	++	+	+	+	-	++	++
Input dealers	-	-	-	+	++	++	+	-	-	-	-
Traders	++	-	-	+	+	+	+	-	-	-	-
Mobile-phone company	+	+	+	++	++	++	++	++	++	++	+
Government	+	++	++	+	++	++	++	++	+	++	+
Telecentres	-	-	+	++	++	+	+	++	-	+	+

Legend: ++ fully responsible, + somewhat responsible - not responsible

4.7 Mobile Phone Based Interactions amongst Stakeholders

Table 18 shows the nature of interaction between stakeholders; the relations were labeled as either strong (++), moderate/weak (+) and bad (-) or exploitative relationships (E). However, only few pairs had strong linkages, including farmers with input dealers, government and researchers, government and mobile phone companies. Other links showed moderate and or weak relations. Furthermore, exploitative relations were also reported to exist, for instance, the interaction between traders (Table 18). The reason for the existence of exploitative relationship was that, each of the traders was after making profit, and did not inform fellow traders about where a traded product was obtained. Equally, input suppliers were found to be selfish, and did not refer customers to other shops if they did not have the needed product. An input dealer would rather ask a customer to come later when he would have already collected the product from their fellow input dealers. For instance, one FGDs member contended as follows:

> *"Input suppliers do not cooperate amongst themselves, if a buyer misses a product in one shop, the vender does not refer the customer to another shop; instead he/she asks him or her to come later. It becomes easy for venders to buy a product for a customer from a fellow input seller than referring him or her to a shop having the product worrying of losing such customer(s) in the future."*

Some farmers were reported to be selfish about sharing their knowledge, which limited other farmers from trying to find knowledge and information. For instance, one farmer in Kilolo District in Lugalo Village reported that there was definitely no cooperation among some farmers due selfishness. Basically, the study established that the effectiveness of linkage amongst stakeholders is influenced by a number of factors including formality of contacts, relevance of services, and timeliness of accessibility of services.

Table 18: Mobile phone based interactions amongst stakeholders

Stakeholders	Farmers	Extension Agents	Researchers	Input dealers	Traders	Phone Companies	Government
Farmers		(-)	(-)	(++)	(+)	(-)	(-)
Extension Agents	(-)		(-)	(-)	(-)	(-)	(+)
Researchers	(-)	(-)		(-)	(-)	(+)	(++)
Input dealers	(++)	(-)	(-)	E	(-)	(-)	(-)
Traders	(+)	(-)	(-)	(-)	E	(-)	(-)
Phone Companies	(-)	(-)	(+)	(-)	(-)		(++)
Government	(-)	(+)	(++)	(-)	(-)	(++)	

Legend**:** E-exploitative or bad linkage, (-) Weak **l**ink (+) moderate linkage; (++) good/strong relationship

Further, Venn diagrams (Fig. 12) illustrate interactions among stakeholders such as government, mobile phone companies, input suppliers, traders, seed multipliers, researchers, extension agents, telecentres and farmers as noted during the FGDs. Their linkage was assessed based on the nature of knowledge sharing, information exchange, joint planning and or resource sharing. Farmers represent the central focus of the networking and are placed at the middle of the main square of the Venn diagram. The thickness of the arrows signifies strong links and relationships in terms of powers and effect. Thick arrows indicate strong linkage while the thin ones denote weak relations and or linkages. Thick arrows also imply that there is clear knowledge of services provided by a particular stakeholder including its relevance and accessibility. For instance, farmers had direct and strong links with input dealers, fellow farmers and extension agents. Also, the government had a strong link with mobile phone companies, seed multipliers and information processors.

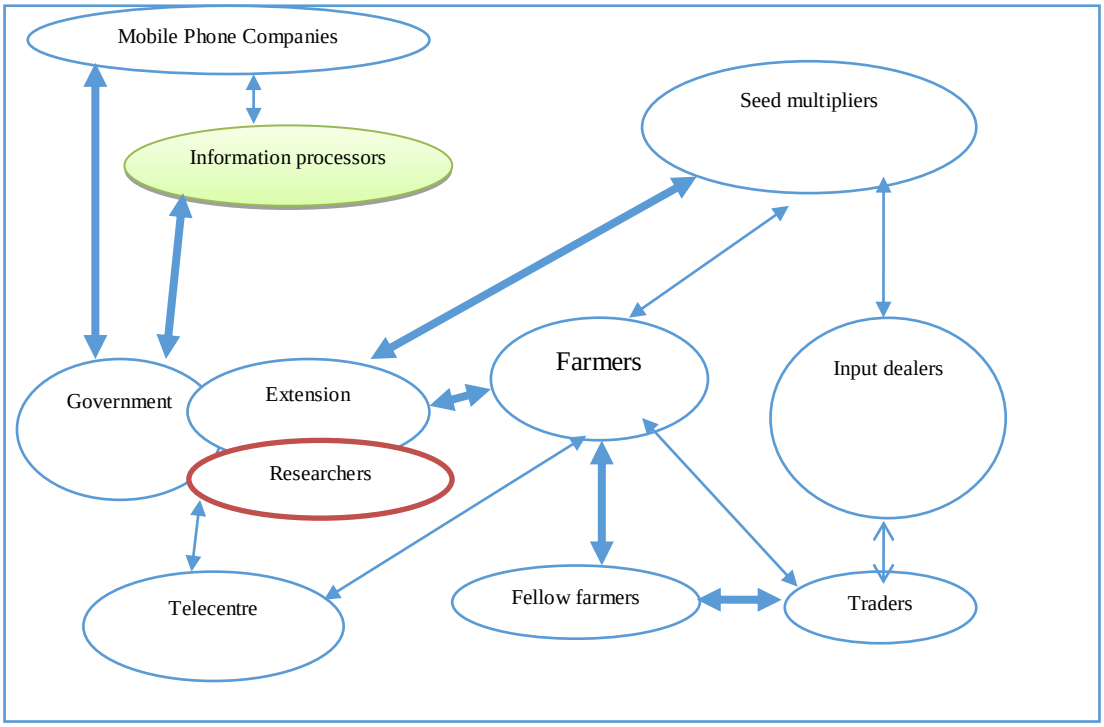

Figure 11: Venn diagram showing interaction among stakeholders

Further, a chi-square test was used to examine whether or not interaction between farmers with other stakeholders had an association with the use of mobile phones to communicate agricultural information. Table 19 indicates that, with an exception of telecentre and researchers, the interaction with other stakeholders had a significant association with famers' use of mobile phones to acquire and use agricultural information. The interactions with fellow farmers, traders, input suppliers and extension agents were statistically significant at $\rho \leq 0.01$. This confirms that networking and or interactions among stakeholders is highly associated with the use of mobile phones to communicate agricultural information.

This result gives evidence to reject the fourth null hypothesis which stated that interaction between stakeholders has no statistically significant relationship with the use of mobile phones in communicating agricultural information.

The findings are in line with those by Klerk and Saayman (2012) who found that, in order for one actor (i.e. farmer) to acquire and use agricultural information through mobile phone, collaboration with other stakeholders is inevitable. Generally, regular interactions allow for greater openness, and, hence, facilitate transfer of knowledge (Kale *et al*., 2000). Other studies (Wang *et al*., 2011; Watson, 2012) have hyped that networking is a critical component of the knowledge management dispensation, whose absence would make it difficult to set knowledge into motion and facilitate sharing. According to Watson (2012), social interaction between farmers can be likened to the interaction within a parade of elephants operating in networks. It is from this backdrop that the researcher analyzed mobile phones' based interactions amongst stakeholders and determine its effect on communicating agricultural information.

Table 19: Chi- Square results of interactions between farmers and other stakeholders

Contact with	**Frequency of contact with a particular actor**				**Chi-Square tests**	
	Never	**Rarely**	**Frequently**	**Always**	χ^2	**P-value**
Input suppliers	15	97	38	17	104.1	0.000
Extension agents	16	124	28	8	87.38	0.000
Researchers	138	89	0	2	8.10	0.052
Traders	46	157	20	0	35.04	0.000
Tele-centres	138	66	6	7	5.31	0.504
Fellow farmers	14	188	15	4	94.54	0.000

4.8 Institutional Factors Underlying the Use of Mobile Phones to Communicate Agricultural Information

This section presents findings for objective five of the study which sought to determine institutional factors influencing the use mobile phones in communicating agricultural information. The central research question addressed in this section was: "Which institutional factors influence the use of mobile phones in communicating agricultural information and how? In other words, the study hypothesized that institutional factors have no statistically significant influence on the use mobile phones in communicating agricultural information." The study identified a number of institutional aspects that had effects on the use of mobile phones in communicating agricultural information: Such factors are collectively merged around four major areas: infrastructure, regulatory issues, and communication and technical factors. Further, other aspects discussed include cost and arbitrary charges by mobile phone companies to mobile phone users (Table 20).

4.8.1 Infrastructural support

Two challenging aspects were listed under infrastructural problems, one being poor mobile phone network coverage and the other one being poor rural electrification. Since many farmers in the study area lived in rural areas, accessibility to network seemed to be a problem. Of the 240 respondents, 33.5% argued about the absence of mobile phone towers which they believed had led to poor network coverage and quality in their locality. Another problem counted was poor rural electrification; of the 240 respondents, 27.9% contented that poor rural electrification added to high running costs in terms of phone battery charging. A chi-square test revealed that infrastructural support was significantly associated in the use of mobile phones to communicate agricultural information at

$\chi^2 = 2.39$, $\rho \leq 0.012$. Equally, similar arguments were reported during FGDs, for instance, one FGD member in Malui village in Kilosa District was quoted saying:

> *"Lack of electricity has become a big issue as far as mobile phone use is concerned. Currently, in Malui village, mobile phone charging services are far more expensive than buying air time."*

The results entail the need for infrastructural support which, according to Lawson (2003) and Hudson (2006) are possible only with systems of established social rules. According to Knetter (1989), for efficient performance of any particular programme, institutional support is a must. However, as pointed out by one key informant at the Ministry of Livestock and Fisheries Development, to reach an effective infrastructural reform, a number of aspects need to be addressed, including positive political commitment towards the proposed reforms at all levels from the grass-roots level to higher level authorities.

4.8.2 Regulatory reforms and provisions

Another institutional aspect identified was regulatory issues; of the 240 respondents, 17.9% highlighted that policy uncertainties affected their use of mobile phones to communicate agricultural information. On the other hand, 10.8% argued about the need to strengthen rules and regulations governing the use of mobile phones in order to monitor both investment and services concerning mobile phone use to communicate agricultural information. A chi-square test reveal that regulatory reform and support had a statistically significant association with the use of mobile phones at $\chi^2 = 2.80$, $\rho \leq 0.01$. The findings are in line with Furuholt and Matotay (2011) who found that mobile phone users in Tanzania spent about 10% of total monthly expenditure on mobile phones implying that famers spend a lot of their incomes on using mobile phones.

Similar views were presented during FGDs, for instance, one key informant in Tindiga village in Kilosa District was quoted saying:

> *"Failure to have rules and regulations to monitor service charges will ultimately lead to high costs and arbitrary charges to users. High cost predisposes back beneficiaries from adopting and or using mobile phone technology."*

Another FGD discussant in Kilolo village in Kilolo district said that:

> *"There are situations where mobile phone companies impose costs absurdly; there is a need for the government to observe and act accordingly by setting regulations to protect us from such un-necessary changes."*

Literature indicates that at present in Tanzania, rules and regulations that enforce national ICT Policy are not clear (TCRA, 2011). As such, both the policy itself and the regulatory body (TCRA) are ineffectively operating, particularly in rural areas. Also, it is expected that regulatory plans will effectively guide commitments placed upon public or private entities concerning with mobile phones applications.

4.8.3 Communication strategy

Other two aspects emphasized in order to improve the use of mobile phones to communicate agricultural information which both fall under communication strategy include; one, the need for the government to have plans to put in force campaigns and adverts about the use of mobile phones in agriculture, then the other one is provision of experts who can help farmers improve their know-how in using mobile phone to communicate agricultural information (Table 20). Of the 240 respondents, 45% emphasized the need for campaigns and adverts to make more farmers get aware about the potentials that mobile phones offer. On the other hand, of the 240 respondents, 40% contended about the need for experts to help them use mobile phones better to communicate agricultural information. A chi-square test revealed that, communication strategy had a statistically significant relationship with the use of mobile phones to communicate agricultural information at $\chi^2 = 2.39$, $\rho \leq 0.023$.

During FGDs and key informant interviews, it appears that administrators of various mobile phone programmes look a lead to develop communication plans and setting up mobile phone applications without observing what exactly people need in order for the programme to succeed. This is contrary to the principles of programming. Steyn (2000) proposes that, planners need to go closer to clients and discuss their intents and the expected consequences associated with the plans before developing the plan. This is in line with the conclusion made by Steyn (2001). As noted by Steyn (2001), irrespective of the type of intent, the first step for an effective programme implementation should be identification of audience. Thus, audience research should be carried out first to find out how the audience can be reached most effectively. Later, a communication plan is made, and decision upon materials to be developed is also made. The widespread distribution of the material follows when field-testing and possible adjustments are already made. It is at that stage the material can be distributed (Bronn, 2001; Grunig, 2000; Steyn, 2001).

4.8.4 Technology characteristics

Respondents reported constraints relating to the difficulty of using mobile phone technology to communicate agricultural information. Basically, two technology related problems were raised, one being high cost of both buying and running mobile phones, hence the need to build the necessary capacity amongst stakeholders including provision of subsidy on mobile phones. The need to capacitate is in agreement with (Neven *et al*., 2009; Gollakota, 2008; World Bank, 2006) who suggested some structural and financial solutions for more support to farmers so that they can pool their limited resources amongst them-selves or with other actors to enter new markets or access new resources.

Statistically, of the 240 respondents, 29.6% claimed that the technology was expensive, and they called upon the need for subsidy to enable them be able to improve their proficiency in using the technology. Another problem is technology complexity; respondents claimed the need for technical assistance including provision of simple phones which they could easily work with (Table 20). Of the 240 respondents, 17.9% indicated that the type of mobile phones owned had a statistically significant association with the use of mobile phones to communicate agricultural information at $\chi^2 = 0.17$, $\rho \leq 0.008$. As such, apart from demanding for subsidy on mobile phones, the respondents also requested for some support, including the need for training that could improve their knowledge and aptitudes of using mobile phones.

Table 20: Institutional factors underlying the use of mobile phones to CAI

Institutional aspects	Use MP to CAI		χ^2	ρ -value
	Frequency	Percentage		
Infrastructural support				
Network coverage and quality	80	33.5	2.39	0.012**
Rural electrification	67	27.9		
Regulatory reform and support				
Policy issues and guidelines	43	17.9	2.80	0.01**
Rules and regulations	26	10.8		
Communication strategies				
Campaigns and adverts	108	45	0.09	0.023**
Provision of expertise	96	40		
Technological factors				
High buying and running cost	71	29.6	0.17	0.008**
Technology complexity	43	17.9		

**Statistically significant at $p \leq 0.05$

4.9 Theoretical Implications

Three theoretical frameworks were specified and several of their constructs were applied in this study. Each theory had a unique contribution to the study, for instance, interpreting results in light of the Actor Network Theory, the study found that interaction among

stakeholders had a significant relationship with the use of mobile phones to communicate agricultural information. The findings revealed that different stakeholders needed to interact across levels for them to effective use mobile phones to communicate agricultural information. Of course, ANT is interested in the ways people are networked, hence a conclusion that the study adds additional support for the theory.

On the other hand, social cognitive theory provided insights on how to design successful programmes. The study found that many social, cultural, and economic factors contribute to the development, maintenance, and change of communication behaviour patterns. It was generally recognized that, mobile phone promotion interventions are most likely to be effective if they embrace an environmentally friendly perspective. That is, interventions should not only be targeted at individuals but should also affect interpersonal, organizational, and environmental factors influencing communication behaviour. Usually, strategies to change communication behaviours have been focusing on individual-level factors such as knowledge, beliefs, and skills. Thus, the study alerts that, intervention strategies need to be broadened to target factors at other levels of influence such as organizational policies and the built environment. This means that, behavioural interventions should be sensitive to contextual factors. This implies that, a more productive strategy to promote mobile phone use to communicate agricultural information would also include environmental change, for example expanding the availability and affordability of mobile phones. When this is done along with individual skill training, longer-lasting and meaningful changes can be achieved.

Another theory fit in this study is Rogers's diffusion of innovation theory. A key premise of the Diffusion of Innovations Model is that some innovations diffuse quickly and widely, while others are weakly or never adopted, and others are adopted but

subsequently abandoned. And that, innovations are adopted by different individuals and spread at different rates in subgroups of individuals. Three groups of variables have been recycled to explain these different outcomes in this study: (1) characteristics of the innovation; (2) characteristics of adopters; and (3) environmental context.

4.10 Summary of the Chapter

This section summarises the key findings of the research regarding the role of different stakeholder in support for the use of mobile phones in communicating agricultural information including theoretical and proven contribution of mobile phone services in agricultural technology innovation processes. Generally, the use of mobile phones in communicating agricultural information is becoming commoner and offers more diverse and multiple functions that support farmers at different stages of agricultural production. The main argument of this study is that, like many other technologies, the establishment of mobile phone technology alone may not be enough; rather, there should be efforts to support its use amongst stakeholders. Based on the study findings little attention has been paid to address the roles of different stakeholders that could enhance the use of mobile phones in communicating agricultural information in Tanzania. Thus, in an attempt to attract a greater number of mobile phone users and thereby encouraging the application of mobile phones in communicating agricultural information within the country, there should be efforts to support its use.

The study found some important roles that different stakeholders could play to enhance the use of mobile phones in communicating agricultural information. The researcher believes that different development partners will find the results interesting and helpful; for instance, mobile phone operators may find it helpful especially when planning new market penetration strategies. The results would also help government and other

development agencies to perfect their promotion practices for improved mobile phone practices in communicating agricultural information. However, the variables tested might not be the only ones to explain roles and factors influencing the use of mobile phones to communicate agricultural information; thus it would be better to conduct further research to explore other explanatory factors and the way various applications suit to our environments.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

The sections underneath refer to conclusions and recommendations of the study as per study objectives.

5.1 Conclusions

The conclusion are presented under five major areas of the research, based on research objectives, that is conclusion based on respondents' socio-economic characteristics, respondents' information needs, roles of different stakeholders associated with the use of mobile phones in communicating agricultural information, the nature of interlinkage or interactions amongst stakeholders relating to the use of mobile phone in communicating agricultural information, and institutional factors underlying the use of mobile phones in communicating agricultural information.

5.1.1 Conclusion on socio-economic characteristics

A successful use of mobile phones in communicating agricultural information, among other things, is dependent on farmers' characteristics. A binary logistic regression analysis identified a number of socio-demographic variables that influenced the use of mobile phones in communicating agricultural information. These factors included age, literacy levels, farming systems, income levels and farmers' involvement in off-farm activities. In terms of age, relatively young farmers (≤ 45 years old) were found mostly using mobile phones to communicate agricultural information than elderly farmers (> 45 years). Furthermore, based on education levels, the use of mobile phones to communicate agricultural information had a positive coefficient (0.012) which increased with an increase of farmers' literacy levels.

Based on scale of production, the use of mobile phone in communicating agricultural information was largely skewed to farmers with large farms (> one hectare) than those with small farms (≤ one hectare). The explanation for this is that farmers with large farms are able to make a surplus, which they can use to buy mobile phones and use in communicating agricultural information. Further, distances from markets were associated with more use of mobile phones in communicate agricultural information. Other respondents' characteristics influencing farmers' ability to use mobile phones in communicating agricultural information included, types of mobile phone and its application options, membership to farmer organizations and capability in using mobile phone technology. Conclusively, the use of mobile phones in communicating agricultural information is significantly influenced by farmers' socio-demographic and contextual characteristics.

5.1.2 Conclusion on respondents' information needs

The study findings showed that agricultural information needs and sources differed among respondents and varied over time. One key explanation for their differences in needs and information sources was the type of farming systems farmers undertook. Differences in information needs and sources were observed between livestock keepers and crop growers. Thus, the study concludes that different farming systems and information needs among stakeholders significantly affect the use of mobile phones to communicate agricultural information. However, the study findings further showed that differences on information sources were also associated with availability, accessibility and reliability of information sources.

5.1.3 Conclusion on roles played by different stakeholders

The study identified some roles that different stakeholders need to play in order to enhance the use of mobile phones in communicating agricultural information. The government of Tanzania, for example, has the role of promoting the use of mobile phones in communicating agricultural information. The most effective government strategy to promote the use of mobile phone has been to involve the private sector to invest in mobile phone development. Other plans that the government has include supporting the use of mobile phones to communicate agricultural information through building infrastructure such as, rural electrification, allowing more mobile phone service providers for reducing running cost. Clearly, during FGDs it was revealed that investors could become motivated to invest and offer their services in remote areas if they were supported and motivated including devouring good roads and electricity.

On the other hand, telecentres help farmers to use mobile phones in communicating agricultural information. Nevertheless, little efforts have been made by the government to sustain telecentres. Further, it was revealed that telecentres have good opportunities to train farmers on the use of mobile phones to communicate agricultural information and help farmers on other technical aspects of ICTs.

From these findings it is conclude that stakeholders like input suppliers, traders and agricultural researchers, TMAs and TCRA enhance the use of mobile phones to communicate agricultural information. For example, TMAs collaborated with agricultural researchers, extension agents, farmer organizations and private sectors in using mobile phones to communicate agricultural information by providing weather information. On the other hand, TCRA enhanced the provision of communication services in the country through certification and control of mobile phone investment.

5.1.4 Conclusion on multi-stakeholder interactions

From the findings, it is concluded that multi-stakeholder relations ensure knowledge sharing and enhanced collective actions. During FGDs fora, interaction amongst stakeholders was named as one of the common challenges of mobile phone use in communicating agricultural information. Further, the study identified other factors that influenced the effectiveness of linkages amongst stakeholders including their nature contacts, awareness of roles of other stakeholders, relevance of services, and accessibility of services provided.

5.1.5 Conclusion on institutional aspects

Infrastructural inadequacies have resulted into insufficient coverage of mobile phone services. Lack of access to infrastructure, for instance, appeared to hinder effective use of mobile phones in communicating agricultural information. For example, poor mobile phone network meant that users could not access services. Even with network availability, it was of little use if the service was not affordable. Electricity in rural areas was a problem too. Similarly, as evidenced during key informant interviews, ICT policies were not favourable towards promoting the use of mobile phones in communicating agricultural information.

Other lessons learnt include the fact that smallholder farmers lack awareness of various mobile phone applications available through mobile phones such at Tigo Kilimo, M-FAIS, or Vodacom klub, including their potential contribution in agricultural production. Other barriers included cost, irrelevant content, complexity of the technology, and lack or poor rural electricity structures.

5.2 Recommendations

Based on conclusions the specified above, recommendations for enhancing the use of mobile phones in communicating agricultural information are given below and could be achieved through a combination of strategies; thus, the study recommends interventions in the following areas.

i. Owing to the fact that socio-demographic characteristics are significantly associated with the use of mobile phones in communicating agricultural information, mobile phone service providers such as Tigo, Vodacom, Airtel, Zantel and TTCL need to reflect on these characteristics when developing mobile phone applications and content which would be held by users valuable.

ii. Researchers need to make a thoughtful review of their clients so that specifically they serve particular groups of clients based on their real agricultural information needs. This will serve as a solution to the fact that different groups of farmers vary in their requirements at different peaks of production periods.

iii. Jointly, local government authorities in the study districts, in collaboration with mobile phone service providers, ought to educate famers through sensitization and mobilization campaigns on apt usage of mobile phones to communicate agricultural information. Equally, local government authorities should improve telecentres so that they can grow into real centres for training smallholder farmers in ICTs, including mobile phones. As such, they need to set aside funds for training smallholder farmers about the use of mobile phones in communicating agricultural information.

iv. As evidenced in the results section, farmers had more contacts with input sellers compared to other stakeholders. This could be interpreted that there is a need to encourage the relationship between smallholder farmers with input suppliers. Therefore, government authorities, through researchers, should liaise with mobile phone service providers to subsidize smallholder farmers' linkage with input suppliers, providing free texts or calls.

v. Local government authorities in Kilolo and Kilosa should increase efforts to improve rural infrastructures, especially those meant for reliable electric power supply, to enhance mobile phone use.

vi. Based on the fact that multi-stakeholder networking brings stakeholders together and ensures knowledge sharing among actors, local government authorities in Kilolo and Kilosa should regularly organize meetings with various stakeholders for exchange of ideas meant to increase mobile phone use in communicating agricultural information.

5.3 Areas for Further Research

Following the limitations of this study, for instance, choosing a sample being chosen basing on mobile phones ownership leaving behind people and places without mobile phones could be a problem, similar studies could be carried out with varying methodologies. For example, one could explore types of mobile phone applications that smallholder farmers in Tanzania commonly use to communicate agricultural information. Such a study could focus on aspects like cost, applicability and overall effects of different mobile phone applications on farm productivity.

The findings will provide opportunities to understand the contextual value of various mobile phone applications and signpost areas which need aptness for development. The analysis could further extend the current line of research to other parts of Tanzania and make a comparative analysis of the applicability of various mobile phone applications already operating in Tanzania.

Conversely, it is important to note that it is somehow difficult to isolate the overall effect of mobile phones on productivity due to the pervasiveness of the technology, particularly in agriculture where mobile phones have been found to influence the entire production process. Thus, the role of mobile phones vis-à-vis other channels in communicating agricultural also warrants further analysis.

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APPENDICES

Appendix 1: Questionnaire for farmers

Dear respondents,

This interview guide is prepared to collect data with regard to roles of different stakeholders on the use of mobile phones to communicate agricultural information. The study is conducted for academic purposes, results are meant to provide input to my PhD thesis. Feel free to provide your responses to the questions. All responses will be confidential.

General Information

Region……..District…….…….Division……

Ward…….Village……...

Part A: Respondents' characteristics

Demographic characteristics	Status
A1. Age group (In years)?	Bellow 25 [__], 25 – 35 [__], 35– 45 [__] 46 -60 [__] Above 60 [__]
A2. Sex of respondents	Male [__] Female [__]
A3. Marital status	Never married [__] Married [__] Divorced [__] Widow [__] Widower[__]
A4. Respondent's literacy level	No formal schooling [__] Primary education [__] Secondary education [__] College or university [__] Other(s) (specify)…….

Part B: Questions related to production parameters/farming practices

B1. Which agricultural based enterprise(s) are you involved with?

[__] Crop production

[__] Livestock production

[__] Mixed farming

[__] Others (specify)……

B2. In case you are involved with crop production, which type of crops do you produce?

In order of importance

[__] Maize
[__] Sunflower
[__] Paddy
[__] Irish Potato
[__] Tomato
[__] Onion
[__] Others (Specify)……

B3. In case you are involved with livestock, which animal(s) do you own? In order of their importance

[__] Cattle
[__] Pig
[__] Chicken
[__] Goats
[__] Others Specify) ……

B4. Farm size (in hectare)

[__] Small (≤ 1 ha)
[__] Medium (1.01- 5 ha)
[__] Large (> 5)

B5. Are you a member of any farmers group or association? Yes [__] No [__]

If yes, which group or association?

[__] Farmer Field School
[__] One Acre Fund
[__] Women group
[__] Others…….

B6. On average, at which range do you consider your annual income fit (in Tanzanian shillings)

[__] ≤ 1600.00
[__] 1600.00– 3200.00
[__] Above 3200.00

Part C: Questions related to use of mobile phones in communicating agricultural information

C_1. For how long have you owned mobile phone?

[__] Less than a year
[__] 1-2 years
[__] 2-3 years
[__] 3-5 years
[__] Above 5 years

C_2. Do you use mobile phone to communicate agricultural information?

[__] Yes [__] No

If yes, how long have you been using it? ……

C3. What kind of information do you send or receive through mobile phone on regard to the crops listed in B2 above?

[__] Weather forecast
[__] Consulting experts for agronomic practices
[__] Market information
[__] Availability of agricultural inputs
[__] Crop varieties
[__] Credit availability
[__] Others (Specify)……

C4. What kind information do you send or receive via mobile phone on regard to the animals listed in B3 above?

[__] Parasites and diseases control
[__] Consulting experts for good animal husbandry
[__] Market information
[__] Availability of animal feeds
[__] Prices of livestock & livestock products
[__] Transport costs
[__] Others Specify)……

C5. Is there any help you get regarding mobile phone usage skills to communicate agricultural information? If yes, from whom do you learn mobile phone usage skills?

Tick the appropriate

[__] Fellow farmers

[__] Extension agents
[__] Telecentres;
[__] Mobile phone companies
[__] NGOs
[__] Media (Radio/Television advertisement)
[__] Agricultural researchers
[__] Input dealers/Traders
[__] Agro-processors
[__] Others, (Specify)……

C6. How do you rate the usefulness of Mobile phone in delivering agricultural information?

[__] Not useful
[__] Fairly useful
[__] Useful
[__] Very useful

C7. How do you rate yourself regarding your ability to use mobile phones to communicate agricultural information? *Tick (√) the appropriate*

[__] High

[__] Medium

[__] Low

C8. Which of the following application does your mobile phone have and to what extent you use it to communicate agricultural information? In case you do not use any of the application below, give reasons, why?

Mobile phone applications (Tick √) if applicable)	Extent of use				Why not using
	Never	Rarely	Often	Very often	
[__] Send / Receive Voice Calls					
[__] Send / Receive , SMS					
[__] Internet application					
[__] Video/video conversations					
[__] Photo gulley/Taking Pictures					
[__] Others (specify)……					

C9. On average, how much (Tshs) do you pay daily as you use mobile phone to communicate agricultural information? …….. (Tshs)

C10. Who pays the cost of using mobile phone in communicating agricultural information?

[__] Self

[__] Parents

[__] Brother/sister

[__] Spouse

[__] Son/daughter

[__] government

[__] others (Specify)…….

C11. Is cost keeping you back on the use of mobile phone to communicate agricultural information?

[__] Yes

[__] No

If yes, how do you overcome?

……

……

C12. Does the adoption of mobile phone use in communicating agricultural information help you to overcome the obstacles to getting agricultural information?

Yes [__] No [__]

If Yes, how?

……

……

C13. What role(s) does Mobile Phone Companies play in helping you use Mobile phones to communicate agricultural information?

……

……

C14. What role(s) do government/government officials play in order to enable farmers use Mobile phones to communicate agricultural information?

……

……

C15. What Opportunities prevails in your area that gives hope for the use of Mobile Phone in communicating agricultural information in Tanzania?

……

……

C16. What are the main challenges you face while using mobile phones to communicate agricultural information to other stakeholders?

……

……

17. Has the use of other means of communicating agricultural information increased or decreased since you started using mobile phones to communicate agricultural information? Large decrease (1) Slight decrease (2) No change (3) Slight increase (4) Large increase (5). Tick (√) only one box regarding each issue.

Means of communication	Magnitude of change				
Use of letters and post office					
Office visits					
Making farm visits					
Attend meeting					
Consulting fellow farmers					
Visits to extension home					
Listening to Radio					
Watching TV					
Reading books and newspapers					

18. Has your investment in the use of mobile phones in communicating agricultural information been helpful? Code: 1 = Very unhelpful, 2 = Unhelpful, 3 = No opinion, 4 = Helpful, 5 = Very helpful. Read item(s) and then place appropriate code in appropriate box, then, for positive responses indicate how).

Items	Response	If helpful, how
For communicating agricultural information		
Help in case of emergencies i.e. deaths, thefts		
Contact relatives and or friends		
Send and or receive money		
Arrange for social functions i.e. wedding		

19. Indicate the extent to which use of mobile phones in communicating agricultural information have affected each of the following benefits to you? Code: 1 = Not applicable, 2 = No effect, 3 = Small effect, 4 = Medium effect, 5 = Large effect. Read item(s) and then place appropriate code in appropriate box.

Benefits	Response				
Easy contact with extension agents and other stakeholders					
To obtain better market prices					
Easy contact with fellow famers					
Timely selling of agricultural produces					
Increased production					
Increase revenues					
Saves time and money due to fewer travels made					
Better access to agricultural market information					

Section D: Interactions amongst stakeholders

D1. Do you communicate agricultural information through mobile phone?

[__]Yes

[__] No

D2. If yes, whom do you contact for agricultural information?

……

……

D3. How do you assess yourself in terms of capability to interact with stakeholders listed below using mobile phones for agricultural information?

Stakeholder	Capability	Reasons for low capability
Government	High [__] Medium [__] Low [__]	
Phone companies	High [__] Medium [__] Low [__]	
Extension agents	High [__] Medium [__] Low [__]	
Input dealers	High [__] Medium [__] Low [__]	
Traders	High [__] Medium [__] Low [__]	
Fellow famer	High [__] Medium [__] Low [__]	
Others (specify)	High [__] Medium [__] Low [__]	

D4. What kinds of support services have been availed by different stakeholders to enable you to use mobile phones to communicate agricultural information by farmers in Tanzania?

Type of support	Response
Adapting content to local context	Yes [__] No [__]
Government subsidy	Yes [__] No [__]
Digital literacy training	Yes [__] No [__]
Enabling connectivity through improved network coverage	Yes [__] No [__]
Availability of skilled personnel	Yes [__] No [__]
Open access networks	Yes [__] No [__]
Improved infrastructure	Yes [__] No [__]
Policies/regulations influencing investment	Yes [__] No [__]
Others (Specify)……	Yes [__] No [__]

D5. How do you use mobile phones to communicate agricultural information?

……

……

D6. Which of the following statements best describe your attitude towards the use of mobile phones? (Use 1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree)

Statements describing respondents'attitude	Response
Mobile phones are easy to use and operate	
Mobile phones are easily accessible	
Mobile phones are affordable to purchase compared to other ICTs	
Learning how to use and operate mobile phones is easy for farmers	

D7. What type of phone do you own?

……

D8. Which mobile phone apps do you most prefer to communicate agricultural information?

[__] Outgoing voice calls
[__] Receiving voice calls
[__] Sending or receive text messages
[__] internet
[__] MMS
[__] Photo gulley

D9. Have you ever attended any seminar or workshop on the use of mobile phone to communicate agricultural information? Yes [__] No [__]

D10. Do you have any established contact in your phone that in case of any agricultural information you will call/text? If Yes, which stakeholder(s)?

……

……

D11. Do you keep any written record for agricultural information you communicate through mobile phone for future reference? If Yes, which information?

……

……

D12. In which area of you agricultural production cycle mobile phone provides more information? i.e. marketing, input, agronomic, weather forecast, others (specify)

……

……..……

D13. How often do you communicate agricultural information with i.e. extension agents, fellow farmers, input dealers, researchers, telecentre and traders?

D14. Do you think mobile phone has caused any impact on your farming activity? If yes, How?

……

……

D15. What other means of communication have you been using to communicate agricultural information?

……

……

D16. Is there anything else you would like to add about the use of mobile phone to communicate agricultural information?

……

……..……

D17. Where do you obtain the following inputs for you crop production? i.e.

Input	Place
Fertilizer	
Seeds	
Herbicides	
Insecticide	
Livestock feeds	

D18.How likely is it in five years to come for you to continue using mobile phone to communicate agricultural information?

[__] Very likely

[__] Likely

[__] Neutral

[__] Unlikely

[__] Very unlikely

Part E. Questionsrelating to the role of telecentre in communicating agricultural stakeholder linkages

E1. Do you have telecentre services in your area? Yes [__] No [__]

E2. If Yes in E1 above, which services do telecentres provide to famers?

[__] Computer access and use

[__] Internet access

[__] Technical advice on computers

[__] Teaching and or training

[__] Agricultural information and or advisory services

[__] Others (specify)

……

……

E3. Do you have access to services named in E2 above? Yes [__] No [__]

E4. If yes in E3 above, rate the usefulness of services rendered by the telecentre?

[__] Not useful

[__] fairly useful

[__] Useful

[__] Very useful

E5. What is the agency of organization of the center? [__] Government [__] Private

E6. Which benefits have you been receiving from the telecentre?

[__] Enhanced information delivery
[__] Agricultural growth through reduced information asymmetry
[__] Improved agricultural value chain efficiency
[__] Improved agricultural extension service
[__] Support knowledge sharing and capacity building
[__] Others (specify)……

E7. What challenges does the telecentre face in its operations?

[__] Funding for initial investment
[__] Availability of local information
[__] Level of digital literacy of participants
[__] Lack of skilled personnel to manage centers
[__] Trust in the telecentre
[__] Language barrier
[__]Others (specify)……

E8. If you were to give advice, what do you think should be done in order to improve the use of mobile phone in communicating agricultural information?

……

……

THANK YOU FOR YOUR COOPERATION

Appendix 2: Questions for interview with government officials

A: General information

Ministry/Institution:	Phone number:
Name and Title of Respondent:	Location:
Sex: Male [__] Female [__]	Date:

B: The use of mobile phones in communicating agricultural information

1. Does the government/ministry foster any mobile phone application(s) in communicating agricultural information? [__] YES [__] NO
2. If Yes in Question 1 above, what type of application does the government support farmers on their use of mobile phones to communicate agricultural information?

   ……
   ……

3. Is there a way to ensure relevance of the content for information distributed to farmers via mobile phone? [__] YES [__] NO, If yes, how?

   ……
   ……

4. Is there any kind of feedback that you get from farmers on regard to the use of mobile phone in communicating agricultural information? [__] YES [__] NO, If yes, which feedback?

   ……
   ……

5. What is the perceived impact of mobile phones by farmers in communicating agricultural information?

   ……

   ……

6. In Tanzania context, is national communication policy conducive for widespread mobile phone use in both rural and urban areas? For example, in terms of transparency, deregulation, and investment?

   ……

   ……

7. Do you think laws and regulations affect use of mobile phones to communicate agricultural information? [__] YES [__] NO, If yes, how?

   ……

   ……..……

8. Apart from the state, are there any other agencies/organizations that are involved in promoting the use of mobile phones by farmers to communicating agricultural information? [__] YES [__] NO, If yes, what roles they play?

   ……

   ……

9. Is there political will by government to do what is needed to enable the integration of mobile phone technology throughout society? [__] YES [__] NO, If yes how?

   ……..……

   ……

10. What changes do you think are needed to create an environment that fosters smooth use of mobile phones by farmers in Tanzania?

    ……

    ……

11. In your opinion, how do you think mobile phones could be used to improve farming practices?

……

……

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Appendix 3: A checklist for interview with mobile phone service providers

A: General information

Name: ……. Name of organization……

Title/occupation: …… Telephone number: ……

B. Characteristics and description of the program

B1. Do you have any programme involved with the use of mobile phone to communicate agricultural information?

B2. What kind of agricultural information is being addressed? How do you ensure that the public know about your programme?

.....

.....

B2. Why did you decide to disseminate such information via mobile phone?

……

……

B3. What are the benefits for stakeholders adopting the apps?

……

……

C. Target customers

C1. Who are the exactly targeted users of the services delivered?

……

C2. Do you think farmers need help to be able to participate effectively with the programme? If yes, what type of support do you think they need?

.....

.....

C3. How do you guarantee equitable access among varied users?

……

……

……

C4. Has your organization partnered with other organizations for the program? If yes, with whom?

……

……

C5. How is the programme(s) funded?

……

……

C6. Have you faced any challenges upon implementing the programme? Yes No

C7. If yes, please elaborate on the kind of challenges have you faced and ways you overcome them?

……

……

C8. Were customers/farmers consulted prior to the programme operation? [__] YES [__] NO, If yes how?

……

……

Part D: Scope of mobile phone service provision

D1. What geographic level does the service cover?

……

……

D2. Have you considered the availability of other channels of communication by farmers? [__] YES [__] NO, If yes, which channels?

……

……

D3. Do you think Mobile phone technology is more effective for delivery of agricultural information than the available channels? [__] YES [__] NO, If yes, why?

……

……

D4. Have you thought of integrating your programme within the existing channels? If yes, which channel and how?

……..……

……..……..……

D5. Why did you come up with this programme? Whose need is being addresses?

……

……

D6. How do you ensure that the programme utilizes content which is appropriately localized?

……

……

D7. Do you think that there is a scope for further expansion of the existing project? [__] YES [__] NO, If yes, how?

……

……

D8. How do you think access to mobile phone technology could be increased?

……

……

D9. Which mode of technology application(s) should get more priority for further expansion? Explain why?

……

……

D10. Are there any training or basic skill (e.g. literacy) requirements? Yes No

D11. Who do you think need most the training? (Service users, service providers or both)

D12. Is there cost associated with using this program? Yes No

D13. If the above answer is yes then what is it and who pays?

……

……

D14. Is support available for stakeholders to engage in the programme? If yes what kind and by which institution(s)?

……

……

D15. Does your programme require government action? [__] YES [__] NO, If yes, how?

……

……..……..

D16. How do you ensure farmers' capacities for their effective participation in your programme?

……

……..……..

D17. Do you have any feedback mechanisms so that you listen to the raised concerns and suggestions?

……

……..……

Part E: Sustainability of mobile phone applications

E1. What has been the financial and or livelihood impact of the programme?

……

……

E2. Is local capacity being developed? [__] YES [__] NO, If Yes, how?

……

……

E3. How do infrastructure been organized?

……

……

Part F: Effects of the Mobile phone applications to the target society

F1. Generally, would you consider the programme to be a success or failure? Why?

……

……

F2. What are the most noticeable changes on the livelihoods of the service to users?

……

……

F3. Have there been specific capacity building efforts to help farmer reach the goal? Yes No, if yes, what efforts have been made?

……

……

F4. What aspects of the programme would you have implemented differently, if you were to re-launch the programme?

……

……

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Appendix 4: A checklist for key informants interviews i.e. researchers, traders, extension agents and input dealers

A: General information

1. Title of key informant: ……
2. Sex: Male [__] Female [__]
3. Institution name: ……

B: Adoption of Mobile Phone

1. Experience (in years) with the work position?

……

……

……

Do you use mobile phone to send or receive any agricultural information? [__] YES [__] NO, if yes, what kind of information and with whom do you communicate?

……

……

……

2. Does information gained through mobile phone aid you to improve your crops and/or livestock productivity? [__] YES [__] NO, Give reason for the choice made

……

……

3. What do you think has been the impact of the use of mobile phone on your livelihood?

……

……..……

4. In your opinion, do farmers use mobile phones in communicating agricultural information? [__] YES [__] NO, if Yes how? Have you ever contacted farmers for agricultural information?

……

……

5. What is the perceived impact of mobile phones in the communication of agricultural information by farmers?

……

……

6. What are your general comments on farmers' use of mobile phones in communicating agricultural information?

……

….……

C: Type of support farmers get in using Mobile phones

1. What are the challenges commonly facing people trying to use mobile phone to communicate agricultural information?

……

……

2. Is there any help available to enable the use of mobile phone in communicating agricultural information? [__] YES [__] NO, If yes, which kind, how and by whom?

   ……

   ……

   ……

3. In your opinion, what do you think should be done in order to improve the use of mobile phone in communicate agricultural information?

   ……

   ……

Appendix 5: A checklist for interview with telecentre representatives

1. Which group of people benefits the service from this telecentre?

   ……

   ……

2. Do you promote the use of telecentre to farmers? [__] YES [__] NO
3. If Yes in Qn2 above, how do you sensitize the use of mobile phone in communicate agricultural information?

   ……

   ……

4. Are farmers coming to the centre seeking agricultural information? [__] YES [__] NO
5. If Yes in Qn 4, which services does the center provide to famers?

   ……

   ……

6. Which service do famers need most? Which media do you to communicate with farmers?

   ……

   ……

7. On average, what expenses (per day) incurred specifically for communicating agricultural information?

   ……

   ……

8. What are the challenges you face in helping farmers to use mobile phone in communicating agricultural information?

   ……

   ……

9. In your opinion, what are the strengths and weaknesses of this telecentre in helping the target clients?

   ……

   ……

10. What do you suggest in order to improve the performance of the center?

    ……

    ……

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Appendix 6: A checklist for interviews with representatives from TCRA and TMA

1. What is the current situation of mobile phone use in communicating agricultural information in Tanzania?
2. What kind of control and or measures does TCRA coerce with mobile phone companies to enable smooth use of mobile phone to communicate agricultural information?
3. What role does TCRA play to ensure effective use of mobile phone by farmers to communicate agricultural information?
4. Is there any government policy governing mobile phone companies' investments in agriculture?
5. Do you think the use of mobile phone to CAI helps farmers? [__] YES [__] NO, If yes, how? What about those without mobile phones?
6. Is there any evidence that farming communities are changing as a result of agricultural information provided through mobile phone?
7. How could farmers be helped so that they better use mobile phone to communicate agricultural information? Name agents for such help

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Appendix 7: Guiding questions for Focus Group Discussions

1. On average, what do you think is the status of Mobile phone ownership and use in your area?
2. What are the common use(s) of your mobile phone?
3. Do you think farmers are using mobile phone to communicate agricultural information in the study area? [__] YES [__] NO, If yes, to what extent?
4. What kind of agricultural information do they communicate through mobile phones?
5. Whom do farmers contact for agricultural information through mobile phone?
6. Do you think mobile phone helps farming community improve productivity? [__] YES [__] NO, If yes, how?
7. How does a person without a phone perceived by a community?
8. What do you think keeps farmers back from using mobile phones to communicate agricultural information?
9. How do you think famers could be helped in order to use mobile phone to communicate agricultural information? Who can help them?
10. Does the farming community really changing as a result of using mobile phone to communicate agricultural information? [__] YES [__] NO, If yes, how?
11. What kind of information and communication channels do you use to disseminate agriculture information to farmers in this area?
12. How do you assess the use of mobile phones by farmers to get agriculture information?
13. Which role do different stakeholders (government officials, Mobile phone companies, input dealers, researchers, telecentre, traders and extension agents) play to govern mobile phone companies' investments in agriculture?

14. In which areas do you think the government has not well done to enhance the use of mobile phone in communicating agricultural information?
15. What do you suggest that the government should do to enhance the use of mobile phone in communicating agricultural information?
16. Are there benefits from using mobile phone to communicate agricultural information? [__] YES [__] NO, If yes, what are they?
17. Are there some challenges that hinder the use of mobile phones in communicating agricultural related information to farmers? [__] YES [__] NO, if yes, what are the most important ones?
18. In general, what do you recommend to be done in order to increase farmers' use of mobile phones in communicating agricultural information?

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