ASSESSMENT OF FARMERS' USE OF MOBILE PHONES IN COMMUNICATING AGRICULTURAL INFORMATION IN *MAGHARIBI* A DISTRICT, ZANZIBAR

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ABSTRACT

Agriculture remains an important economic sector for contributing to food self-sufficiency and incomes in Zanzibar. However, its performance is limited by poor access to extension services on improved technologies to increase production and productivity due to shortage of Block Extension Officers in *Shehia*. Currently, mobile phones are among the reliable media to communicate agricultural information in sub-sahara Africa, which can be used to provide better linkage between farmers and agricultural experts. This study determined the extent to which farmers used mobile phones to communicate agricultural information in *Magharibi* A District. Specifically, the study examined farmers' socio-economic factors influencing the use of mobile phones; identified crop-and livestock-related information that farmers communicated using mobile phones; determined mobile phone modes that farmers used to communicate agricultural information; determined institutional support mechanisms influencing farmers' use of mobile phones for communicating agricultural information and challenges affecting farmers use of mobile phones. A cross-sectional research design was employed and a total of 383 randomly selected respondents were sampled. Data were collected using interview schedules, checklists and interview guides. Quantitative data was analyzed using the SPSS version 21 and qualitative data was analyzed using content analysis. The study results indicate that socio-economic determinants of mobile phone use were farmers' household size, average monthly income, type of farming practices, farming experiences, and membership in SACCOS. Furthermore, the results show that mobile phones were used to communicate production-, market- and weather-related information on cassava, plantain, chicken and dairy cattle; and the most preferable modes of communication was voice calls and SMSs. Similarly, the results indicate that farmers received support from different institutions to enable their effective use of mobile phones. However, higher call tariffs, network infrastructure,

unavailability of electricity, policies and regulations were found to limit the use of mobile phones. The study recommends that *Magharibi* A District should support farmers in using mobile phones for communicating agricultural information. Also, *Magharibi* A District should educate farmers on appropriate use of mobile phones. The Government should create enabling policies and regulatory environment and ensure availability of electricity at affordable cost to encourage more farmers to use mobile phones.

DECLARATION

I, HASHIM HAMZA CHANDE, do hereby declare to the Senate of Sokoine University of Agriculture that this thesis is a result of my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted for an award in any other institution.

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LIST OF ABBREVIATIONS AND ACRONYMS

AST	Adaptive Structuration Theory
BEOs	Block Extension Officers
BSNL	Bharat Sanchar Nigam Limited
CA	Content Analysis
CBO	Community Based Organization
CD	Corporate Digest
CEO	Chief Extension Officer
CMS	Cassava Measurement Study
CVR	Content Validity Ratio
DADO	District Agricultural Development Officer
DAECD	Department of Agricultural Extension and Community Development
DIT	Diffusion of Innovation Theory
FAO	Food and Agriculture Organization
FBO	Faith Based Organization
FFS	Farmer Field School
FGDs	Focus Group Discussions
GDP	Gross Domestic Product
ICTs	Information and Communication Technologies
IFFCO	Indian Farmers Fertilizer Cooperative Limited
IKSL	IFFCO Kisan Sanchar Limited
ILO	International Labour Organization
IVRS	Interactive Voice Response System

KII	Key Informants Interview
KIs	Key Informants
LS	Likert Scale
MALE	Ministry of Agriculture, Livestock and Environment
MANRLF	Ministry of Agriculture, Natural Resources, Livestock and Fisheries
MMSs	Multimedia Messaging Services
MTN	Multinational Telecommunications Network
NAP	National Agricultural Policy
NBS	National Bureau of Statistics
NGO	Non-governmental Organization
NULS	Norwegian University of Life Sciences
OCGSZ	Office of the Chief Government Statistician Zanzibar
QPM	Quality Protein Maize
RADO	Regional Agricultural Development Officer
RGoZ	Revolutionary Government of Zanzibar
SACCOS	Savings and Credit Cooperative Society
SMS	Subject Matter Specialist
SMS	Short Message Service
SPSS	Statistical Package for Social Sciences
SSA	Sub-Saharan Africa
SUA	Sokoine University of Agriculture
TAHA	Tanzania Horticulture Association
TAM	Technology Acceptance Model
TCRA	Tanzania Communication Regulatory Authority

TTCL	Tanzania Telecommunication Company Limited
URT	United Republic of Tanzania
UWAMWIMA	*Umoja wa Wakulima wa Matunda na Mboga mboga Zanzibar*
VIF	Variance Inflation Factor
WBG	World Bank Group

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Zanzibar is a semi-autonomous part of the United Republic of Tanzania and agriculture remains an important economic sector, both in its contribution to food self-sufficiency and for household income. It provides employment to most of the Isle's labour force, with 37.8% of rural population being engaged in agricultural production (OCGSZ, 2012) and about 80% of the total population derives their livelihood directly or indirectly from the sector (RGoZ, 2010). The sector contributed 25.7% of the GDP by 2016 with a growth rate of 5.7% (OCGSZ, 2017). However, performance of the sector in Zanzibar, as in many other developing countries and regional states of the sub-Sahara Africa is limited by a number of challenges, mainly associated with continuous application of inappropriate farming technologies, limited investment opportunities, a slow pace towards commercializing agricultural production, poor marketing infrastructure and unpredictable impacts of climate changes (RGoZ, 2009).

Poor access to advisory services and inadequate up-to-date agricultural knowledge on improved farming technologies that have a significant effect on increasing agricultural production and productivity (RGoZ, 2010; Kameswari *et al.,* 2011). In much of the developing world, rural farming communities struggle to access timely, relevant and up-to-date agricultural information to support their production and marketing of crops and livestock (Norton *et al.*, 2016). Farmers in particular, require accurate, quality and timely agricultural information and knowledge regarding farming operations and practices, post-

harvest processing, marketing and weather forecast in order to make an informed decision (Sanga *et al.*, 2013).

According to Stolle (2015) in Tanzanian one of the numerous challenges that prevent farmers from managing their farms effectively is limited access to up-to-date information such as weather forecasts, market prices and agricultural knowledge. Thus, the challenges caused by limited access to agricultural information and knowledge led to majority of rural farming communities to have limited access to timely, relevant and up-to-date agricultural information to support their production and marketing. At the same time, the development and spread of Information and Communication Technologies (ICTs) globally, has led to speeding up of communication of information in various sectors including agriculture.

ICTs have changed the way agricultural knowledge is produced, processed, stored, retrieved and transmitted to different agricultural stakeholders(Ansari and Pandey, 2013). In fact the high penetration of mobile phones coverage in Asian, sub-Saharan African (SSA) and Latin American countries had made more than 60% of its population to have access to mobile phone by 2009 (Chhachhar and Hassan, 2013). Nearly five billion people in developing countries now use and do business on mobile phones (WBG, 2012). In Tanzania, ICTs such as radio, television, mobile phones, computers and internet have potentials in communicating agricultural information if they are effectively used (Mtega and Msungu, 2013). Furthermore, Nyamba and Mlozi (2012) reported that farmers in Kilolo District find it convenient to use mobile phones to access agricultural information.

Thus, mobile phones are the only modern ICT that are widely accessible to farmers (FAO, 2014). According to the Tanzania Communications Regulatory Authority (TCRA) as of

December, 2016, there were 40 million mobile phone subscribers in Tanzania (TCRA, 2016). Also, in 2012, about 71.4% of Zanzibar rural households owned and used mobile phones (URT, 2014), in social services such as news, weather forecasting, sports, and agriculture information, which has a potential for farmers to communicate agricultural information with extension agents and to supplement the traditional extension methods. For example, in Sri Lanka, a considerable number of farmers use mobile phones to contact agriculture extension agents and other farmers in their area (Dissanayeke and Wanigasundera, 2014). In developing countries, including Tanzania, extension agents, service providers and their clients use mobile phones to process and communicate agricultural information (Okwu and Iorkaa, 2011). Furthermore, Sife *et al.* (2010); Falola and Adewumi (2012) reported that mobile phones contribute to reduction of poverty and improvement of rural livelihoods by providing fast and easy modes of communication, hence, strengthening social networks.

Mobile phones also reduce vulnerabilities to accidents and thefts and can cut down travel costs since farmers can order their supplies of fertilizer, herbicides and improved varieties while at home or farm (Asa and Uwem, 2017; Sife *et al.*, 2010). Mobile phones have become one of the most cost-effective and reliable medium used to communicate agricultural information in our age due to the high cost of delivering information through face-to-face interaction (Mittal and Mehar, 2012). The performance of agricultural sector depends largely on effective access and use of agricultural technologies at farm level. Mobile phones complement face-to-face interaction and provide a new way to reach many farmers geographically isolated to solve their farming problems and enhance production and productivity.

1.2 Problem Statement

Agricultural extension services in Zanzibar are mandated to support farmers' efforts towards increasing agricultural production and productivity through provision of up-to-date agricultural information. However, the use of traditional approach of extension service delivery system through interpersonal contacts is facing a number of challenges including shortage of Block Extension Officers (BEOs) in the *Shehia* (Bie, 2013). For example, currently in Zanzibar out of the 301 *Shehia*, only 124 *Shehia* have BEOs. This has led to the low ratio of BEOs to farmers of 1:1500 instead of 1:500 as recommended by the World Bank (Obinna and Agu-Aguiyi, 2014). Hence, of the 301 agricultural *Shehia* only, 41.2% received extension advisory service in Zanzibar.

The shortage of BEOs is one of the most critical challenges to reach majority of farmers in rural areas leading to low access to up-to-date and timely agricultural information through face-to-face interaction and hence to low use of modern agricultural technologies by farmers. Inadequate extension services delivery leads to poor access to agricultural information that hinders the transfer of technology at the farm level (Mittal and Mehar, 2012; Ronald *et al.*, 2015). At the same time, farmers need to access appropriate agricultural information on improved technologies to make proper decision which in turn improves production. Thus, the use of traditional approach of extension service delivery does not provide efficient and effective communication of agricultural information to the farming communities.

However, according to Haruna *et al.* (2013), the use of mobile phones has increased extension agent contacts and farmers' production capacity. The opportunities of ICTs development including mobile phones have high potential to overcome the information

asymmetry through provision of better linkage between farmers and agricultural experts for timely and appropriate technical advice to enhance agricultural production and productivity (Kahenya *et al.*, 2014). The use of mobile phones in communicating agricultural information by the farming communities could be an option for overcoming the shortage of BEOs, low access to agricultural information and low adoption of the modern agricultural technologies through provision of better linkage between farmers and agricultural experts for timely and appropriate technical advice to enhance agricultural production and productivity.

Despite the increasing benefits of using mobile phones to communicate agricultural information in various parts of the world, currently more information is required to determine the status of mobile phones use in communicating agricultural information to bridge the information gap and to overcome information asymmetry to the farming communities in Zanzibar so as to increase production and productivity. Thus, it is essential to find out factors that influence and constraint farmers on use of mobile phones, to understand types of crop- and livestock-related information and frequency of communication, modes of mobile phones mainly used to communicate agricultural information with extension agents as well as institutional support provided to influence their use. Therefore, this study aimed at determining the extent to which farmers are using mobile phones to communicate agricultural information with extension agents, specifically in *Magharibi* A, District of Zanzibar.

1.3 Justification of the Study

In Tanzania, the common practice for communicating agricultural information to farmers is through the use of public extension agents, farmer-to-farmer visits, farmers' sharing of

own experiences, field days, Farmer Field Schools (FFSs), demonstration plots, prints, radio and television programs (MALE, 2010; Sanga *et al.,* 2014). An effective agricultural extension delivery service depends on agricultural information reaching many farmers and identified farmers' problems reaching the extension service quickly and regularly (Orikpe and Orikpe, 2013). The role of extension agents is to use different approaches and media to transfer agricultural information to address the farmers' problems. Mobile phones have proven to be a powerful tool in transferring agricultural information (Chhachhar and Hassan, 2013). If extension agents and farmers are enabled to use mobile phones to communicate agricultural information, the agricultural sector will benefit greatly (Swanson and Rajalahti, 2010).

The findings of this study provide a better understanding of the actual use of mobile phone in communicating agricultural information in the study area, essential economic factors that influence its use, types of crop- and livestock-related information frequently farmers communicated, mobile phone modes farmers use to communicate agricultural information, institutional support provided to influence its use as well as challenges limiting farmers in using mobile phones to communicate agricultural information. The finding also will create an understanding of information needs, providing baseline information to policy makers on developing policies and strategies enhancing farmers' use of mobile phones in communicating agricultural information, form a basis for recommending solutions to existing constraints and suggesting ways that can improve communication and dissemination of agricultural information. The study findings will guide the planning and coordinating of extension advisory services on the use of mobile phones to communicate and disseminate agricultural information for improving production and productivity. The research findings will also contribute to the literature on the related topic and provide a roadmap for other similar studies.

1.4 Study Objectives

1.4.1 Overall objective

The overall objective of the study was to determine the extent to which farmers used mobile phones in communicating agricultural information with extension agents in *Magharibi* A District of Zanzibar.

1.4.2 Specific objectives

The specific objectives of the study were to:

i. Examine socio-economic factors of the farmers influencing the use of mobile phones to communicate agricultural information with extension agents.
ii. Identify crop-and livestock-related information that farmers communicate with extension agents using mobile phones.
iii. Determine mobile phones modes that farmers used to communicate agricultural information with extension agents.
iv. Determine institutional support mechanisms influencing farmers in using mobile phones to communicate agricultural information with extension agents.
v. Assess challenges faced farmers in using mobile phones to communicate agricultural information with extension agents.

1.4.3 Hypotheses

The study hypotheses were guided by the above objectives of the study on the use of mobile phones in communicating agricultural information with extension agents in *Magharibi* A District of Zanzibar were tested as:

i. **Ho_1**: There is no statistically significant influence of the farmers' socio-economic factors and the use of mobile phones to communicate agricultural information with extension agents.

ii. **Ho_2**: There is no statistically significant association of the crop-and livestock-related information and the use of mobile phones to communicate agricultural information with extension agents.

iii. **Ho_3**: There is no statistically significant association of the institutional support provision and the use of mobile phones to communicate agricultural information with extension agents.

iv. **Ho_4**: There is no statistically significant association of the challenges affecting farmers in using mobile phones and the use of mobile phones to communicate agricultural information with extension agents.

1.5 Review of Theories

There is no single theory/model that can explain all aspects of communication and technology adoption theories, different models can be used to explain adoption decisions of new technologies in communication. This study is based on three theoretical perspectives of communication and technology adoption. These are Diffusion of Innovation theory, Technology Acceptance theory, and Adaptive Structuration theory.

1.5.1 Diffusion of Innovation Theory (DIT)

According to Rogers' diffusion theory (1983, 2013), diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system. According to Ogbeide and Ele (2015) , the theory of diffusion of innovation is how innovation is accepted by a social group and becomes part of the existing social system. Similarly, Rogers (2013) revealed that, adoption occurs when a perceived new technology is best fit in addressing one’s needs and he/she makes full use of it. Rogers defines an innovation as an idea, practice, or project that is perceived as new by an

individual or other unit of adoption (Rogers, 1983; Rogers, 2013; Sahin, 2006). An innovation presents an individual or an organization with a new alternative or alternatives of solving problems (Rogers, 1983). This implies that farmers and extension agents perceive mobile phones as an alternative and valuable new tool in communicating agricultural information to overcome information asymmetry.

According to this model, socio-economic acceptance, opportunities and constraints of innovation (mobile phones) to the member of social system (farmers and extension agents) have an influence on the acceptance and use of the innovation. The diffusion of innovation model has a major influence on the way information is disseminated to end-users (Magesa *et al.,* 2014). This implies that the use of mobile phones to communicate agricultural information by extension agents and farmers has influence on increasing production and productivity. The extent of diffusion of this an innovation can be attributed to five characteristics of the innovation, namely; relative advantage, compatibility, complexity, trialability and observability (Sahin, 2006). These characteristics have significant influence on the acceptance or rejection of the innovation.

According to Sahota and Kameswari (2014), compatibility, relative advantage, and complexity have the most significant relationships to acceptance across a broad range of innovations. However, the socio-economic status of the farmers, crop- and livestock-related information communicated, opportunities (institutional support mechanisms) and barriers (constraints of use mobile phones) have significant influences on acceptance and rejection of the use of mobile phone as a new technology to communicate agricultural information.

1.5.2 Technology Acceptance Model (TAM)

Davis' (1989) theoretical framework proposes a relationship between users' acceptance of a new information system (IS) and the users' perceptions of the ease of use and usefulness of the new information system. This model emphasizes how a technology influences an individual's perception toward the usage of a specific technology. This theory is relevant to the study because it is concerned with acceptance and use of new information system such as mobile phones and how people accept and use them. According to the model, the acceptance of a new technology by a user is based on perceived usefulness, refers to the extent to which the user believes that use of a particular system/technology would help to enhance his or her job performance/efficiency.

In addition, perceived ease of use, refers to the extent to which the user would be comfortable in using the features of the particular system/technology (Ju *et al.*, 2014; Sahota and Kameswari, 2014). Both perceived usefulness and perceived ease of use are independent variables that influence the end users' belief in the technology and can be used to predict the acceptance and the use of a particular information system/technology. Based on those arguments, the acceptance and effective utilization of mobile phones in communicating agricultural information is a major consideration for extension agents and farmers to make informed decisions on the interventions as well improve sharing of agricultural knowledge among agricultural communities.

The theoretical framework of "perceived usefulness of use mobile phones in communicating agricultural information" and "perceived ease of use mobile phones in communicating agricultural information" guides the study objectives to examine the socio-economic characteristics, crop and livestock-related information that farmers and

extension agents communicated, modes of mobile phones use to communicate, institutional support mechanisms and constraints affecting the use of mobile phones. Based on this theoretical framework, acceptance and rationale of use of mobile phones to communicate agricultural information by extension agents and farmers was considered in this study. The implication of acceptance and rationale of use of mobile phones to communicate agricultural information would provide the extension services with new opportunity to communicate and share agricultural knowledge to the farming communities more effectively.

1.5.3 Adaptive Structuration Theory

DeSanctis and Poole (1994) adapted Giddens' theory to study the interaction of groups and organizations with information technology and called it Adaptive Structuration Theory (AST). The theory has focused on group process, that is, members' use of rules and resources in interaction and interested in group product that is produced and reproduced through the interaction. The implication of this theory is that groups (as farmers) and organizations (as agricultural extension services) using information technology (as mobile phones) for their work (agriculture extension communication) create perceptions about the role and utility of the technology (as a new way of communicating agricultural information) and how it can be applied to their activities (sharing agricultural information and knowledge easily and quickly to reduce information asymmetry).

AST is a viable approach for studying the role of advanced information technologies (such as mobile phones) in driving organizational changes (agricultural extension delivery services), and in the way of doing business (such as communicating agricultural information to farmers). The theory guides the study by examining the use of mobile

phones to communicate agricultural information with extension agents as influenced by the farmers' perception of the usefulness to them, the influence of the socio-economic status, types of crop- and livestock-related information, institutional support and constraints of use mobile phones. On acceptance of mobile phones technology as a new agricultural information communication tool by farmers, their perceptions on the increased benefits parallel to the traditional means of communication can influence more use of mobile phones in agriculture for increased production and productivity.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Information and Communication Technology

Information and Communication Technology (ICT) is an umbrella term that covers any communication device or application, encompassing: radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications and is known for transferring information more effectively than other communication methods in agricultural extension (Abdulwaheed *et al.,* 2016). The application of ICTs is slowly replacing the traditional ways of agricultural-related information communicated to farmers. ICTs play a significant role in enhancing agricultural production by providing relevant agricultural information to farmers such as agricultural technologies, commodity prices and weather forecasts (Chavula, 2014). In Tanzania, ICT contributed to the GDP from 1.5% in 2004 to 2.4% in 2013 and the sector growth has increased from 17.4% of GDP in 2004 to 22.8% by 2013 (URT, 2016). According to Paul *et al.* (2014) in the present age ICT has become an indispensable means of passing agricultural-related information to an individual farmer or a group of farmers and achievement of high agricultural productivity depends on the availability and access to appropriate agricultural information and dissemination tools for the right target groups.

2.2 Mobile Phones Ownership and Usage in Agriculture

Mobile phones is one of the modern ICTs, whose ownership and usage are increasing among the farming communities, and which will also increase the chances of the farming communities of using mobile phones in communicating agricultural information by extension agents. Hassan and Semkwiji (2011) indicate that it is possible for a household

to have more than one mobile phone handsets. Mobile phones facilitate the collection, storage, analysis and sharing of data and information, and are changing many aspects of life among a large and growing share of the world's population (Deichmann *et al.,* 2016). The mobile phone helps farmers in getting information about commodity prices in different markets (Jehan *et al.,* 2014). A study by Sobalaje and Adigun (2013), in Boluwaduro Local Government Area of Osun State, Nigeria found that 63.5% of the yam farmers preferred to use mobile phones to access agricultural information.

2.3 Language Used in Mobile Phone Communication

Language plays an important role in the acceptance and use of mobile phones. Currently most of the mobile phone content is dominated by the English language. However, the use of local languages in mobile phone application and communication would increase use by farmers and enable them to easily communicate and clearly understand the information content. This argument is supported by Dissanayeke and Wanigasundera (2014), who reported that SMS services communicated in the English language were a major barrier to communicating agricultural information among agricultural stakeholders in Sri Lanka. Also, Syiem and Raj (2015) asserted that, most of the mobile phone menus were in the English language which limits some farmers to use mobile phones.

According to Ajayi and Gunn (2009), the English language remains dominant in accessing information but attention must be given to multilingual access as explored in many Asian countries, such as Japan, Vietnam, Thailand, China and Indonesia. Information must be customized and disseminated in languages that farmers can easily understand (Ajani and Agwu, 2012). This implies that multilingual access to agricultural information services will enable more farmers to understand the contents and encourage them to utilize

information services more easily and quickly in their production. Farmers require relevant localized information in languages they can understand and in formats they can use (FAO, 2014). According to Lekopanye and Meenakshi (2017), language barrier is one of the challenges faced by most livestock farmers, since most of them only understand only their local languages while ICT applications are programmed to run in the English language.

2.4 Preferred Service Providers

The reliability and availability of mobile phone service providers and network coverage for the farming communities give farmers opportunities to use them more frequently. According to Ansari and Pandey (2013), in India of the five service providers namely Idea Cellular Limited, Bharat Sanchar Nigam Ltd (BSNL), Airtel, Vodafone and Uninor, more than half of the respondents (55.5%) prefer to use Idea Cellular Limited due to its coverage. In Bangladesh the leading mobile phone operators Grameen Phone, Banglalink established call centers that provide agriculture information all over the country to the target population (Hasan, 2015). In Tanzania, the fastest growing five mobile telephony providers are Tigo, Zanzibar Telecom (Zantel), Vodacom, Tanzania Telecommunication Company Limited (TTCL) and Airtel (Sife *et al.,* 2010). According to Magesa *et al.* (2014), Vodacom, Tigo and Airtel were the mobile companies that provided communication service on agricultural marketing information to the rural farmers in Tanzania. Available service providers in the study area were Tanzania Telecommunication Company Limited (TTCL), Tigo, Zain, Vodacom and Zantel (Mwakaje, 2010).

2.5 Mobile Phone Use in Communicating Agriculture-Related Information in other Countries

Mobile phones are one of the fast communication tools which can regularly, quickly and timely provide relevant agricultural information to the farming communities. For example,

in 2008 Indian Farmers Fertilizer Cooperative Limited (IFFCO) and Kisan Sanchar Limited (IKSL) launched and implemented a special ICT project for farmers and cooperatives in Uttarakh State whereby all farmers having Airtel Green Card accessed up to five free voice messages related to agriculture on a daily basis and also could call a dedicated helpline to seek answers to specific queries (Sahota and Kameswari, 2014). According to Singh *et al.* (2015) in Interactive Voice Response System (IVRS) mode in India, the mobile based agri-advisory services offers text, voice and video content based agricultural information services through mobile phones.

In Zimbabwe, there are a number of mobile phone-based services providing farmers access to market prices and enabling them to negotiate better deals with traders and improve the timing of getting their crops to market. Mobile-based market information systems and services naturally provide farmers with opportunity to send SMS to a specific number which then gives them wholesale and retail prices of crops (Chisita and Malapela, 2014). In Kenya, *Kilimo Salama,* a micro-insurance programme, allows farmers to insure their crops using their phones and *Mkulima* Young Champions is a leading digital initiative for young farmers, that draws more youth into farming, helps them to learn from each other, trade and overcome agricultural challenges by using radio, short message services (SMSs) and social media to discuss agricultural topics and shared successes (Irungu *et al.*, 2015).

Furthermore, the DrumNet project used mobile phones and a computer based platform to link the various value chain actors and to provide them with production and market information, and also helped farmers to access input credit under interlinked credit scheme and allowed farmers to negotiate fairer prices for their produce under a production and marketing contract (Okello, 2010). Likewise, in Uganda, Grameen Foundation launched

the SMS-based comprehensive system designed to work with mobile phones to reach the broadest possible audience in western Uganda to help them deliver market information to farmers, while Agrinet in Uganda was located in markets to collect and disseminate market intelligence through the use of SMS linked to physical information boards (Miwanda *et al.,* 2014). According to Adamides and Stylianou (2013) and Hasan (2015) mobile phones significantly reduce communication and information costs for the rural poor in developing countries.

2.6 Mobile Phone Use in Communicating Agriculture-related Information in Tanzania

In Tanzania the number of mobile phones ownership and use has increased quickly. According to URT (2014a) 63% of the households in Tanzania Mainland owned mobile phones, while in Zanzibar mobile phones ownership was higher (at 80% of households) than in Tanzania Mainland. The spread and increasing number of mobile phone ownership and use among the majority of small scale farmers in Tanzania led to the three major mobile phone service providers to launch special mobile phone applications to assist farmers to access agricultural information through mobile phones by using Short Message Services (SMS). In 2012, Tigo launched *TigoKilimo* service to enable farmers to have free access to weather forecast, agronomic best practices and market prices and had over 40 000 subscribers in October 2013 (Stolle, 2015).

In 2013 Zantel in partnership with the Ministry of Agriculture, Food and Cooperatives and Sibesonke Limited launched *Z-KILIMO* a special mobile service for farmers to enable them to access timely and relevant modem agricultural information (CD, 2013). In 2014, Vodacom launched *KilimoKlub* to give farmers an opportunity to access market

information, weather forecast and financial transactions (Vodacom, 2015). Over 30 000 small-scale farmers in Tanzania expected to participate in *KilimoKlub* (Pesatimes, 2014). The use of cell phone in agriculture has increased extension agent contacts and increased farmer's production capacity (Haruna *et al.*, 2013).

2.7 Agricultural Extension Services in Zanzibar

Extension originally was regarded as a service to "extend" research-based knowledge to the rural sector to improve the lives of farmers (Davis, 2008). The main purpose of agricultural extension activities is to communicate relevant and useful information to the end users in order to persuade them to adopt that which will eventually lead to increase in agricultural production (Yakubu *et al.,* 2013). According to Ajani and Agwu (2012), agricultural extension is an essential mechanism for delivering knowledge (information) and advice as an input for modern farming. Furthermore, according to Shah *et al.* (2013), extension agents plays important role in educating farmers by encouraging them to learn, adopt new technologies and spread them to other farmers. Okwoche and Asogwa (2012), reported that extension agents carried out the responsibilities of educating and disseminating useful and timely agricultural information to the farmers.

Therefore, agriculture extension services in Zanzibar are important for farmers to improve their production and productivity, and eventually to increase their incomes, self-food sufficiency, and their living standards. The agricultural extension service in Zanzibar is mainly coordinated and supervised by the Ministry of Agriculture, Natural Resources, Livestock and Fisheries under the Department of Agriculture which is mandated to disseminate agricultural information to the farming communities. The task of providing agricultural information to farmers is primarily vested in government agencies or the

public extension system; however, most of the extension agents are poorly equipped and use individual contact extension methods to communicate and to disseminate agricultural technologies to farmers (Kaske *et al.*, 2017). However, few private sector organizations including non-governmental organizations (NGOs), community based organizations (CBOs), faith based organizations (FBOs) and development institutions also participate in delivering extension services.

At the moment all extension agents are government employees under the Ministry responsible to agriculture. At national level the extension service is coordinated by Chief Extension Officer (CEO) who is responsible for coordinating and developing of all agricultural extension activities and work together with Regional Agricultural Development officers (RADOs) and District Agricultural Officers (DADOs) at Regional and District levels respectively. At the District level there are a number of Subject Matter Specialists (SMSs) in different disciplines (i.e. food crop production, animal production, plant protection, horticulture, forestry, environments and fisheries) who are responsible for providing the technical assistance to Block Extension Officers (BEOs) working and communicating directly with farmers at *Shehia* level. However, both SMSs and BEOs are all accountable to DADO.

Traditionally extension services in Zanzibar are delivered by extension agents through the conventional individual contact (Training and Visit), demonstration plots, field days, *Mkulima* newsletter, radio and television broadcasts. Participatory approaches such as the Farmers Field Schools (FFS) that gives farmers a better opportunity to learn practically all important aspects of agricultural production have become a common method of extension service delivery in Zanzibar nowadays. However, most of times, use of face to face extension contact is difficult for extension agents to provide all extension services to the rural farmers hence the necessity to harness the mobile phones. According to Adamides

and Stylianou (2013), extension services should take advantage of the mobile phone and its applications and use it more extensively for the dissemination of agricultural information to the farmers.

2.8 Conceptual Framework of the Study

The conceptual framework for the study is based on assessment of the farmers' use of mobile phones in communicating agricultural information with extension agents as shown in Figure 1. It accommodates a set of background and independent variables that might influence the use of mobile phones to communicate agricultural information. The background in which the study was done incorporated the social, economic, political and environmental contexts of Tanzania. Independent variables included socio-economic factors (sex, age, education, household size, average monthly income, farming practices and member of SACCOS), crop- and livestock-related information, mobile phones modes used, institutional support mechanisms and challenges facing farmers in using mobile phones (Figure 1). All these independent variables and background variables were considered as having direct influence on the dependent variable. In this framework, use of mobile phones to communicate agricultural information was the dependent variable.

2.8.1 Socio-economic factors of the respondents

The social and economic characteristics of the respondents has high influence in acceptance and use or rejection of improved technologies in agriculture such as mobile phones in communicating agricultural information. In this study socio-economic factors of farmers including sex, age, level of education, household size, and average annual income, type of farming practices and membership of SACCOS were measured to examine their influence on the use of mobile phones in communicating agricultural information (Figure 1).

2.8.1.1 Sex of the respondents

It is believed that male farmers are better than female farmers in using mobile phones to communicate agricultural information. According to Dissanayeke and Wanigasundera (2014), gender differences could be a limiting factor of accessing agricultural information using mobile phones. Men and women differ in their access to agricultural resources, yet both contribute significantly to agricultural production (Anaglo *et al.*, 2014). The study by Haruna *et al.* (2013) revealed that, majority 94.2% of the respondents were male indicating low participation of women in agriculture and use of mobile phones to source information to get access to good markets, consult experts, emergency help and inputs procurement.

2.8.1.2 Age of the respondents

Age of the respondents can have impact on use of a new technology including mobile phones and accessibility to information. This is supported by Komunte *et al.* (2012) who noted that age influenced use of mobile phones and also supported by a study of Komunte (2015) who found that young farmers in the study area were more available and accessible to ICTs as compared to older farmers. Ogbeide and Ele (2015) also found that young people were more favoured in connection with the use of mobile phones, which was in agreement with the findings of Williams and Agbo (2013). From the above studies, it is evident that young farmers were more motivated to use new technology including mobile phones in day to day businesses. As reported by Nnenna (2013), farming is dominated by young people who are active and within the productive age group.

2.8.1.3 Education level of the respondents

It has been suggested that education has a positive influence on the acceptance and use of new technologies. According to Rehman *et al.* (2013) education has highly significant positive relationship with access to agricultural information. Agwu *et al.* (2008) stated

that, farmers with higher education can use information and communication technologies (ICTs) to improve their rural livelihoods more than those with lower education who might not take full advantage of ICTs in improving their agriculture. Education facilitates farmers' ability to use ICTs and appreciate their importance in farming activities (Ajani and Agwu, 2012). Farmers with higher literacy level are more likely to participate in new ideas and adopt new innovations (Williams and Agbo, 2013). According to Fashina and Odefadehan (2014) farmers with certain level of education will be more exposed to information technology compared to the less educated farmers.

2.8.1.4 Household size of the respondents

Household size has implication on the use of new technologies such as mobile phones and availability of labour for farming and non-farming practices. According to Falola and Adewumi (2012), household size is positively related with the use of mobile by the famers to invite household members for farming operations to save costs of hiring labourers. The presence of a large household size encourages use of mobile phones to enhance communication of outside members (Animashaun *et al.*, 2014). Akinola (2017) revealed that family size had positive significant influence on farmers' use of mobile phones for agricultural information. Farmers' household size was significantly influence on the level of utilization of ICTs as a source of agricultural information in the study area (Williams and Agbo, 2013).

2.8.1.5 Average monthly income of the respondents

Farmers' incomes encourage usage of modern technologies and determine affordability of capital intensive technology in the household. According to Okwu *et al.* (2007), low income families can be affected in using capital intensive modern technologies. This finding is similar to that of Nnenna (2013) who reported that, farmers who are low income earners, may not possess the financial muscle required to purchase and utilise ICT

facilities. This is rational as mobile phones are costly and make them unaffordable to some of the farmers or affect the choice of the mode of phone that they will opt to use (Falola and Adewumi, 2012).

2.8.1.6 Farming experiences of the respondents

Farming experience enabled farmers to use technology and perform better in their production. The higher the farming experience, the more the farmer would have gained more knowledge and technological ideas on how to tackle farm production (Nnenna, 2013). Experience in agriculture and farming being the major occupation could be the likelihood of farmers owning and use of mobile phone (Haruna *et al.*, 2013). According to Obinna and Agu-Aguiyi (2014), about, 65 % of the respondents had farming experience between 11 – 30 years which indicated that depended more with their indigenous knowledge on agricultural production, environment and other natural resources to sustain their production than use of mobile phones.

2.8.1.7 Type of farming practices of the respondents

Majority of rural communities are involved in farming practices as their primary occupation and farming practices such as crop farming, livestock keeping, mixed farming and fisheries have an impact on the use of mobile phones. According to Obinna and Agu-Aguiyi (2014) most 66.7 % of the respondents had farming as their primary occupation. Mutunga and Waema (2016) found that mobile phones usage in rural livelihoods varied according to the type of farming practiced by smallholder farmers. In Oyo State, Nigeria, most 62.3% of the cell phone user practiced mixed farming (Bolarinwa and Oyeyinka, 2011).

2.8.1.8 Membership in associations

Membership in associations such as cooperative societies, agricultural associations and SACCOS empower the farming communities in accessing and use of technologies

including mobile phones to share agricultural related information, knowledge and experiences. In study by Obinna (2014), revealed that 90.5 % of the respondents owned mobile phones and belonged to organizations. According to Falola *et al.* (2013) membership in association is expected to influence the use of mobile telecommunications services for agricultural activities by farmers as it can be used to pass information and share farming experiences. Farmers belonged to a farmers' organization influence others to adopt new technologies, able to access inputs at slightly lower rates, encourage members to work very hard and increase the chances with which extension agents contact members, thus reducing cost of service delivery and service providers (Mbanda-Obura *et al.,* 2017).

2.8.2 Crop-and livestock-related information communicated using mobile phones

Crop and livestock-related information that farmers communicate using mobile phones with extension agents measured was on cassava, plantain, dairy cattle and chicken keeping which including related-information on production, market and weather (Figure 1). These information and knowledge could have significant influence on the use of mobile phones to communicate agricultural information and to make informed decision on agricultural production. According to Dissanayeke and Wanigasundera (2014), in their study in the Galenbindunuwewa Division, North Central Province of Sri Lanka, there were four major uses of mobile phones in communicating agricultural information to farmers, including providing market information like market prices and technical advice on issues of pest and disease management, fertilizer recommendations and post-harvest management, weather forecasts and voice communications with extension agents, input suppliers, agriculture labour and traders.

In India, mobile phone is used to disseminate timely information regarding best cultivation practices, seed availability, cropping pattern, weather forecasts, fertilizer usage, market information, organic practices and information about vaccination, insurance alerts, and

livestock diseases, exotic and indigenous breeds, feeding management, livestock rearing and government schemes on animal husbandry (Belakeri *et al.,* 2017). According to Lwoga *et al.* (2011), farmers in Tanzania need information and knowledge on improvement of soil fertility, control of plant pests and diseases, environmental conservation, control of animal diseases, livestock husbandry, value added techniques, and agricultural tools. Ansari and Pandey (2013) identified information on disease identification and control, fertilizer application dose method and timing, harvesting time, marketing and sowing time.

Mittal and Mehar (2012) recognized that farmers use mobile phones to communicate geographical information, cropping system, recommended quantity and quality of inputs and timely use, good agricultural and crop management practices. Farmers use mobile phones to access market price information (Ajani and Agwu, 2012; Makhijani *et al.,* 2015). A study by Magesa *et al.* (2014) in Hai District in Kilimanjaro Region, and Mvomero and Kilosa Districts in Morogoro Region, found that three-quarters, 75.9%, of farmers depends on mobile phones for communicating information on agricultural markets. According to Ganesan *et al.* (2013) information on weather factors like rainfall, temperature and humidity was perceived most appropriate by about 47.16% of farmers while about 36.24% of farmers rated it as appropriate.

2.8.3 Mobile phones modes used in communicating agricultural information

In communicating agricultural information using mobile phones, various mode and facilities such as voice call, short messaging system (SMS), voice call messaging, pictures, video, internet, Facebook and WhatsApp were used. For the purpose of this study mobile phones modes including SMSs, voice call, voice call messaging, pictures and video mode used were measured (Figure 1). For example, in China voice call service is currently a key

channel to get connected with the farmers who can call in to get information and guidance on policy, technology, marketing, business, or other relevant professional and social information (Zhang *et al.,* 2016). Likewise, the Digital Early Warning Network in Tanzania uses SMS to receive information about cassava disease outbreaks from farmers (Aldosari *et al.,* 2017).

According to Onyeneke *et al.* (2016) in Nigeria some of the ICT applications such as short messaging services and calls were used by farmers to access agricultural information, while in Bangladesh there has been a proliferation of mobile phone based applications and services in the agricultural sector, providing information on market prices, weather, transport and agricultural techniques via voice, SMS and internet (Hasan, 2015). In Ethiopia, over three quarters of the household heads received phone calls related to agriculture but SMS was hardly used (Kaske *et al.,* 2017). In Kenya, agricultural market information services (MIS) applications send farmers crop pricing information via SMS (Wyche and Steinfield, 2015). According to Aker and Mbiti (2010) in Tamale Ghana farmers are able to send a text message to learn about corn and tomato prices in Accra, over 400 kilometers away. Rather than always traveling to visit a farmer, extension agents use a combination of voice, text, videos, and internet to reduce transaction costs (Deichmann *et al.,* 2016).

According to the study by Muricho (2014), 45.3% and 14.1% of the respondents use voice calls and SMSs respectively in accessing banana production information in the study area. SMSs and voice messages were commonly used for accessing timely market prices, reaching clients, sharing accurate production information and money transactions (Irungu *et al.,* 2015). Farmers also used SMSs to access advisory service on fertilizer management

(Syiem and Raj, 2015). In Kwara State, Nigeria most, 91.4%, of the farmers preferred text messaging as the only means of receiving any agricultural-related information from the government (Paul *et al.,* 2014). According Ogbeide and Ele (2015) farmers and other stakeholders make calls, send SMSs or MMSs to each other to access information on agricultural value chains.

2.8.4 Institutional support mechanisms influence use of mobile phones

Institutional support such as provision of financial, materials, guidance and technical support could enhance the use of mobile phones to communicate agricultural information to the farming communities (Figure 1). This study measured nine selected institution support including awareness creation, free airtime and subscription fees, loans, infrastructure, network coverage, policies and regulations that influenced the use of mobile phones in agriculture. According to Lwoga (2010) the formulation of policies and laws on the ICT sector in Tanzania has facilitated market entry, customer services, costs reduction and increased productivity of the mobile phones telecommunication services. To increase the use of mobile phones by the farmers especially those with low incomes, there is need to subsidize the cost of mobile phone services (Ansari and Pandey, 2013).

ICT implementation in agricultural communication relies on various institutional support mechanisms such as awareness, financial support, training, network infrastructure, policies and regulations, organizational and human support. According to Mutunga and Waema (2016) mobile phone was found to have the greatest effect on smallholder farmers' livelihoods when used in the context of market oriented farming with adequate supporting infrastructure and strong policies and regulations that mainstream and integrate its use in agricultural activities. To support development and expanded use of ICTs including mobile

phones in communicating agricultural information in Tanzania various policies, regulations, Acts and strategies have been formulated. These include development of the National Telecommunication Policy of 1997, National ICT Policy of 2003, National ICT Policy of 2016, ICT policy for Basic Education of 2007, Water and Irrigation ICT Policy of 2016, Tanzania Communications Act 18 of 1993 and Tanzania Communications Regulatory Act of 2003.

2.8.5 Challenges affecting the use of mobile phones

Various challenges are reported to inhibit the use of mobile phones in the communication of agricultural information. Four main categories of challenges that inhibit farmers to use mobile phones in communicating agricultural information were measured including network, human, operational and electricity challenges (Figure 1). There are also variables under each category measured. According to Sanga *et al.* (2014), gender differences, literacy, mobile phone ownership and network coverage could be limiting factors. Fluctuation of telecommunication services, inadequate access to mobile services and lack of electric power supply constrain farmers to use mobile phone services (Falola and Adewumi, 2012). High service charges, poor quality of mobile phone and its accessories were the major constraints to the effective use of mobile phone (Haruna *et al.,* 2013). According to Owino (2014), due to high cost of airtime, charging and battery replacement, only 21% of farmers used mobile phones to access agricultural information.

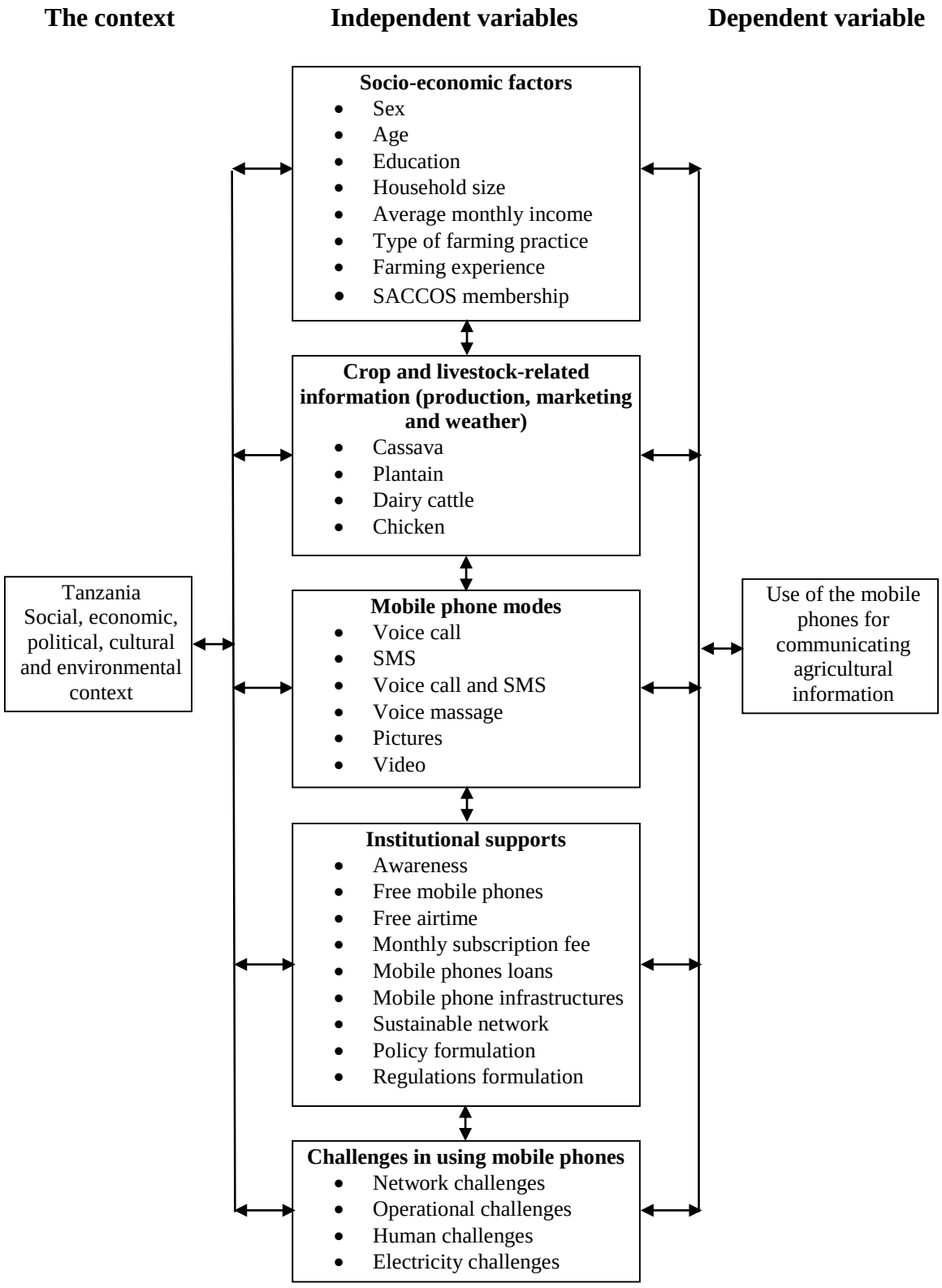

Figure 1: Conceptual framework for the assessment of farmers' use of mobile phones in communicating agricultural information in *Magharibi* A District in Zanzibar.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the Study Area

The study was carried out in *Magharibi* (A) District of Zanzibar previously known as *Magharibi* District (Figure 2). The District was purposively selected because of having a high concentration (93.9%)of households growing crops and keeping livestock as major economic activities, and its good mobile phone network coverage, 49.2% of its population aged 15 years and above use mobile phone services (OCGSZ, 2012). It is the second district with the largest number of households engaged in crop production and is the first district with the largest number (61.4%) of households engaged in livestock keeping as a major economic activities and 53% of agricultural households with access to extension services (RGoZ, 2012). According to Mittal and Mehar (2012) farmers who regularly connect with extension agents are more likely to accept improved technology earlier.

3.1.1 Geographical location

Zanzibar is located on the Tanzania eastern coast of the Indian Ocean about 30km of the east coast of Africa. The Island is located between latitude $04^0$51' South and longitude $39^0$11' East. *Magharibi* (A) District is one of the three districts of the *Mjini/Magharibi* Region of Zanzibar. It is bordered to the north by the *Kaskazini* Region, to the east by the *Kati* Region, to the west by the Indian Ocean/*Mjini* District, to the south by *Magharibi* (B) District (Figure 2). According to the 2012 Tanzania National Census, the district had a human population of 190 001 with an average household size of 5.2 persons.

3.1.2 The use of mobile phones

In Zanzibar, 80% of households owned and use mobile phones (URT, 2014). According to Office of the Chief Government Statistician Zanzibar (OCGSZ, 2012), the use of mobile

phones by the population in the age range 15 years and above by district shows that *Magharibi* District has the second highest users of mobile phones after *Mjini*. About a fifth (20.9%), of the people in that age range above use mobile phones in *Magharibi* Distinct. Use of mobiles is more common in *Magharibi* rural areas (26.2%), compared to *Magharibi* urban areas (17.3%); and it is more common among females (21.7%) compared to males (20.3%). More than one third of the females in *Magharibi* rural (30.9%) used mobile phones. The use of mobile phones was less common by male farmer respondents than the females. The distribution in the use of mobile phones by age suggests that the young adults in the age group 30 – 34 years are more likely to use of mobile phones; this is true to both, rural and urban areas. About four-fifths of mobile phone users are in the age range 20 – 49 years. Generally, in Zanzibar, more than four fifths of females in the rural areas, and three fifths of females in urban areas do not use mobile phones. For the male population, two thirds in rural areas and half in urban areas do not use mobile phones.

3.1.3 Socio-economic activities

The majority of people in *Magharibi* A District are involved in growing crops and keeping livestock as their major occupation and economic activity. The main food crops cultivated are cassava, plantains and banana, paddy, sweet potatoes, cocoyam, yams and maize. The livestock kept are cattle, goats, pigs, rabbits and poultry including chicken, ducks, guinea fowls and pigeons.

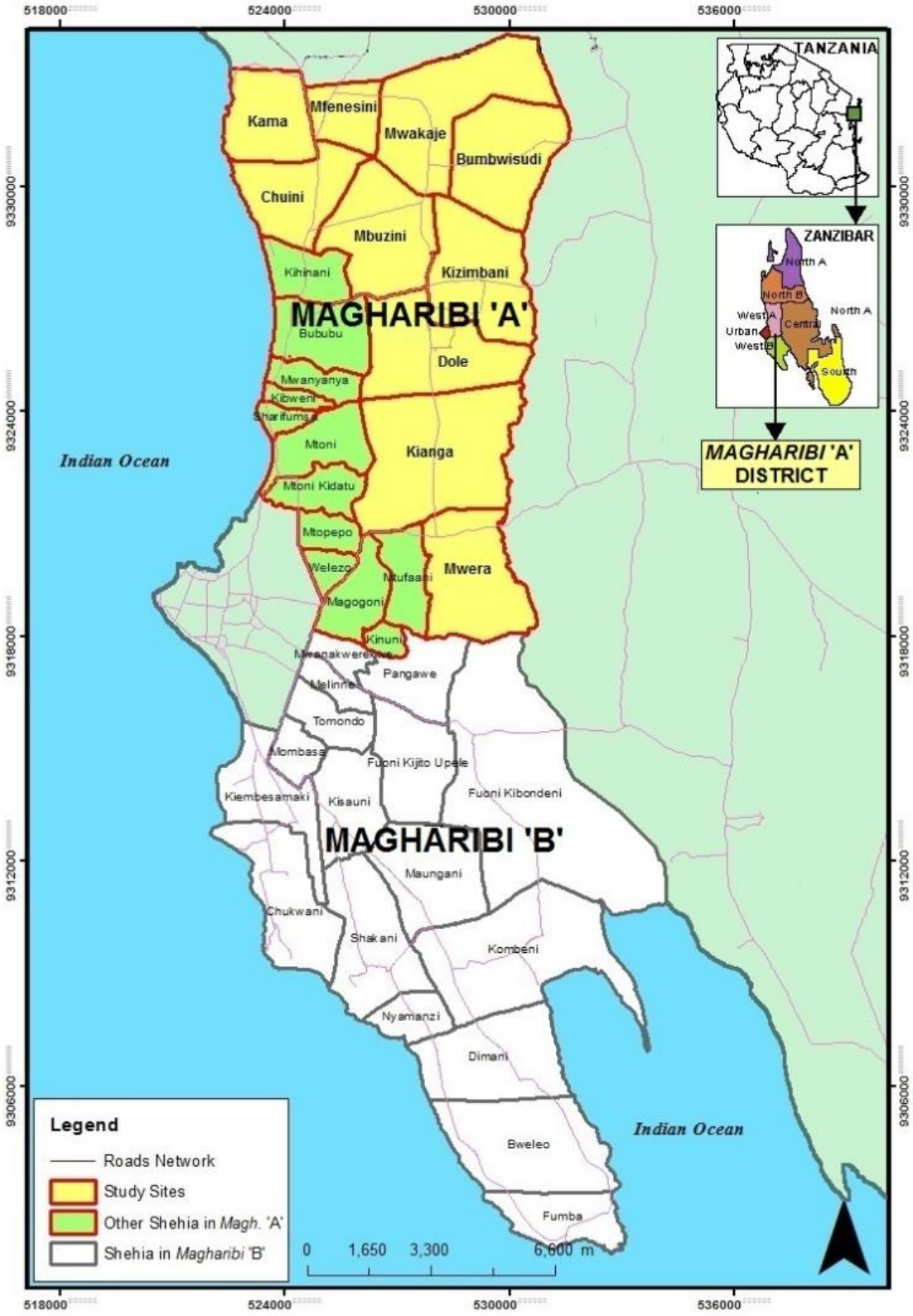

Figure 2: Map of physical location of the study area

3.2 Research Design

A cross-sectional research design was employed in the study. According to Amin (2005), the design is suitable for gathering data from a selected sample at a single point in time to obtain information on preferences, attitudes, practices and interests of a group of people on a particular issue. The design is useful in determination of relationships between and among variables. It is generally quick, easy, and cheap to perform due to the method uses minimum time as well as minimum resources.

3.3 Study Population, Sampling Frame, Sampling Procedure and Sample Size

The target population for the study was farmers growing crops and keeping livestock located in the ten purposively selected *Shehia* of *Magharibi* A District of Zanzibar which are Mwera, Kianga, Dole, Kizimbani, Bumbwisudi, Mwakaje, Mfenesini, Chuini, Kama and Mbuzini due to their potential for agricultural activities. The sampling frame was farmers involved in cassava production, plantain production, dairy cattle keeping and chicken keeping and who owned and used mobile phones. The selection of these crops and livestock was based on their importance for food and income in Zanzibar. According to the OCGSZ (2016), quantity of cassava production is leading by 47.5% of all other food crops, quantity of banana and plantain count as the third, 17% of important food crops, while the *Magharibi* A District is the highest, 39.7% of the quantity of chicken eggs production and is the second highest, 13.4% of the quantity of dairy cattle milk production. The sampling unit was an individual farmers involved in at least two of the said agricultural enterprises, having owning and using of mobile phones.

Proportionate stratified random sampling technique based on *Shehia* and gender was applied to ensure equal representation of *Shehia*, male and females from each of the 10

selected *Shehia* that participated in the study due to the division of population sample into *Shehia*. According to Mbanda-Obura *et al.* (2017) stratified sampling ensures unbiased representation and inclusion of all the farmers as well as the cost per observation may be reduced by stratification. There were 1545 farmers in the list obtained from the *Migharibi* A District Agricultural Development Office in Zanzibar. Based on the established criteria, only 775 farmers were qualified to be selected to participate in the study as shown in Table 1.

Table 1: Proportionate Sampling of Study Respondents

Shehia	**Sex**		**Total**	**Male**	**Female**	**Total**
	Male	**Female**	**farmers**	**proportion sampled**	**proportion sampled**	**farmers sampled**
Mwera	52	20	72	20	16	36
Kianga	16	9	25	6	7	13
Dole	58	13	71	22	11	32
Kizimbani	125	48	173	47	39	86
Kama	33	15	48	12	12	25
Mbuzini	45	51	96	17	41	58
Mwakaje	46	14	60	17	11	29
Bumbwisudi	47	41	88	18	33	51
Chuini	39	17	56	15	14	29
Mfenesini	68	18	86	26	15	40
Total	**529**	**246**	**775**	**200**	**200**	**400**

Random sampling techniques using random number computer generated were applied to select respondents for the study and a total of 400 farmers were randomly selected of which 200 were males and 200 were females. According to Halim and Ishak (2014) in referring to Roscoe (1975), the appropriate sample size for a study ranged from 30 to 500,

the sample size larger than 500 will cause a Type II error. Key informants (KIs) such as DADO, SMSs, BEOs and *Shehia* were purposively selected and involved in the study.

A total of six focus group discussions (FGDs) with six to seven participants purposively selected were held. The sample size was statistically determined using the Taro Yamane (1967) formula for a finite population (Okon *et al.,* 2014). This method is only applicable when the numerical strength of the population is finite (Senam and Akpan, 2014; Okon *et al.,* 2014): The formula is presented as follow: $n = N / 1 + N(e)^2$……(1)

Where: n = sample size; N = finite population (50297) according to National Population and Housing Census 2012); e = level of precision (0.05); 1 = Unit (constant); Therefore: $n = 50297/1+50297(0.05)^2$; $n = 399.99 \approx 400$ (Rounded up).

3.4 Methods of Data Collection

3.4.1 Primary data collection

Both quantitative and qualitative data collection methods were applied. The quantitative data was gathered from respondents through semi-structured interview schedules. Qualitative data was obtained from Focus Group Discussions (FDGs) and Key Informants (KIs) interviews.

3.4.1.1 Interview schedule

Of the 400 respondents randomly selected in ten *Shehia*, data was collected from only 383 respondents by using close ended interview schedule of which 192 were male and 191were female. The remaining 17 sampled farmers were not reached due to various reasons including absence from their homes, illness and disruption by other events such as burials during data collection. The three trained enumerators under supervision of researcher read the questions in the semi-structured interview schedules to the respondents and their

responses were recorded. The information collected was divided into four sections. Section one asked information on respondents' socio-economic characteristics, section two pursued information on crop- and livestock-related information, frequency and mode used to communicate, section three collected information on institutional support mechanisms influencing use of mobile phones and section four dealt with challenges affecting respondents' use of mobile phones.

3.4.1.2 Focus group discussions (FGDs)

A total of six FGDs were held in six *Shehia* namely: Kianga, Dole, Kizimbani, Bumbwisudi, Mfenesini and Chuini with the involvement of six to seven participants purposively selected among the farmers who grow selected crop, keep selected livestock, owned and use mobile phones of whom four farmers (including one to two female farmers), *Sheha* and Block Extension Officer (BEO) of the respective *Shehia*, making a total of 38 participants who were involved in direct discussion with the researcher to collect primary data that complemented the information obtained from farmers' interviews. The selection of participants in FGDs was according to Rio-roberts (2011) who suggested that focus groups with six to 12 participants should be adequate to generate sufficient discussion. The choice of this method was to help the researcher to capture in-depth information from the participants. During the discussions the discussants expressed more and revealed more information and therefore verbal explanation led to more understanding and the researcher asked more questions regarding some unclear expressions and hence leading to gathering more data.

3.4.1.3 Key informant interviews

A total of five face to face Key informant interviews were conducted at different times. This involved the District Agricultural Development Officer (DADO), and four Subject

Matter Specialists (SMSs) for crop production, plant protection, animal production and animal health in order to obtain necessary information on crops-and livestock-related information communicated with farmers using mobile phones, opinions and challenges faced in using mobile phones for the purpose of knowing how effectively they use mobile phones in communicating agricultural information. This approach was used to assist the researcher to collect more information from the informants and also to validate what was collected during farmers' interviews and focus group discussions.

3.5 Validity and Reliability of Data Collection Tool

3.5.1 Validity of the data collection tool

Validity is an important aspect to consider when preparing research instrument (questionnaire). Validity refers to the ability of the instrument to produce accurate results and to measure what is supposed to be measure (Amin, 2005). A research instrument is said to be valid if it actually measures what was supposed to measure and the data collected honestly and accurately represent the respondents' opinions (Kimberlin and Winterstein, 2008). There are several types of validity measures. For this study, content validity was the most important measure. Therefore, in validating research instrument experts at Sokoine University of Agriculture and fellow students read the data collection tool and made necessary corrections. Also, the researcher in collaboration with the District Extension Officers and Agricultural Statistician made thoroughly scrutinize of each item in the data collection tool to ensure it produce answers as intended. According to Taherdoost (2016), content validity refers to the extent that measurement instrument items are relevant and representative of the target construct which usually depends on the judgment of experts in the field, literature review or content validity ratio.

3.5.2 Reliability of data collection tool

Reliability was an important aspect to the data collection tool (questionnaire) to test the internal consistence of the tool. Reliability is the degree to which an assessment tool produces stable and consistent results. In this study, this was done to ascertain the semi-structured questionnaire's stability and consistency. To achieve this, the tool was pre-tested in *Kati* District in Dunga Kiembeni and Binguni Shehia. Twenty farmers (eight were females, 12 were males) were purposively selected as the area had similar characteristics as those found in the study area. The earlier validated data collection tool was administered to twenty farmers. The collected data from this exercise was coded and entered in the SPSS and adapting the spilt-half reliability analysis by using the Spearman-Brown formula to yield the reliability coefficient, which are expressed as Cronbach alpha correlation coefficients. The Spearman-Brown formula expressed as:

$r_c = 2r/1+r$……(2)

Whereas r_c = reliability coefficient of the whole test and r = reliability coefficient of the two halves. Generally, "test reliabilities of an research instrument (questionnaire) should be at least 0.70 or 0.80 in group research" (Ellis, 2013; Radhakrishna *et al*., 2003). Hence, the reliability coefficient of this test (r_c) was 0.73, which was within the recommended range, meaning that the instrument was reliable.

3.6 Method of Data Analysis

3.6.1 Quantitative data analysis

Data collected was coded, summarized and analyzed using the Statistical Package for Social Sciences software version 21 computer program for quantitative data analysis. The frequency counts, percentages, mean and standard deviation were used to describe the data, while Chi-square test was used to establish association of the variables in the study;

Likert Rating Scale (LRS) was used to rank the score of the variables and Binary Logistic Regression model used to test the hypotheses. For objective 1, data were analyzed using frequency counts and percentage to examine socio-demographic factors on the use of mobile phone to communicate agricultural information with extension agents and the binary logistic regression model used to determine socio-demographic factors influencing the use of mobile phone to communicate agricultural information with extension agents. The Binary Logistic Regression that was used is given by:

$Z = Log[p/1-p]=Log$……..…….. (3)

$Y = \alpha+ \beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X4+\beta_5X_5+\beta_6X_6+\beta_7X_7+\beta_8X_8 +\varepsilon_i$……..….. (4)

Where;

Y= probability of use of mobile phones in communicating crop-and livestock-related information. 1 = if use and 0 otherwise;

α = the estimate for the intercept (constant);

β = regression coefficient explaining changes caused in Z by changes in the dependent variable;

X_1 = Sex of the respondents (Dummy variable 0 for female, 1 for male);

X_2 = Age of respondents (Dummy variable 0 for Young, 1 for otherwise);

X_3 = Education levels (Dummy variable 0 for Informal, 1 for otherwise);

X_4 = Household size (Dummy variable 0 for Small household, 1 for otherwise);

X_5 = Monthly average incomes (Dummy variable 0 for low income, 1 for otherwise);

X_6 = Type of farming practices (Dummy variable 0 for crop growing only, 1 for mixed farming);

X_7 = Farming experiences (Dummy variable 0 for less than 2 years, 1 for otherwise);

X_8 = Membership in SACCOS (Dummy variable 0 for No, 1 for Yes);

ε_i = Error term;

$\beta_1 - \beta_8$ = regression coefficients of the explanatory variables which are to be estimated; $X_1 - X_8$ = explanatory variables (socio-economic factors).

For objective 2, data was analyzed and presented using frequency distributions, percentages and ranking the crop- and livestock-related information and their frequency of use mobile phones classified as seldom (1) if one used the mobile phones when needed, often (2) when used in monthly basis, and always (3) when used in weekly to daily basis, and chi-square tests used to study the association of crop- and livestock-related information variables and the use of mobile phone. Likewise, for Objective 3, was analyzed and presented using frequency distribution, percentages of mobile phone modes that farmers' frequently used to communicate agricultural information with extension agents and chi-square test used to examine the association of mobile phone modes and the use of mobile phone. For Objective 4, was analyzed and presented using frequency distribution and percentages used to rank score of the type of institutional support provided to farmers influencing use of mobile phones in communicating agricultural information with extension agents and chi-square test were used to find out the association of institutional support provided and the use of mobile phones. Finally objective 5 was achieved by listing 26 possible challenges that limit farmers' use of mobile phones in communicating agricultural information and Likert Scale (LS) of 26 statements was used to rate the level of seriousness of the identified challenges affecting farmers on using mobile phones in communicating agricultural information with extension agents. A four point Likert Scale (LS) was used and graded from 4 to 1 scores as follows, 4= High, 3=Moderate, 2=Low and 1=Not existing. The likert formula is expressed as:

$X_S = \Sigma fn/Nr$……..…….. (5)

Where: X_S = mean score; Σ = summation; f = frequency of each response (4, 3, 2, 1) pattern; n = likert numerical values (responses of the respondents) and; Nr = number of respondents to each response category (total number of respondents);

However, the scale was later merged into three LSR as follows: 1 = Low, 2=Moderate and 3=High, to achieve overall results. These were 1 × 26 = 26 the minimum (low scores), whereas (26+78)/2 = 52 the average (moderate scores) and maximum (high scores) 3 × 26 = 78 as the highest cut-off point. Thus, 1= low defined by 26 – 51 indicates low constraints, while 2 = average defined by 52 indicates mild constraints and 3 = high defined by 53 – 78 indicates high constraints, respectively. Chi-square test was also used to determine the association between challenges facing farmers and the use of mobile phone to communicate agricultural information.

3.6.2 Qualitative data analysis

Qualitative data collected from FDGs and KIIs were conceptualized, summarized, categorized and analyzed by using Content Analysis (CA) based on the pre-determined factors to validate and elaborate findings obtained from descriptive analysis. According to Elo and Kyngäs (2008)in referring to Cole (1988), content analysis is a technique for systematically analysing written, verbal or visual communication messages. In qualitative content analysis, data are presented in words and themes, which make it possible to draw some interpretation of the results (Bengtsson, 2016). The researcher recorded, sorted and transcribed issues that endured during FDGs and KIIs into practical themes in relation to study objectives and represented the responses' patterns/meaning within the quantitative finding. The techniques used mainly were on transcription of the information into specific themes based on the content and meaning of the text (quotations) related to mobile phone use in the study area to elaborate and complement the quantitative results of the study.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

4.1 Respondents' Socio-Demographic Characteristics and Mobile Phone Usage

Of the 383 respondents who possessed and used mobile phones, 50.1% were males and 49.9% females and of these 73.9% were married and 26% were single. This indicates that males, females were approximately of equal proportion and married respondents were dominant in agricultural practices and use of mobile phones in the study area could be due to high dependence on farming for their livelihood. According to Nenna (2016), married people are careful in the use of appropriate agricultural information retrieved from various ICTs, in order to meet up with the family responsibilities. Furthermore, 54.8% were adults aged between 36 to 55 years old, while 25.3% of the respondents were above 55 years, and few, 19.8% were youth aged between 20 to 35 years.

Based on education level, 42.8% had attained secondary education, 39.9% had completed primary education, 16.2% had no formal education and few, only 1.1% had a tertiary education. This result indicates that secondary education leavers dominated in study area due to the form II is a compulsory education in Zanzibar. The higher the educational level of farmers, the more they are willing to use information provided (Miwanda *et al.,* 2014). Similarly, about half, 49.6%, had 6 - 10 members per household, followed by 42.6% who had less than 5 members per household and few, 7.8%, who had a large family size of more than 10 members. This indicates that respondents who had large household size were more involved in the study area. According to Musafiri and Mirzabaev (2014), extended families have a significant role in sharing risk, incomes and other resources to support their relatives, especially in agriculture-dependent societies where variations in production and income are frequent.

Table 2: Respondents' socio-demographic characteristics (n=383)

Variable	Frequency n	Percentage %
Sex		
Female	191	49.9
Male	192	50.1
Age		
Young (20-35 years)	76	19.8
Adult (36-55 years)	210	54.8
Old (>55 years)	97	25.3
Marital status		
Single	100	26.1
Married	283	73.9
Education level		
Informal	62	16.2
Primary	153	39.9
Secondary	164	42.8
Tertiary	4	2.1
Household size		
Less than 5 members	163	42.6
6-10 members	190	49.6
More than 10 members	30	7.8
Average monthly income		
Less than 100 000TZS/mnth	235	61.4
100 001 – 500 000TZS/mnth	129	33.7
More than 500 000TZS/mnth	19	5
Farming experiences		
Less than 2 years	10	2.6
2-5 years	69	18.0
6-10 years	89	23.2
More than10 years	215	56.1
Farm size		
Less than 0.4ha	167	43.6
0.4-1.2ha	194	50.7
More than >1.2ha	22	5.7

Again, 61.4% earned less than TZS 100 000 per month, followed by 33.7% who earned TZS.100 001 to 500 000 per month and few, 5% earned above TZS 500 000. This indicates that more than two third of the respondents in the study were low income earners. According to Okwu and Iorkaa (2011) and Nnenna (2013), farmers with low incomes might not be in a position to afford the use of new ICTs.

As for farming experiences as shown in Table 2 few, 2.6% of the respondents had been involved in farming practices less than 2 years, followed by 18% who had been involved between 2 to 5 years and 23.2% for between 6 to 10 years, while more than half 56.1% of the respondents had been involved for more than 10 years. This indicates that majority of the respondents had long experiences in farming practices. Furthermore, 43.6% of the respondents had farm size less than 0.4ha, followed by 50.7% of the respondents having farm size that ranged from 0.4-1.2ha, while few 5.7% of the respondents have farm size larger than1.2ha. This indicates that most of the respondents owned small to medium farm size for agricultural production.

4.1.1 Respondents' mobile phones ownership and usage

All of the 383 respondents who owned and used mobile phone involved in the study as shown in Table 3, more than half, 51.7% they had owned mobile phones before year 2012. This implies that majority of the respondents had a long experience on using mobile phones which could be an opportunity of using mobile phones to communicate agricultural information with extension agents. Moreover, 97.7% of the respondents indicated to owning single handset, while few, 2.3% had owned two to three handsets. This is in line with Kwakwa (2012) in Ghana who found that majority, 73.4%, of the respondents in the study area had owned only one mobile phone handset.

Furthermore, results in Table 3 show that, majority, 95.3% of the respondents reported to have ordinary type of mobile phones while, few, 3.7% owned smart phones and only 1% owned both types. The type of mobile phones has an implication on the functionality and available information services to be accessed. According to Osman *et al*. (2012), youth perceived smartphones as more important compared to their older counterparts, hence

those with advanced knowledge were better off in using smartphones to access the latest information. This indicates that use of Smartphones depends on incomes, age and education level of the respondents. The low use of smartphones could be due to low incomes and participation of youth on farming activities in the study area.

Table 3: Respondents' mobile phone ownership and usage (n=383)

Variable	Frequency n	Percentage %
Year owned mobile phones		
Before 2012	198	51.7
2012	55	14.4
2013	38	9.9
2014	39	10.2
2015	53	13.8
Number of mobile handset owned		
One mobile handset	374	97.7
Two or three mobile handsets	9	2.3
Type of mobile phones owned		
Ordinary phones	365	95.3
Smartphones	14	3.7
Both types	4	1.0
Daily expenditure in mobile contacts		
Less than 500 TZS/day	231	60.3
500 - 1 000 TZS/day	133	34.7
1 001 - 2 000 TZS/day	15	3.9
More than 2 001 TZS/day	4	1.0
Mobile phone service providers		
Zantel	366	79.6
Tigo	75	16.3
Airtel	14	3.0
Vodacom	5	1.1

Of the 383 respondents, more than half, 60.3% said they had spent less than TZS 500 per day on airtime recharging, while, 34.7% spent between TZS 500 to 1 000 per day and few, 3.9% and 1% of them spent TZS 1 001 to 2 000 per day and TZS. 2 000 per day for

airtime recharge, respectively. This indicates that majority of respondents spent less on use mobile phones to communicated agricultural information in the study area could be due to having low incomes and practicing subsistence farming. These results also are support by KIs interviews as on participant said that:

> *Majority of farmers are not able to call extension agents when they require assistances. They just beep and wait for the extension agents to call them. The implication of less expenditure on the mobile phones airtime recharge is that majority of the farmers have low monthly incomes (DADO, June 2, 2016).*

As presented in Table 3, there were only four licensed operational mobile telecommunication networks existing in the study area. These were Zantel, Tigo, Airtel and Vodacom. However, majority, 79.6% of the respondents mentioned that they had subscribed to Zantel network, followed by 16.3% who subscribed to Tigo network. Yet fewer, 3.0% and 1.1% subscribed to Airtel and Vodacom networks, respectively. In any case, respondents were not restricted to subscribe to more than one mobile network available in the study area. This implies that, Zantel was the most preferred mobile network, hence has high potential to be used in communicating agriculture information in the study area. Similarly, FGD participants reported that, they prefer to use Zantel because majority of them have subscribed to Zantel and it is cheaper to use in their area than other mobile phone network such as Tigo, Vodacom and Airtel (Dole Shehia, June 13, 2016).

4.1.2 Mobile phone use to communicate agricultural information with extension agents

Of the 383 respondents, more than a quarter, 47.5% indicated that they had used mobile phones to communicate agricultural information with extension agents, whereas, 52.5% they had never used mobile phones to communicate agricultural information with extension agents. This result is in line with those of Okwoche and Asogwa (2012) and

Lwoga *et al*. (2011) who reported that, 47.8% and 44.1% of the respondents in Nigeria and Tanzania, respectively used mobile phones to communicate agricultural information with extension agents. This result also is in line with what diffusion of innovation theory suggested that adoption occur when perceived new technology is best fit in addressing one's needs and he/she make full use of it (Rogers, 2013) and technology acceptance model of Davis (1989) that emphasize on how a technology influences an individual perception toward the use of specific technology. However, this result indicates that more than half of the respondents were not using mobile phones to communicate agriculture information with extension agents could be due to lack of awareness or use other sources such as their fellow farmers, neighbours or family members to access agricultural information. This would be in line with Magesa *et al.* (2015) who reported that rural citizens heavily depend on their fellows, relatives, village officials and executives, and government officers to access agricultural market information. Also, FGDs in different *Shehia* where participants revealed that, there are few who used mobile phones to contact extension agents because they did not know their *Shehia* extension agents, they did not visit them and also they did not have their mobile phone contacts as well as not being aware on how to use mobile phones to communicate agricultural information with extension agents.

4.2 Socio-Demographic Factors Influencing Use of Mobile Phones to Communicate Agricultural Information with Extension Agents

To achieve this objective, frequency counts and percentage were used to examine selected socio-demographic factors (sex, age, education, household size, average monthly incomes, type of farming practices, farming experiences and membership in SACCOS) and the use of mobile phones to communicate agricultural information with extension agents whereas binary logistic regression model was used to determine their influence on the use of mobile phones to communicate agricultural information.

4.2.1 Respondents' socio-demographic factors and the use of mobile phones to communicate agricultural information with extension agents

Of the 182 respondents who used mobile phone to communicate agricultural information, 47.3% were female and 52.7% were male. The result indicates that there was a difference in sex and use of mobile phoned in communicating agricultural information with extension agents. The result in Table 4 shows that number of male was higher in use of mobile phones than their female counterparts. The possible reasons for this difference could be due to the dominance of male in agricultural activities and need technologies to improve their production and productivity and enhance their income to feed family, while their female counterparts were more involved in household chores and take care of children. This finding is in line with Masuki *et al.* (2010) in South Western, Uganda who reported that overall gender analysis of usage of the phone showed that more male farmers made use of the phone than female farmers.

Furthermore, 18.7% were youth between 20 and 35 years, while 54.9% were in age range between 36 – 55 years, and 26.0% were above 55 years old. The results showed that those farmers who had belonged to age group between 36 - 55 years old were more used mobile phones than all other age groups. The possible reasons for this differences could be due to this age group were innovative, economical active and capable to work and use new technologies such as mobile phones. However, it was expected that the younger farmers to be highly use mobile phones to communicate agricultural information with extension agents because the age group is energetic and active and in the society. According to Mbanda-Obura *et al.* (2017), relatively few youths were involved in farming activities probably because they did not want to soil themselves and in addition, many young farmers do not have adequate resources.

Table 4: Respondents' socio-demographic factors and the use of mobile phones in communicating agricultural information (n=383)

Variables	Used mobile phones n=182(%)	Did not use mobile phones n=201(%)
Sex		
Female	47.3	52.2
Male	52.7	47.8
Age		
Young (20-35 years)	18.7	20.9
Adult (36-55 years)	54.9	54.7
Old (>55 years)	26.4	24.4
Education		
Informal	10.4	21.4
Primary	45.1	35.3
Secondary	42.3	43.3
Tertiary	2.2	0
Household size		
Less than5 members	45.6	39.8
6-10 members	48.4	50.7
More than10 members	6.0	9.5
Average monthly incomes		
Less than 100 000 TZS/mnth	50.5	71.1
100 001 – 500 000 TZS/mnth	39.0	28.9
More than 500 000 TZS/mnth	10.4	0
Type of farming practice		
Crop growing only	43.4	30.3
Mixed farming	56.6	69.7
Farming experiences		
Less than 2 years	3.3	2.0
2-5 years	18.7	17.4
6-10 years	31.3	15.9
More than10 years	46.7	64.7
SACCOS membership		
Yes	23.1	13.4
No	76.9	86.6

Moreover, 45.1% reported to had completed primary school education while 42.3% had completed secondary school education. The remaining few, 10.4%, 2.1% of the respondents had no formal education and completed tertiary education, respectively. The results showed that respondents who had primary education used more mobile phones than all other education levels. The possible reason could be that literacy levels is linked to increased adoption and application of technologies, accessing and sharing information using mobile phones. However, it was expected that respondents with higher levels of education used more mobile phones to communicate agricultural information with extension agents as education has an impact on acquisition of agricultural knowledge. For example, Animashaun *et al.* (2014) in Kwara State, Nigeria found that the possession of formal education increases the chances of the use of mobile phones by respondents.

Further, findings in Table 4 indicate that 45.6% of the respondents had a household size of less than 5 persons, while 48.4% had a household size of 6-10 persons and few, 6%, reported to having a large household size of more than 10 persons. This result showed that there was a difference in numbers of persons in households and use of mobile phones in communicating agricultural information. It was expected that the more persons living in a household the likelihood of using mobile phones increased. However, the results in Table 4 show that those farmers who had household size between 5-10 persons had used mobile phones more to communicate agricultural information than other household sizes. The possible reasons could be due to those farmers who had large household size sharing agricultural technologies among the member of families and spending more money for feeding large household than on using of mobile phones and larger family sizes contribute labour to farming activities. Ajayi and Gunn (2009) in Nigeria found that majority of the respondents, 80.9% had more than 10 family members who served as a source of labour

for agricultural and non-agricultural activities. Thus a large household size helps as source of labour needed for the farming activities (Dzomeku *et al.,* 2011).

Yet, about half 50.5% of the respondents earned less than TZS. 100 000 per month, followed by 39% who earned TZS. 100 001 to 500 000 per month and few, 10.4% they had earned above TZS. 500 000. This result showed that those farmers who had earned less than TZS. 100 000 monthly were used mobile phones more to communicate agricultural information compared to all others with medium to higher incomes. The possible reasons for the differences could be due to those farmers who had higher incomes being the progressive farmers and had more contact with extension agents than all other farmers. This is in line with Okwu and Iorkaa (2011) and Nnenna (2013), farmers with low incomes might not be in a position to afford and use of new ICTs such as mobile phones.

Still, more than half, 56.6% of the respondents mentioned that they had practiced mixed farming while 43.4% they had reported to cultivate crops only. There is a difference in level of use mobile phones to communicate agricultural information on different type of farming practices. The result in Table 4 shows that those farmers who had involved in mixed farming were more used mobile phones than those who had involved in cultivating crop only. The possible reasons could be due to mixed farming involved high capital intensive and requires more technologies to manage the enterprise as livestock provide manure to the farms and crops provide feeds for livestock. According to Ajani and Agwu (2012), farmers' involvements in mixed farming make them economically stronger and are able to afford ICTs that can facilitate agricultural production.

Further, few 3.3% of the respondents had farming experiences of less than 2 years, followed by 18.7% who had farming experience between 2 to 5 years and more than a

quarter 31.3% of the respondents had faming experiences between 6 to 10 years, while one third 46.7% of the respondents had farming experiences for more than 10 years. This result indicates that those farmers who had long experiences in farming practices were more used of mobile phones. The possible reasons for this could be due to those with long experiences had been involved in farming practice in most of their life and require more knowledge of agricultural technology. However, it was expected that those who had long experienced in farming experiences were less in use of mobile phones because acquired a lot of knowledge through their experiences. This result is contrary with Mbanda-Obura *et al.* (2017) who reported that age is correlated with farming experience and it is possible that as one advances in age, experience with farming technology also increases, hence decrease in choice of sources used, given that information has already been acquired through experience.

Additionally, of the 182 respondents who used mobile phone to communicate with extension agents, 23.1% said they were members of SACCOS and more than two third 76.9% they had being a member of SACCOS. The result in Table 5 shows that those farmers who had not being a member of SACCOS were used mobile phones in communicating agricultural information than those who had a member of SACCOS. However, it was expected that being a member of SACCOS the likelihood of using mobile phones increased because enables one to borrow money which could be used to buy mobile phones. The possible reasons could be due to being a member of SACCOS have a greater chance of sharing knowledge and experiences within the organization so that reduces the use of mobile phones. The findings are in line with Eronmwon *et al.* (2014) in Nigeria who found only 32.4% of marketers were members of a market association. The result contradict those of Falola *et al.* (2013) who found that, majority of the farmers in

Ilorin State in Nigeria were not members of any agricultural association and had no access to extension services. According to Bolarinwa *et al.* (2011), reported that poultry farmers should be encouraged to join or form associations as this will foster unity among them, and enable them to benefit from government subsidies and loans. This result is in line with what adaptive structuration theory emphasizes on the group process, that is members use of rules and resources in interaction and interested in group product that is produced and reproduced through the interaction (DeSanctis and Poole, 1994).

4.2.2 Respondents' socio-demographic factors influencing the use of mobile phones to communicate agricultural information with extension agents

To test the null hypothesis I (Ho:$_1$) a binary logistic regression model was employed to assess the statistically influence of the eight selected socio-demographic predictors' variables: sex (X_1), age (X_2), education level (X_3), household size (X_4), average monthly income (X_5), type of farming practices (X_6), farming experiences (X_7) and SACCOS membership (X_8). The choice of the model was based on dichotomous nature of the dependent variable, (for example, 1 if the respondent used mobile phone and 0 otherwise). According to Etyang *et al.* (2014), logistic regression is used if the dependent variable response is binary. The specific model estimated from the data was: logit (use of mobile phones). $Y_i = \alpha_i + \beta_1(X_1) + \beta_2(X_2) + \beta_3(X_3) + \beta_4(X_4) + \beta_5(X_5) + \beta_6(X_6) + \beta_7(X_7) + \beta_8(X_8) + \varepsilon_i$. Where, Y_i is probability of using mobile phone in communicating agricultural information with extension agents in the study areas. Y is the dependent variable; logit use of mobile phones, α is the estimate for the intercept (constant) and β_1, β_2, ...,β_8 are estimates for the coefficients of the seven predictors.

The chi-square results in Table 5 indicate that explanatory variables tested null hypothesis has an effect on the dependent variable, and the chi-square value of 52.404 is highly statistically significant at $\rho \leq 0.001$ implying that the model containing all the eight

independent variables was able to predict the influence of mobile phones use in communicating agricultural information with extension agents. These results corroborate with those of Adwere-Boamah and Hufstedler (2015) who found that binary logistic regression analysis results of the five predictors was highly statistically significant indicating that the independent variables significantly predicted the outcome variable.

Table 5: Omnibus tests of model coefficients

		Chi-square	df	ρ- value
Step 1	Step	52.404	8	0.000
	Block	52.404	8	0.000
	Model	52.404	8	0.000

However, the model summary in Table 6, shows the Cox and Snell, and Nagelkerke pseudo R^2 statistics explaining between 0.128 and 0.171 of the variance that could be predicted from the independent variables since larger Cox and Snell and Nagelkerke the more the variation in the dependent variables explained by the model. The model classified acceptability at 48% of the respondents who were using mobile phones and 52% of those who were not using mobile phones.

Table 6: Model summary

Step	-2 Log likelihood	Cox and Snell R Square	Nagelkerke R Square
1	477.604(a)	0.128	0.171

Note: a. Estimation terminated at iteration number 4 because parameter estimates changed by less than 0.001.

The logit regression results (Table 7) of the selected seven socio-demographic factors influencing use of mobile phones in communicating agriculture information show that Variable Inflation Factor (VIF) of all seven selected variable tested in the model ranged

from 1.03 to 1.36, which means there was no multicollinearity problem existing in the explanatory variables as stipulated by Yoo *et al.* (2014). The author stated that binary dependent variable can also be checked for multicollinearity in the linear regression model and if VIF value is greater than 10 it indicates the existences of a multicollinearity problem. Furthermore, the predicted percentage change was calculated in order to bring more meaningful results. According to Ali (2012) the percentage change on Y_i due to each independent variable (X_i) can be calculated as $\Delta Y_i = 100 \times (\exp^{\beta} - 1)$. Where: ΔYi = percentage change of independent variable and $\exp^{\beta}$ is an Odd ratio of dependent variable.

Furthermore, Table 7 shows the binary regression results of the eight selected socio-demographic variables for using mobile phones in communicating agricultural information with extension agents. As a results shows that household size had negative beta coefficient of β = -0.435, meaning that an increase number of household members decreased the likelihood of using mobile phones by 35.2%. However, household size was statistically significant at $\rho \leq 0.023$, implying that it influenced the use of mobile phones in communicating agricultural information. This result revealed that as members of the family increase, the chance of using mobile phones in communicating agricultural information decreases. This meant that respondents with larger family spend less on mobile phones because they can share agricultural information among the family members and need to spend more on satisfying big family needs. This is according to Yaseen *et al.* (2016) who found that in Pakistan and China family size had a significant influence on the use of internet as an ICTs tool in agriculture. The findings also confirm to those of Olumba and Rahji (2014) study in Anambra State, Nigeria who found that household size had a significant relationship with the farmers' level of adoption of the technologies,

which means that household size is likely to influence adoption and use of technology including mobile phones.

Table 7: Respondents' socio-demographic factors influencing the use of mobile phones to communicate agricultural information with extension agents (n=383)

Variables	β	S.E.	Wald	ρ- value	Exp(B)	Predicted % change	VIF
Sex	0.177	0.230	0.590	0.443^{ns}	1.193	19.3	1.10
Age	0.355	0.192	3.413	0.065^{ns}	1.426	42.6	1.36
Education level	0.128	0.161	0.627	0.429^{ns}	1.136	13.6	1.19
Household size	-0.435	0.191	5.164	0.023*	0.648	-35.2	1.14
Average monthly income	0.973	0.206	22.334	0.000**	2.647	164.7	1.11
Type of farming practices	-0.285	0.117	5.934	0.015*	0.752	-24.8	1.05
Farming experience	-0.282	0.144	3.826	0.050*	0.754	-24.6	1.28
Membership in SACCOS	0.678	0.291	5.440	0.020*	1.969	96.6	1.03
Constant	-0.427	0.732	0.340	0.560	0.652		

Note: Number of obs = 383, LR chi^2 (8) = 52.404, Prob> chi^2 ≥ 0.001, Log likelihood = 477.604, Df=1, Pseudo R^2 = 0.128, ns=not significant, *, ** = significant at 5% and 1% probability level, respectively

Moreover, average monthly income had positive beta coefficients of β = 0.973, meaning that an increase of one unit of average monthly income the likelihood of using mobile phones increased by 164.7%. and average monthly incomes was highly statistically significant at ρ≤ 0.001 implying that it influenced the use of mobile phones in communicating agricultural information. This result shows that the income of the farmers is a key determinant of the use of mobile phones, as farmers' income increases their chance of using mobile phones to communicate agricultural information increases possible because have ability to purchase mobile phone and pay for airtime recharges. This is in line with the findings of Adejoh *et al.* (2017) who found that as the annual income of the

farmers increases so does the likelihood of using mobile phones for fish marketing increases.

Yet, results in Table 7 show that the type of farming practices had negative beta coefficient of β = -0.285, meaning that more farmers practiced mixed faming the likelihood of using mobile phones decreased by 24.8%. However, farming practices was statistically significant at $\rho \leq 0.015$, implying that the more farmers inclined to mono-cropping the more they used mobile phones in communicating agricultural information. The result indicates that when more farmers are engaged in mixed farming their chances of using mobile phones to communicate agricultural information decreases. This could mean that respondents involved in mixed farming have more knowledge on farming practices and therefore are less needed to use mobile phone to access information from extension agents. This is contrary to Ali (2012), who found that adoption of ICT-based information is significantly higher among farmers who cultivate diversified multiple crops.

Still, results in Table 7 show that farming experiences had negative beta coefficient of β = -0.282, meaning that an increase in years of farming decreased the likelihood of using mobile phones to communicate agricultural information by 24.6%. However, farming experiences was statistically significant at $\rho \leq 0.050$, implying that it influenced the use of mobile phones in communicating agricultural information. This result revealed that as farming experiences increase, the chance of using mobile phones in communicating agricultural information decreases. This could mean that as respondents involved in farming experiences for long time have adequate knowledge and skills in agricultural production and therefore are less willing to use mobile phones to communicate agricultural information. This is contrary to Williams and Agbo (2013), who found that The farming experience was positive and statistically significant, indicated that farmers whose farming experience is higher sought for and utilized ICTs as a source of agricultural

information more than those with lower farming experience because they understood relevance of ICTs more than those with lower farming experience.

Nevertheless, results in Table 7 show that, membership of SACCOS had positive beta coefficient of $\beta = 0.678$, meaning that membership to SACCOS increased the likelihood of using mobile phones by 96.6% and SACCOS membership was highly statistically significant at $\rho \leq 0.020$, implying that being member in SACCOS probably improved the economic power of individual and it influenced the use of mobile phones in communicating agricultural information. This shows that as more farmers become members of a SACCOS the chance of using mobile phones in sourcing agricultural information increases. The findings corroborate those of Okello *et al*. (2014) in Kirinyaga, Bungoma and Migori Districts, Kenya who found that, membership to a farmer's organization positively influenced the use of the ICT-based market information services. Also the findings of Falola *et al.* (2013) study in Ondo state, Nigeria showed that membership of agricultural association was positively and significantly related to technical efficiency of the farmers.

In summary, on testing the null hypothesis I (Ho_1) on Table 7, the binary logistic regression analysis results indicate that, household size, average monthly incomes, type of farming practices, farming experiences and membership of SACCOS were essential predictor variables that statistically influenced the respondents' use of mobile phones in communicating agricultural information with extension agents. Hence, the null hypothesis I (Ho_1) is rejected. However, some independent variables in the logit model that had no statistically significant influence on the use of mobile phones in communicating agricultural information with extension agents were sex, age and education level of the respondents. Hence, accepted the null hypothesis (Ho_1). These study findings conflict with

those of Williams and Agbo (2013) study in Ebonyi State, Nigeria who found that gender was statistically significant and had a negative coefficient in the level of access and use of ICT as a source of agricultural technology delivery in the study area. The author stated that male farmers had more access to ICT than their female counterparts. Also, Animashaun *et al.* (2014) study in in Kwara State, Nigeria who found that age and formal education attainment were statistically significant on the use of mobile phones that as age of the respondents increased use of mobile phones also increased, as possession of formal education increased use of mobile phones also increased. This result is in line with what diffusion of innovation theory model emphasizes that socio-economic acceptance of innovation to the member of social system have an influence on the acceptance and use of the innovation (Rogers, 1983, 2013). And of what technology acceptance model (Davis, 1989) emphasizes that socio-personal characteristics of the respondents significantly influences perceived ease of use and perceived usefulness.

4.3 Crop- and Livestock-related Information that Respondents Communicated and Mobile Phones Modes Used to Communicate Agricultural Information with Extension Agents

In order to achieve the second objective and third objective of the study, frequency counts and percentage used to identify type of crop-and livestock-related information that respondents communicated using mobile phones based on four selected commodities in ranking order and their frequency of use was assessed into three categories as seldom (1) if one used mobile phones when needed, often (2) when used on monthly basis, and always (3) when used on weekly and daily basis. Whereas, mobile phones modes used was assessed in six categories including SMS (1), voice call (2), SMS together with voice call (3), voice messaging (4), pictures (5) and video mode (6) after eliminating non-response. To test the null hypothesis II (Ho_2) a chi-square test was employed to determine the

statistically significant association of the crop-and livestock-related information and the use of mobile phones to communicate agricultural information with extension agents.

4.3.1 Farming enterprises that respondents communicated using mobile phone

Of the 383 respondents, most 371 (96.9%) and 354(92.4%) grew cassava and plantain, respectively, of whom, less than a half, 177(47.7%) and 174(49.2%) had used mobile phones to communicate cassava and plantain-related information with extension agents, respectively (Table 8). On the other hand, 99(25.8%) and 142(37.1%) of the respondents kept dairy cattle and chicken, respectively, while more than two third 73(73.7%) and 113(79.6%) of whom had used mobile phones to communicate dairy cattle and chicken-related information with extension agents, respectively. This result indicates that most of the respondents in the study area were involved in cassava and plantain production rather than in chicken and dairy cattle farming.

Based on respondents' mobile phones use in communicating agricultural information with extension agents, those involved in dairy cattle and chicken keeping were higher in use of mobile phones although, they were few in keeping dairy cattle and chicken than those who grow cassava and plantain. This could be due to the higher risk involved in livestock keeping, which requires higher capital and more intensive management and also their returns are higher than those of crop farming. At the same time, chi-square test results show that livestock keeping was highly statistically significant associated with the use of mobile phones at $\rho \leq 0.001$, followed by plantain production was statistically significant at $\rho \leq 0.025$, while cassava production was not statistically significant at $\rho \leq 0.680$, implying that it was not statistically significant associated with the use of mobile phones. The reasons could be due to cassava had been long traditionally cultivated by the majority of farmers hence they need little information from other sources such as mobile phones.

A study by Nyamba and Mlozi (2012) in Kilosa District, Morogoro and Kilolo District, Iringa of Tanzania, reported that about half, 52.6% of the respondents found mobile phones helpful for them to easily obtain the agricultural information they needed. This result is confirm with what adaptive structuration theory emphasizes on the role of advanced information technology in driving organization changes in the way of doing their business (DeSanctis and Poole, 1994) and of the diffusion of innovation theory of (Rogers, 1983) that an innovation presents an individual or organization with a new alternative or alternatives of solving problems.

Table 8: Farming enterprise that respondents communicated using mobile phones (n=383)

Farming enterprise	Use mobile phones		Not use mobile phones		Total	χ^2	ρ-value
	n	(%)	n	(%)			
Growing cassava	177	47.7	194	52.3	371	0.170	0.680^{ns}
Growing plantain	174	49.2	180	50.8	354	4.999	0.025*
Keeping dairy cattle	73	73.7	26	26.3	99	36.799	0.000**
Keeping chicken	113	79.6	29	20.4	142	92.997	0.000**

Note: ***Statistically significant at 0.05, ****Statistically significant at 0.01, **ns** = Not statistically significant at 0.05, χ^2= Chi-square value

4.3.2 Crop-related information that respondents communicated using mobile phones with extension agents

On examining the crop-related information that respondents communicated with extension agents using mobile phones, information communicated was related to cassava and plantain production, marketing and weather-related information. According to Uzuegbu and Naga (2014), majority of the cassava farmers needs information on how to manage the risks associated with cassava farming such as pest and disease control, weather and

environmental issues which are vital for their farming success. Mobile phones are the most useful sources of creating awareness and communication of cassava production related information (Nenna, 2016).Also Mwombe *et al.* (2014) in Gatanga District, Kenya reported that about 31% of the farmers used mobile phones to get information on production and marketing of their banana/plantains.

4.3.2.1 Cassava production-related information that respondents communicated using mobile phones with extension agents

Of the 177 respondents who had used mobile phones to communicate cassava-related information with extension agents, cassava production-related information ranked highest (Table 9). The results show that information communicated was on diseases and insect-pests control methods, on selection of planting materials, on planting methods and on preparation of planting materials. Other information was on land preparation, on methods of manure application, on access to manure, on weed control methods, on harvesting methods, on access to farm tools and on storage methods. In addition, information on post-harvesting methods, on access to farm labour and on access to credits was communicated. The results indicate that majority of cassava growers frequently communicated on disease control methods, insect-pests control methods and on selection of planting materials, whereas information on post-harvesting methods, on access to farm labour and on access to credit was the less frequently communicated by farmers in the study area. This could be attributed to farmers' awareness, knowledge and experiences on the effects of insect-pests and diseases infestation as constraints to increased cassava yield and the use of recommended planting materials for better cassava yields.

However, less use of mobile phones could be attributed to the use of traditional storage facilities and traditional post-harvesting handling of harvested cassava tubers such as

burying fresh harvested cassava tubers in the soil to increase shelf life or peeling, chopping and open-sun drying of tubers for future uses, having large household size and depends on family members to carry out field operations and unavailability of credit facilities in the study area. These results are in line with those of Ganesan *et al.* (2013) who reported that majority of farmers perceived information on insect-pests and diseases control as most important in production and mobile phone as easy and convenient for accessing this information.

According to Mwango'mbe *et al.* (2013), limited access to storage information leads to lack of storage technologies and improper storage facilities. Falola and Adewumi (2012) reported that, majority of farmers tend to use mobile phones to request assistance from family members for farming operations in order to save costs incurred on hiring labour. However, this result is contrary to the findings by Omoregbee and Banmeke (2014), who asserted that, few respondents use mobile phones to seek information on planting methods because majority of them knew and are aware of the recommended cassava planting methods and planting materials. Haruna *et al.* (2013), revealed that, farmers perceived mobile phones as an effective means of sourcing credit facilities. Furthermore, FGD participants reported that, low use of mobile phone on communicating cassava production information is because majority of them got an opportunity to attend PADEP training through the farmers groups and extension agents from the project who gave them training on good husbandry practices for cassava production (Mfenesini *Shehia,* June 16, 2016).

Results in Table 9show that 79.3% of the respondents who had used mobile phones rarely communicated on cassava production-related information and 13.1% had communicated in monthly basis, while, 7.6% of the respondents had communicated in weekly and daily

basis. The chi-square test result shows that 14 selected cassava production-related information were highly statistically significant associated at $\rho \leq 0.001$, implying that cassava production-related information influenced the use of mobile phones to communicate agricultural information with extension agents. However, information on accessibility to credit was not statistically significant associated at $\rho \leq 0.122$, implying that access to credit information was not influenced the use of mobile phones to communicate with extension agents.

Table 9: Cassava production-related information that respondents communicated using mobile phones (n=177)

Cassava production-related information	**Mobile phones use**				**Frequency of use mobile phone**		
	Yes	**No**			**Seldom**	**Often**	**Always**
	n(%)	**n(%)**	**Rank**	**ρ-value**	**n(%)**	**n(%)**	**n(%)**
Diseases control methods	113(63.8)	64(36.2)	1	0.000**	73(41.2)	22(12.4)	18(10.2)
Insect-pest control methods	110(62.1)	67(37.9)	2	0.000**	86(48.6)	12(6.8)	12(6.8)
Selection of planting materials	71(40.1)	106(59.9)	3	0.000**	62(35.0)	6(3.4)	3(1.7)
Planting methods	53(29.9)	124(70.1)	4	0.000**	44(24.9)	8(4.5)	1(0.6)
Planting materials preparation	49(27.7)	128(72.3)	5	0.000**	38(21.5)	8(4.5)	3(1.7)
Land preparation	47(26.6)	130(73.4)	6	0.000**	42(23.7)	5(2.8)	0(0.0)
Manure applications methods	36(20.3)	141(79.7)	7	0.000**	29(16.4)	5(2.8)	2(1.1)
Access to manure	34(19.2)	143(80.8)	8	0.000**	24(13.6)	8(4.5)	2(1.1)
Weeding methods	31(17.5)	146(82.5)	9	0.000**	27(15.3)	3(1.7)	1(0.6)
Harvesting methods	30(16.9)	147(83.1)	10	0.000**	15(8.5)	7(4.0)	8(4.5)
Access to farm tools	23(13.0)	154(87.0)	11	0.000**	23(13.0)	0(0.0)	0(0.0)
Storage methods	21(11.9)	156(88.1)	12	0.000**	20(11.3)	1(0.6)	0(0.0)
Post-harvesting methods	20(11.3)	157(88.7)	13	0.000**	20(11.3)	0(0.0)	0(0.0)
Access to farm labour	16(9.0)	161(91.0)	14	0.000**	16(9.0)	0(0.0)	0(0.0)
Access to credits	3(1.7)	174(98.3)	15	0.172^{ns}	2(1.1)	1(0.6)	0(0.0)
Total frequency use of mobile phones					**521(79.3)**	**86(13.1)**	**50(7.6)**

Note: **Statistically significant at 0.01, ns = not statistically significant at 0.05

The possible reason for that could be unavailability of credit facilitates in the study area and the farmers access credit informally from their fellow farmers, neighbours or their farming organization such as SACCOS.

4.3.2.2 Cassava market-related information that the respondents communicated using mobile phones with extension agents

Of the 177 respondents who had used mobile phones who communicated cassava-related information with extension agents, cassava market-related information communicated ranked highest (Table 10). The result show that information communicated was on market prices, on selling of cassava crops, on bargain market price and on buying planting materials. Other information was on purchasing of farm manure, on buying of farm tools and on market transportation costs. This result indicates that majority of cassava growers highly needed information on market prices, selling of cassava crops and on bargain market prices, few needed information on purchasing farm manures, farm tools and on market transportation costs. This could be attributed to farmers' awareness and knowledge of cassava market prices from different distant market outlets. Such knowledge increased their negotiation power with traders and enabled them to make proper decisions on better selling prices of their cassava tubers as well as evade exploitation of middlemen

However, low use of mobile phones on purchasing manure, farm tools and on market transportation costs could be attributed to use of traditional methods of farming and farm tools, and selling harvested cassava tubers directly to the customers at farm gate. This was due to its bulkiness and difficulty to transport to the distance markets. The result is in line with Miwanda *et al.* (2014) and Olaniyi and Adewale (2014) who reported that market price information is an important factor to farmers because it enabled them to negotiate better prices with traders. McNulty and Oparinde (2015) also reported that mobile phones are good options for improving market communications by enabling farmers to affirm their bargaining powers. Olaniyi and Adewale (2014) asserted that farmers relied on mobile phones for accessing timely and relevant information on the market prices of farm

inputs. Long distance to market place and high crop transportation costs, led to more farmers selling their harvested cassava tubers at the farm gate (Okoye *et al.,* 2016). According to Nyaga (2012)if a mechanism is put in place, farmers and extension agents would use mobile phones to exchange information on current market and technology.

Table 10: Cassava market-related information that respondents communicated using mobile phones (n=177)

Cassava market-related information	**Mobile phones use**				**Frequency of use mobile phone**		
	Yes	**No**			**Seldom**	**Often**	**Always**
	n(%)	**n(%)**	**Rank**	**ρ-value**	**n(%)**	**n(%)**	**n(%)**
Marketing prices	99(55.9)	78(44.1)	1	0.000**	72(40.7)	25(14.1)	2(1.1)
Selling crop produces	75(42.4)	102(57.6)	2	0.000**	69(39.0)	6(3.4)	0(0.0)
Bargain marketing prices	70(39.5)	107(60.5)	3	0.000**	31(17.5)	39(22.0)	0(0.0)
Purchasing planting materials	42(23.7)	135(76.3)	4	0.000**	35(19.8)	7(4.0)	0(0.0)
Selling planting materials	35(19.8)	142(80.2)	5	0.000**	32(18.1)	3(1.7)	0(0.0)
Purchasing farm manure	29(16.4)	148(83.6)	6	0.000**	24(13.6)	5(2.8)	0(0.0)
Purchasing farm tools	14(7.9)	163(92.1)	7	0.000**	14(7.9)	0(0.0)	0(0.0)
Marketing transportation costs	7(4.0)	170(96.0)	8	0.016*	6(3.4)	1(0.6)	0(0.0)
Total frequency use of mobile phones					**283(76.3)**	**86(23.2)**	**2(0.5)**

Note: *Statistically significant at 0.05, **statistically significant at 0.01

As shown in Table 10, with respect to the frequency of use mobile phone to communicate cassava market-related information with extension agents, three-quarters (76.3%) of the respondents had rarely used mobile phones to communicate on cassava market-related information and 23.2% of the respondents had used mobile phone on monthly basis, while, few 0.5% had used mobile phones on weekly and daily basis. The chi-square test result revealed that all selected cassava market-related information were statistically significant associated at $\rho \leq 0.001$ and at $\rho \leq 0.016$ on market transportation costs information,

implying that cassava market-related information influenced the use of mobile phones to communicate agricultural information with extension agents.

4.3.2.3 Cassava weather-related information communicated using mobile phones with extension agents

Of the 177 respondents who had used mobile phones to communicate cassava-related information with extension agents, cassava weather-related information was ranked highest (Table 11). The results show that information communicated was on onset of rainfall, on outbreak of insect-pests, on outbreak of diseases and on proper time for planting. Other information was on climatic change, on drought occurrence, on proper time for harvesting and on flooding occurrence. This result indicates that majority of cassava growers needed information on rainfall, on outbreak of insect-pests and on diseases and least information needed was on drought occurrence, on proper time for harvesting and on flooding occurrences. This could be attributed to the importance of rainfall on supplying soil moisture for growth so as to make proper decision on planting date to use available moisture and effects of insect-pests and diseases outbreak that enabled to minimize production and farmers profits.

However, the less needed information on drought occurrence, on proper time for harvesting and on flooding information could be attributed to nature of cassava to withstand adverse condition, farmers' experiences in cassava maturity and use of traditional knowledge to predict occurrence of flooding. This finding is in line with Mittal and Mehar (2012), who reported that access to weather information on rainfall distribution, helps farmers to make timely decision on planting and application of inputs such as fertilizers, pesticides and herbicides in the farms. Okwu and Iorkaa (2011) reported that mobile phones use is effective as a warning system for diseases and insect-

pests outbreaks before their occurrences. Anjum (2015) reported that mobile phones can be used for weather predictions expert advice on timely planting or harvesting techniques. However, these results contradict those of Masinde and Bagula (2011) who reported that mobile phones use is a cheaper drought prediction solution. Keoduangsine and Goodwin (2012) reported that mobile phones are an alternative means to alert on flooding occurrences than other ICTs because they are owned by majority and rarely switched off at night.

Table 11: Cassava weather-related information that respondents communicated using mobile phones (n=177)

Cassava weather-related information	**Mobile phones use**				**Frequency of use mobile phone**		
	Yes	**No**			**Seldom**	**Often**	**Always**
	n(%)	**n(%)**	**Rank**	**ρ-value**	**n(%)**	**n(%)**	**n(%)**
Onset of rainfall	105(59.3)	72(40.7)	1	0.000**	93(52.5)	12(6.8)	0(0.0)
Alert on diseases outbreak	105(59.3)	72(40.7)	2	0.000**	90(50.8)	15(8.5)	0(0.0)
Alert on insect-pest outbreak	89(50.3)	88(49.7)	3	0.000**	71(40.1)	18(10.2)	0(0.0)
Proper time for planting	86(48.6)	91(51.4)	4	0.000**	77(43.5)	9(5.1)	0(0.0)
Alert on climatic changes	74(41.8)	103(58.2)	5	0.000**	56(31.6)	18(10.2)	0(0.0)
Alert on drought occurrence	39(22.0)	138(78.0)	6	0.000**	38(21.5)	1(0.6)	0(0.0)
Proper time for harvesting	36(20.3)	141(79.7)	7	0.000**	31(17.5)	5(2.8)	0(0.0)
Alert on flooding occurrence	30(16.9)	147(83.1)	8	0.000**	30(16.9)	0(0.0)	0(0.0)
Total frequency use of mobile phones					**486(86.2)**	**78(13.8)**	**0(0.0)**

Note: **Statistically significant at 0.01

Based on the respondents' responses on the frequency use mobile phones to communicate cassava weather-related information with extension agents, as shown in (Table 11), 86.2% of the respondents had rarely communicated cassava weather-related information and 13.8% indicated to had communicated on monthly basis, whereas none had communicated on weekly and daily basis. The chi-square results show that all of the cassava weather-

related information were highly statistically significant associated at $\rho \leq 0.001$, implying that cassava weather-related information influenced the use of mobile phones to communicate agricultural information with extension agents.

In summary, the findings of mobile phones use to communicate cassava-related information with extension agents show that majority of the cassava farmers needed production-related information on managing the effects associated with insect-pest and diseases and were on use of recommended planting materials. Respondents needed marketing information to understand market prices from different markets to enable them to negotiate and sell their cassava tubers profitably. Weather-related information was highly required especially on rainfall, outbreak of insect-pests and diseases which were critical for production and marketing of cassava tubers. Generally, cassava growers rarely used mobile phones to communicate cassava-related information. However, most of the cassava-related information was statistically significantly associated with the use of mobile phones in communicating agricultural information with the exception of access to credit facilities and therefore the null hypothesis was accepted.

4.3.3 Mobile phone modes that respondents used to communicate cassava-related information with extension agents

Of the 177 respondents who used mobile phones to communicate on cassava production-related information as shown in Table 12, found that 61.3% used SMS, 29.8% used voice call, 6.8% used both SMS and voice calls, whereas, 0.8% used voice messaging, 0.8% used picture and 0.5% used video mode to communicate cassava production-related information with extension agents. The result indicates that SMS was highly used to seek information on cassava production-related information, while voice calls, both SMS

together with the voice call, voice messaging, picture and video mode was rarely used. This could be due to SMS being cheaper than voice call and can reach many farmers in short time, can be shared among the farmers and provide references if stored in the mobile phones.

The low use of other modes could be due to the majority of farmers had less knowledge and skills to operate mobile phones or use of ordinary mobile phones with less capacity and functionalities. The results are in line with Belakeri *et al.* (2017) who reported that 83%, of farmers, mainly depended on the SMSs as an appropriate to the integrated pest management, disease management, new varieties, seeds and organic practices. According to Sousa *et al.* (2016) study in Mali and Burkina Faso who found that video-based information is particularly advantageous to illiterate farmers and has potential to transform the typically top-down nature of information flow from extension agents to farmers.

Furthermore, 10.5%, 78.4% and 11.1% of the respondents had used SMS, voice call and both SMS together with voice call mode to communicate cassava market-related information with extension agents, respectively. The result indicates that voice call mode was mostly used on sourcing cassava market-related information than other modes. This could be due to natures of the harvested cassava tubers that need immediately market to avoid perishability and voice call can be the possible channel for sourcing market information and prices from the different market for better marketing of cassava tubers. The results are in line with Courtois and Subervie (2013) who reported that farmers obtained market information services for making a call or sending a text message. According to Deichmann *et al.* (2016) study in Morocco found that farmers use both voice

call and SMS to coordinate with local truckers to improve product transportation and reduce post-harvest losses.

Further, findings in Table 12 show that weather-related information communicated by using SMS (53.7%), voice call (40.8%) and SMS together with voice call (5.5%). This result indicates that farmers highly used SMS and voice call to communicate cassava weather-related information with extension agents, while they made less use of both SMS together with the voice call. This result is in line with Gichamba and Lukandu (2012) study in Kenya who found that SMS is a widely used application of mobile technology in agriculture, farmers interact with experts and systems via SMS on receiving weather updates and the best practices of the various sectors of agricultural information.

Table 12: Mobile phones modes that respondents used to communicate cassava-related information (n=177)

Cassava-related variable	**Mode of mobile phone used**						
	SMS	**Call**	**SMS and Call**	**Voice**	**Picture**	**Video**	
	(%)	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**ρ -value**
Cassava production-related information	61.3	29.8	6.8	0.8	0.8	0.5	
Cassava market-related information	10.5	78.4	11.1	0	0	0	
Cassava weather-related information	53.7	40.8	5.5	0	0	0	
Overall mode used	**46.8**	**45.0**	**7.3**	**0.3**	**0.3**	**0.2**	0.000**

Note: **Statistically significant at 0.01

Overall, mobile phones modes used to communicate cassava-related information with extension agents as shown in Table 12. Of the 177 respondents less than half, 46.8% they had used SMS, followed by 45% of the respondents had used voice call. However, few, 7.3%, 0.3%, 0.3% and 0.2% of the respondents had used both SMS together with the voice

call, voice message, pictures and video messaging mode, respectively. This result indicates that solely SMS and voice call were the preferable mode used to communicate cassava-related information in the study area. The possible reasons of use solely SMS and voice call could be due to the need of accessing timely production information to reduce crop risk and immediately taking action to marketing to reduce yield loss and increase farmers' incomes. According to Asa and Uwem (2017), agricultural information is often shared by the farmers via text messages and voice calls. Wyche *et al*. (2010) study in Kenya and Zambia reported that mobile phone SMS service was used to disseminate market price data to smallholder farmers in sub-Saharan Africa and other developing regions. However, cassava-related information was statistically significant at $\rho \leq 0.001$, implying that was highly associated with the mobile phones modes used to communicate agricultural information with extension agents.

4.3.3.1 Plantain production-related information that respondents communicated using mobile phones with extension agents

Of the 174 respondents who had used mobile phones to communicate plantain-related information with extension agents, plantain production-related information was ranked the highest (Table 13).The results show that information communicated was on disease control methods, insect-pests control methods, selection of planting materials, on preparation of planting materials and on access to farm manure. Other information was on planting methods, on land preparation, on access to labour, methods of manure application, access to credits and on access to farm tools. In addition, information on weed control methods, on storage methods, post-harvesting and on harvesting methods was communicated. This result indicates that majority of plantain growers highly needed information on diseases and insect-pests controls and selection of planting materials whereas information on storage methods, post-harvesting and harvesting methods were less required in the study area.

This result could be attributed to experiences and knowledge of the farmers on the effect of the diseases and insect-pests and importance of using proper planting materials to increase quantity and improve quality of plantain produced and minimizing the spread of insect-pests and diseases in plantain farms. However, low communication of storage methods, post-harvesting and harvesting methods could be attributed to majority of farmers using traditional methods of harvesting, storage and post-harvesting handling of plantain produces. This finding is in line with the suggestion of Halewood and Surya (2012) that mobile phones can serve as the backbone for early warning systems to mitigate crop diseases risks and safeguard incomes.

According to a study by Oso *et al.* (2011) in Nigeria, use of unprepared planting materials containing immature stage of insect-pests to new farms caused widespread infestation of diseases and insect-pests to the farms, declining of plantain yield linked with the problems of insect-pests and diseases. Disease infestation is a serious constraint to large scale production of plantain all over the world (Nwaiwu *et al.,* 2012). Unavailability of recommended inputs when needed and their limited utilization lead to low use mobile phones to seek information on agricultural inputs (Churi *et al.,* 2012). According to Syiem and Raj (2015), farmers used mobile phones to contact extension agents to enquire about recommended fertilizer dosage. Majority (84%) of farmers carried out land preparation by slashing and burning their farms (Dankyi *et al.,* 2007).

Plantains are highly perishable and are best harvested while at green (Adeniyi and Ayandiji, 2014), so utilization of very poor and primitive preservation techniques lead to most of farmers to encounter serious losses of plantain produces (Nwofe, 2015). High post-harvest losses are among the major problems limiting the availability of plantains (Ayanwale *et al.,* 2016). Furthermore, FGD participants reported that, they did not use

mobile phones to contact extension agents for plantain production-related information because most of them have experiences and knowledge from FFSs training on the plantain production technologies and they only use mobile phones to contact extension agent when they found diseases in their plantain farms for advice on how to control them (Mfenesini *Shehia,* June 16, 2016).

Table 13: Plantain production-related information that respondents communicated using mobile phones (n=174)

Plantain production-related information	**Mobile phones use**				**Frequency of use mobile phone**		
	Yes n(%)	**No n(%)**	**Rank**	**ρ-value**	**Seldom n(%)**	**Often n(%)**	**Always n(%)**
Diseases control methods	126(72.4)	48(27.6)	1	0.000**	96(55.2)	25(14.4)	5(2.9)
Insect-pest control methods	115(66.1)	59(33.9)	2	0.000**	96(55.2)	19(10.9)	0(0.0)
Selection of planting materials	104(59.8)	70(40.2)	3	0.000**	96(55.2)	8(4.6)	0(0.0)
Preparation of planting materials	88(50.6)	86(49.4)	4	0.000**	83(47.7)	5(2.9)	0(0.0)
Access to manure	85(48.9)	89(51.1)	5	0.000**	75(43.1)	10(5.7)	0(0.0)
Planting methods	76(43.7)	98(56.3)	6	0.000**	73(42.0)	3(1.7)	0(0.0)
Land preparation	73(42.0)	101(58.0)	7	0.000**	73(42.0)	0(0.0)	0(0.0)
Access to farm labours	65(37.4)	109(62.6)	8	0.000**	65(37.4)	0(0.0)	0(0.0)
Methods of manure applications	59(33.9)	115(66.1)	9	0.000**	55(31.6)	4(2.3)	0(0.0)
Access to credits	47(27.0)	127(73.0)	10	0.000**	47(27.0)	0(0.0)	0(0.0)
Access to farm tools	39(22.4)	135(77.6)	11	0.000**	39(22.4)	0(0.0)	0(0.0)
Weeding methods	38(21.8)	136(78.2)	12	0.000**	38(21.8)	0(0.0)	0(0.0)
Storage methods	28(16.1)	146(83.9)	13	0.000**	28(16.1)	0(0.0)	0(0.0)
Post-harvesting methods	25(14.4)	149(85.6)	14	0.000**	25(14.4)	0(0.0)	0(0.0)
Harvesting methods	23(13.2)	151(86.8)	15	0.000**	23(13.2)	0(0.0)	0(0.0)
Total frequency use of mobile phones					**912(92.0)**	**74(7.5)**	**5(0.5)**

Note: **Statistically significant at 0.01

Results in Table 13 show that 92% of the respondents had used mobile phones rarely to communicate plantain production-related information and 7.5% of the respondents had used mobile phone on monthly basis, while, few 0.5% had used mobile phones on a

weekly to daily basis. The results of chi-square test revealed that all selected plantain production-related information were highly statistically significant associated at $\rho \leq 0.001$, implying that plantain production-related information influenced the use of mobile phones to communicate agricultural information with extension agents.

4.3.3.2 Plantain market-related information that respondents communicated using mobile phones with extension agents

Of the 174 respondents who had used mobile phones to communicate plantain-related information with extension agents as shown in Table 14, the respondents' responses on plantain market-related information was ranked the highest. The results show that information communicated was on purchasing planting materials, on market prices, on selling of plantain produces, on selling planting materials, on selling plantain produces and on selling planting materials. Other information was on purchasing farm manures, on bargain marketing prices, on market transportation costs and on purchasing farm tools.

This result indicates that plantain producers highly needed information on purchasing and selling planting materials, market prices of plantain and selling of plantain produces and information on bargain marketing prices, on market transportation costs and on purchasing farm tools were in low needed. This could be attributed to the majority of farmers in the study area understanding the advantages of using improved planting materials for successful plantain production and for better gain. However, low uses of mobile phones on bargain marketing prices, on market transportation costs and on purchasing farm tools could be attributed to selling crop produce directly to consumers and wholesalers and low farmers' incomes restricted them to afford and use of modern farm tools.

The result is in line with those of Egbule *et al.* (2013) who reported that information for market sale of crop produce was frequently disseminated to farmers through the mobile phone by extension agents. Daily updates on the prices of agricultural commodities in the local markets of the surrounding district are most useful during harvesting time (Ganesan *et al.,* 2013). Lack of reliable and timely market information is the one of the major contributors to weakened access to market, especially for poor farmers in rural areas (Katengeza, 2012; Mwakaje, 2010). According to Oladejo and Sanusi (2008) and Hossain (2014) majority of farmers sold their plantain produced directly to the retailers, final consumers and food vendors or sell their produce to middlemen or collectors in the village, who subsequently sell the same to wholesalers. More than two-thirds of the farmers said transportation of plantain produce was not a problem to them since traders visited their villages often one to three times a week to purchase their plantain at the farm (Dankyi *et al.,* 2007).

Table 14: Plantain market-related information that respondents communicated using mobile phones (n=174)

Plantain market-related information	**Mobile phones use**				**Frequency of use mobile phone**		
	Yes	**No**			**Seldom**	**Often**	**Always**
	n(%)	**n(%)**	**Rank**	**ρ-value**	**n(%)**	**n(%)**	**n(%)**
Purchasing planting materials	77(44.3)	97(55.7)	1	0.000**	77(44.3)	0(0.0)	0(0.0)
Knowing marketing prices	68(39.1)	106(60.9)	2	0.000**	68(39.1)	0(0.0)	0(0.0)
Selling crop produces	28(16.1)	146(83.9)	3	0.000**	28(16.1)	0(0.0)	0(0.0)
Selling planting materials	28(16.1)	146(83.9)	3	0.000**	28(16.1)	0(0.0)	0(0.0)
Purchasing farm manure	17(9.8)	157(90.2)	5	0.000**	17(9.8)	0(0.0)	0(0.0)
Bargain marketing prices	12(6.9)	162(93.1)	6	0.000**	12(6.9)	0(0.0)	0(0.0)
Marketing transportation costs	10(5.7)	164(94.3)	7	0.000**	10(5.7)	0(0.0)	0(0.0)
Purchasing farm tools	7(4.0)	167(90.0)	8	0.004**	7(4.0)	0(0.0)	0(0.0)
Total frequency use of mobile phones					**247(100)**	**0(0.0)**	**0(0.0)**

**Note: ****Statistically significant at 0.01

Additionally, plantain participants in FGD revealed that, they did not need to contact extension agents for selling plantain, because they had their special customers from town that always contact with them using mobile to seek information on availability of plantain and go directly to buy at farm gate and also informed then to come to buy plantain if were ready to harvest (Mfenesini *Shehia*, June 16, 2016). Furthermore, other FGD participants reported that, they always use mobile phone to contact extension agents to get advice on pest and diseases control, availability and proper method of fertilizer application, but were not using mobile phones to contact extension agents on seeking marketing information because of low production and selling at farmgate (Chuini *Shehia*, June 14, 2016).

Results in Table 14 show that all of the respondents who communicated plantain market-related information in the study area rarely used mobile phones and none of them communicated on monthly basis and in weekly to daily basis. The chi-square results shows that all plantain market-related information were highly statistically significant associated at $\rho \leq 0.001$, implying that plantain market-related information influenced the use of mobile phones to communicate agricultural information with extension agents.

4.3.3.3 Plantain weather-related information that respondents communicated using mobile phones with extension agents

Of the 174 respondents who had used mobile phones to communicate plantain-related information with extension agents as shown in Table 15 the respondents' responses on plantain weather-related information was ranked highest. The results show that information communicated was on alert of diseases outbreak, on alert on insect-pest outbreak, on onset of the rainfall and on proper time for planting. Other information was on proper time for harvesting, on alert of drought occurrence, on flooding occurrences and on climatic changes. This indicates that information on diseases outbreak, on insect-pest outbreak and on rainfall were the most needed by farmers and alert on drought occurrence, on flooding

occurrences and on climatic changes were of least importance. This could be attributed to farmers' knowledge and experiences on significant losses of plantain yields associated with insect-pests and diseases infestation and shortage of rainfall.

However, low use of mobile phones could be attributed to farmers' experiences on predicting weather variability. The results are in line with those of Matotay and Furuholt (2010) who reported that mobile phone applications can improve advance warning of weather risks, insect-pests and disease risks, and other environmental risks and provide timely, locally-relevant information on how to respond to them. Mobile phones enabled farmers to get weather warnings before a disaster happens and enable them to communicate to the technical experts on any anomalies observed in their farms for quick intervention (Ogbeide and Ele, 2015). Ganesan *et al.* (2013) found that 90.8% of the farmers, perceived early warning information on outbreaks of insect-pest and disease infestation and on how to manage the outbreaks as the most appropriate information. Forecasting information influenced planting date and the choice of crop varieties is the most important farm decision-making activities (Mudombi and Nhamo, 2014).

Information on rainfall distribution helps farmers in taking timely decision on time of application of inputs like fertilizers, pesticides, weedicides (Mittal and Mehar, 2012). The need for climate information among smallholder farmers has increased due to improved forecasts and increased complexities of climate risks in agriculture such as erratic rainfall and excessive floods (Churi *et al.,* 2012). Good knowledge on the effects of fluctuating temperature, rainfall and relative humidity on agricultural production could help to improve yield (Salau *et al.,* 2016).

On the frequency of use of mobile phone to communicate plantain weather-related information with extension agents as shown in Table 15, all of the respondents who had

communicated plantain weather-related information with extension agents used mobile phones rarely and none of them communicated on monthly basis, on weekly and daily basis. The chi-square test results show that all selected plantain weather-related information was statistically significant associated at $\rho \leq 0.001$, implying that plantain weather-related information influenced the use of mobile phones to communicate agricultural information with extension agents.

Table 15: Plantains weather-related information communicated using mobile phone with extension agents (n=174)

Plantain-related information	Mobile phones use				Frequency of use mobile phone		
	Yes n(%)	No n(%)	Rank	ρ-value	Seldom n(%)	Often n(%)	Always n(%)
Alert on diseases outbreak	91(52.3)	83(47.7)	1	0.000**	91(52.3)	0(0.0)	0(0.0)
Alert on insect-pest outbreak	84(48.3)	90(51.7)	2	0.000**	84(48.3)	0(0.0)	0(0.0)
Onset of the rainfall	78(44.8)	96(55.2)	3	0.000**	78(44.8)	0(0.0)	0(0.0)
Proper time for planting	75(43.1)	99(56.9)	4	0.000**	75(43.1)	0(0.0)	0(0.0)
Proper time for harvesting	26(14.9)	148(85.1)	5	0.000**	26(14.9)	0(0.0)	0(0.0)
Alert on drought occurrence	22(12.6)	152(87.4)	6	0.000**	22(12.6)	0(0.0)	0(0.0)
Alert on flooding occurrence	18(10.3)	156(89.7)	7	0.000**	18(10.3)	0(0.0)	0(0.0)
Alert on climatic changes	15(8.6)	159(91.4)	8	0.000**	15(8.6)	0(0.0)	0(0.0)
Total frequency use of mobile phones					**409(100)**	**0(0.0)**	**0(0.0)**

**Note: ****Statistically significant at 0.01

In summary, the findings on mobile phones use in communicating plantain-related information with extension agents shows that majority of the plantain growers highly needs production-related information on managing the effects associated with diseases, insect-pests and planting materials to improve plantain production on marketing information farmers needed to purchase planting materials, access to market prices and selling of plantain produces to have better understanding of existing market prices of planting materials and produce. At the same time, weather information which was highly

required was on early warning on diseases outbreak, insect-pest outbreak and onset of the rainfall all of which have serious influence the plantain production. In general, plantain growers rarely used mobile phones to communicate plantain-related information. However, plantain-related information was statistically significant associated with the use of mobile phones in communicating agricultural information.

4.3.4 Mobile phone modes that respondents used to communicate plantain-related information with extension agents

Of the 174 respondents who used mobile phones to communicate plantain-related information with extension agents as shown in Table 16, found that 1.2%, 94.9% and 3.9% had used SMS, voice call and SMS together with the voice call to communicate plantain production related-information, respectively. This result indicates that voice call was mostly used to communicate plantain production-related information, whereas SMS and both SMS together with the voice call was rarely used. This could be due to voice call guaranteed to reach intended recipient and immediately communicate agricultural information once answers the phone than sending SMS. The results are in line with Ifejika (2016) in Nigeria who reported that fisher folk rated voice call as the most effective medium in information seeking over flashing SMS, voice message, video, and pictures mode.

Furthermore, 2.4%, 74.9% and 22.7% of the respondents had used SMS, voice call and SMS together with the voice call to communicate plantain market-related information with extension agents, respectively. This result indicates that voice call was more used to seek information on plantain market-related information. This result could be due to some farmers cultivated plantain as a commercial crop and need quick access and better market

information of their produce. This result contrary with Deichmann *et al.* (2016) who reported that SMS or "texting" is the most used technology on better link buyers and sellers along the agricultural production chain because even poor farmers now tend to have access to modern phones. According to Kirui *et al.* (2015), mobile phones SMS enabled farmers to access buyers who were not previously accessible due to boundaries imposed by traditional social network linkages and geographic constraints.

Further, findings in Table 16 also shows that respondents had used SMS (17.4%), voice call (68.2%) and SMS together with voice call (14.4%) to communicate plantain weather-related information with extension agents. The result indicates that voice call was highly used, while SMS and SMS together with the voice calls were rarely used to seek information on plantain weather-related information. This could be due to sending SMS cannot guarantee the message to reach an intended recipient and not sure the message has been read to the recipient if not acknowledged on receiving. This result contradicts with those of Chhachhar *et al.* (2016) who reported that in Kenya mobile phone SMS service played a key role to save the crop of farmers and send alert messages to each other in case of flooding situation. According to Zhang *et al.* (2016), with the increasing number of farmers who own mobile phones, the information dissemination through SMS has become a key service model.

Yet, voice messaging, picture and video mode were never used to communicate plantain-related information with extension agents. This result could be due to knowledge and skills and type of mobile phones that majority of farmers used has low capacity to record, store, send and receive the voice message, pictures and video clips. According Cai and Abbott (2013) video could help remove the learning obstacle of low literacy people and

has replaced traditional training and served as a stand-alone knowledge and innovation dissemination approach.

Overall, mobile phones mode used to communicate plantain-related information with extension agents as shown in Table 16. Of the 174 respondents who communicate plantain-related information, most, 85.2% of the respondents had used voice calls only, followed by few, 9.4% and 5.4% of the respondents had used both SMS together with voice call and SMS only, respectively. This result indicates that voice call was the preferable mode used to communicate plantain-related information with extension agents. This could be due to the nature of the plantain to be sensitive to insect-pests and diseases and on adverse climatic effects such as drought, strong winds and high temperature that affects its development. This result is in line with Zhang *et al.* (2016) that voice call service currently is a key channel to get connected with the farmers and can call into to get information and guidance on policy, technology, marketing, business, or other relevant professional and social information.

Table 16: Mobile phones modes that respondents used to communicate plantain-related information (n=174)

Plantain-related variable	**Mode of mobile phone used**						
	SMS (%)	**Call (%)**	**SMS and Call (%)**	**Voice (%)**	**Picture n(%)**	**Video n(%)**	**ρ -value**
Plantain production-related information	1.2	94.9	3.9	0	0	0	
Plantain market-related information	2.4	74.9	22.7	0	0	0	
Plantain weather-related information	17.4	68.2	14.4	0	0	0	
Overall mode used	**5.4**	**85.2**	**19.4**	**0**	**0**	**0**	0.000**

Note: **Statistically significant at 0.01

However voice messaging, pictures and video messaging mode was never used in communicating plantain-related information. According to Ifejika (2016) poor usage of media tools like video, camera and voice message were the indication of lack of skill and ignorance. Plantain-related information was statistically significant at $\rho \leq 0.001$ implying that was highly associated with the mobile phone modes used to communicate agricultural information.

4.3.5 Livestock-related information that respondents communicated using mobile phones with extension agents

On examining the livestock-related information that respondents communicated with extension agents using mobile phones, information communicated was related to production, marketing and weather based on dairy cattle and chicken keeping. According to Smollo *et al.* (2016), mobile phones act as a channel used to access animal husbandry information by smallholder dairy farmers. Poultry farmers frequently use mobile phones to exchange poultry information with veterinary medical practitioners (Ofuoku *et al.,* 2007).

4.3.5.1 Dairy cattle production-related information that respondents communicated using mobile phones with extension agents

Of the 73 respondents who had used mobile phones to communicate dairy cattle-related information with extension agents, dairy cattle production-related information was ranked the highest (Table 17). The results show that information communicated was on diseases treatment, disease control methods and dairy cattle vaccination, dairy cattle parasite control methods and on availability of improved breeding. Other information were on improved breeding techniques, feeding techniques, availability of dairy cattle credits, on shed construction, on farm equipment and on storage technique. Furthermore, information

on labour availability, milking techniques and post-harvest handling of milk was communicated.

This indicates that dairy cattle disease treatments, diseases controls methods and availability of vaccination were the most needed information of the dairy farmers in the study area and information on labour availability, milking techniques and post-harvest handlings of milk was the least required. This could be attributed to farmers' awareness and knowledge of the diseases infestation and timely treatment and vaccination of dairy cattle as essential factors of managing and improving dairy cattle production. However, the low use of mobile phones could be attributed to use of family labour and primitive milking techniques and handling.

The results are in line with those of Fue *et al*. (2016), who reported that mobile phones use can enable livestock keepers living in different areas to access information on disease outbreaks and treatment at low cost and in shorter time than direct contact with extension officers. Smollo *et al.* (2016) reported that, about a third of the smallholder dairy farmers using mobile phones accessed parasite and disease, animal nutrition and breeding management information from extension agents. Majority of farmers perceived cattle vaccination as a highly effective disease control measure (Jemberu *et al.,* 2015).Similarly, dairy cattle participants in FGD reported that, they used mobile phones only to contact veterinary doctor when they found their dairy cattle were docile and sleeping frequently to come to check for the problem and paid for the treatment and medicine provided to cattle (Mfenesini *Shehia*, June 16, 2016).

Furthermore, others dairy keeper participants in FGD reported that, they only use mobile phones to call veterinary doctor when they see their dairy cows has symptoms of tonsils,

sleeping unusually and not feeding well, in case of emergency either sick or delivery obstacle to go for checking and treatment (Kianga *Shehia*, June 14, 2016). And also other dairy cattle keeper participants FGD confirmed that, they used mobile phones to get advisory services from veterinary officer such as on keeping exotic breeds, use of AI and control of pests and diseases and if found problems to their cattle call veterinary officers and comes immediately to treat the cattle (*Chuini* Shehia, June 14, 2016).

Table 17: Dairy cattle production-related information that respondents communicated using mobile phones (n=73)

Dairy cattle production-related information	Mobile phones use				Frequency of use mobile phone		
	Yes	No		χ^2	Seldom	Often	Always
	n(%)	n(%)	Rank	ρ-value	n(%)	n(%)	n(%)
Dairy diseases treatment	63(86.3)	10(13.7)	1	0.000**	26(35.6)	24(32.9)	13(17.8)
Dairy diseases control methods	56(76.7)	17(23.3)	2	0.000**	33(45.2)	16(21.9)	7(9.6)
Dairy vaccination	49(67.1)	24(32.9)	3	0.000**	43(58.9)	6(8.2)	0(0.0)
Insect-pests control method	45(61.6)	28(38.4)	4	0.000**	27(37.0)	13(17.8)	5(6.8)
Improved dairy breeding stock	42(57.5)	31(42.5)	5	0.000**	29(39.7)	11(15.1)	2(2.7)
Improved breeding techniques	39(53.4)	34(46.6)	6	0.000**	29(39.7)	6(8.2)	4(5.5)
Dairy feeding techniques	34(46.6)	39(53.4)	7	0.000**	13(17.8)	16(21.9)	5(6.8)
Dairy credit availability	28(38.4)	45(61.6)	8	0.000**	23(31.5)	5(6.8)	0(0.0)
Dairy shed construction	13(17.8)	60(82.2)	9	0.000**	13(17.8)	0(0.0)	0(0.0)
Dairy farm equipments	11(15.1)	62(84.9)	10	0.000**	5(6.8)	6(8.2)	0(0.0)
Dairy storage techniques	8(10.0)	65(89.0)	11	0.000**	5(6.8)	3(4.1)	0(0.0)
Dairy labour availability	7(9.6)	66(90.4)	12	0.000**	4(5.5)	3(4.1)	0(0.0)
Dairy milking techniques	6(8.2)	67(91.8)	13	0.000**	6(8.2)	0(0.0)	0(0.0)
Dairy post-harvesting handling	5(6.8)	68(93.2)	14	0.000**	5(6.8)	0(0.0)	0(0.0)
Total frequency use of mobile phones					**261(64.3)**	**109(26.8)**	**36(8.9)**

Note: **Statistically significant at 0.01

On the respondents' frequency of use of mobile phones to communicate dairy cattle production-related information with extension agents as shown in Table 17, 64.3% of the respondents had rarely communicated dairy cattle production-related information and 26.8% had communicated on a monthly basis, while 8.9% had frequently communicated on a weekly to daily basis. The chi-square results show that all dairy cattle production-related information were highly statistically significant associated at $\rho \leq 0.001$, implying

that dairy cattle production-related information influenced the use of mobile phones to communicate agricultural information with extension agents.

4.3.5.2 Dairy cattle market-related information communicated using mobile phones with extension agents

Of the 73 respondents who had used mobile phones to communicate dairy cattle-related information with extension agents as shown in Table 18, dairy cattle market-related information communicated was ranked highest. The results show that information communicated was on purchase of dairy medicines, on purchase of dairy vaccination, on purchase dairy animals, on purchase of dairy farm equipment and on purchase dairy feeds. Other information was on sale of dairy animals, on access to dairy market price, on sale of dairy milk, on bargaining of dairy market price, on access to dairy market transportation costs and on sale of dairy manure. This indicates that majority of dairy keepers highly needed information on buying dairy medicines, dairy vaccination and dairy animals and information on bargaining dairy market price, on dairy market transportation costs and on sale of dairy manure was of less importance to them. This could be attributed to the threat of parasites and diseases to animal health and farmers' knowledge on maintaining heard immunity for better production.

However, low use of mobile phones could be attributed to majority of farmers keeping local breeds extensively which is difficult to collect manure and sell animals and milk locally directly to wholesalers and consumers at farm gate and so do not require market transportation. This is in line with Richens *et al.* (2015) who suggested that effective communication between farmers and vets could play an important role in achieving optimization of vaccination strategies. The use of mobile phones improves access to and use of information, thereby reducing search costs while improving coordination among

agents and increasing market efficiency (Gichamba and Lukandu, 2012). According to the study by Azeze and Haji (2016) in Southern Ethiopia, majority of farmers sold their milk at informal outlets at farm gate, kiosks shops and local markets, while Smollo *et al.* (2016) reported that majority of farmers use mobile phones to access milk market information from government extension service providers. Hall *et al.* (2012) reported that lack of access to markets due to seasonal variation and lack of bargaining power due to lack of knowledge of market price lead to a drop in potential revenue from dairy cattle. This result is confirmed by one KI participant who reported that:

> *Dairy cattle keepers never contacted me on the marketing of their milk produced because they have their customers who go directly to the farms for buying milk and transporting themselves* (SMS in Livestock Production, June 2, 2016).

Table 18: Dairy cattle market-related information that respondents communicated using mobile phones (n=73)

Dairy cattle market-related information	**Mobile phones use**				**Frequency of use mobile phone**		
	Yes	**No**			**Seldom**	**Often**	**Always**
	n(%)	**n(%)**	**Rank**	**ρ-value**	**n(%)**	**n(%)**	**n(%)**
Purchase dairy medicines	42(57.5)	31(42.5)	1	0.000**	31(42.5)	11(15.1)	0(0.0)
Purchase dairy vaccination	39(53.4)	34(46.6)	2	0.000**	33(45.2)	6(8.2)	0(0.0)
Purchase dairy animals	36(49.3)	37(50.7)	3	0.000**	34(46.6)	2(2.7)	0(0.0)
Purchase dairy farm equipment	29(39.7)	44(60.3)	4	0.000**	22(30.1)	7(9.6)	0(0.0)
Purchase dairy feeds	24(32.9)	49(67.1)	5	0.000**	22(30.1)	2(2.7)	0(0.0)
Sale dairy animals	23(31.5)	50(68.5)	6	0.000**	21(28.8)	2(2.7)	0(0.0)
Dairy market price	10(13.7)	63(86.3)	7	0.000**	7(9.6)	3(4.1)	0(0.0)
Sale dairy milk	7(9.6)	66(9.4)	8	0.000**	6(8.2)	0(0.0)	1(1.4)
Bargaining dairy market price	6(8.2)	67(91.8)	9	0.000**	4(5.5)	2(2.7)	0(0.0)
Dairy transportation costs	5(6.8)	68(93.2)	10	0.000**	5(6.8)	0(0.0)	0(0.0)
Sale dairy manure	3(4.1)	70(95.9)	11	0.000**	3(4.1)	0(0.0)	0(0.0)
Total frequency use of mobile phones					**188(83.9)**	**35(15.6)**	**1(0.4)**

Note: **Statistically significant at 0.01

4.3.5.3 Dairy cattle weather-related information that respondents communicated using mobile phones with extension agents

Of the 73 respondents who had used mobile phones communicated dairy cattle-related information with extension agents, dairy cattle weather-related information was ranked highest (Table 19). The results show that information communicated was on peak period of disease infestation, on period of high feed intake, on period of high water intake, on alert of dairy vaccination period and on peak period of parasite attack. Others communicated on onset of rainfall, on alert of climatic change, on alert of peak period of high temperature and on alert of peak period of high humidity. This shows that majority of dairy cattle keepers highly needed information on diseases infestation, on high feed intake and on high water intake, while information on climatic change, on high temperature and on high humidity was the least needed in the study area. This could be attributed to majority of dairy keepers suffering from various dairy cattle diseases and were sensitive to high feed intake and water intake that have direct effect on animal health and milk yield.

However, the low use of mobile phones could be attributed to lack of knowledge and awareness on the effect of climatic changes, high temperature and high humidity in consideration to their potential limitation on dairy health and milk production. The results are in line with those of Kwaghe *et al.* (2016) who reported that diseases reduce the productivity of sick animals resulting in lowered meat and milk production. Livestock diseases and parasite cause mortalities and reduction of quality and quantity of animal products hence reducing livelihood support to households (Kanui *et al.*, 2016).

Results in Table 19 show that 75.8% of the respondents had used mobile phones rarely to communicate dairy cattle weather-related information and 20.8% they had used mobile

phones on monthly basis, while few, 3.3% of the respondents had used mobile phones on weekly and daily basis. The chi-square test results show that all selected dairy cattle weather-related information were statistically significant associated at $\rho \leq 0.001$, implying that dairy cattle weather-related information influenced he use of mobile phones to communicate agricultural information with extension agents.

Table 19: Dairy cattle weather-related information that respondents communicated using mobile phones (n=73)

Dairy cattle weather-related information	Mobile phones use				Frequency of use mobile phone		
	Yes n(%)	No n(%)	Rank	ρ-value	Seldom n(%)	Often n(%)	Always n(%)
Peak period of diseases infestation	49(67.1)	24(32.9)	1	0.000**	38(52.1)	9(12.3)	2(2.7)
Period of high feed intake	47(64.4)	26(35.6)	2	0.000**	31(42.5)	11(15.1)	5(6.8)
Period of high water intake	35(47.9)	38(52.1)	3	0.000**	26(35.6)	7(9.6)	2(2.7)
Alert on period of dairy vaccination	35(47.9)	38(52.1)	4	0.000**	29(39.7)	6(8.2)	0(0.0)
Peak period of insect-pest attack	31(42.5)	42(57.5)	5	0.000**	24(32.9)	7(9.6)	0(0.0)
Onset of rainfall season	25(34.2)	48(65.8)	6	0.000**	18(24.7)	7(9.6)	0(0.0)
Alert on climatic change	24(32.9)	49(67.1)	7	0.000**	19(26.0)	5(6.8)	0(0.0)
Peak period of high temperature	14(19.2)	59(80.8)	8	0.000**	10(13.7)	4(5.5)	0(0.0)
Peak period of high humidity	9(12.3)	64(87.7)	9	0.000**	9(12.3)	0(0.0)	0(0.0)
Total frequency use of mobile phones					**204(75.8)**	**56(20.8)**	**9(3.3)**

**Note: ****Statistically significant at 0.01

In summary, the findings on mobile phones use to communicate dairy cattle-related information with extension agents show that majority of the dairy cattle keepers highly needs production-related information on diseases treatment, disease control methods and dairy cattle vaccination to manage the effects of diseases. On marketing information farmers highly needed to purchase of dairy medicines, purchase of dairy vaccination, purchase dairy animals and on weather dairy cattle keepers were highly needed forecast information peak period of disease infestation, period of high feed intake, period of high

water intake which associated to dairy cattle health and increasing milk yield. In general, dairy cattle keepers rarely used mobile phones to communicate dairy cattle-related information. However, dairy cattle-related information was statistically significantly associated with the use of mobile phones in communicating agricultural information.

4.3.5.4 Mobile phone modes that respondents used to communicate dairy cattle-related information with extension agents

Of the 73 respondents who used mobile phones communicated on dairy cattle-related information with extension agents as shown in Table 20, found that 8.6% and 91.4% had used mobile phone SMS and voice call to communicate dairy cattle production- related information with extension agents, respectively. The result indicates that voice call was highly used to seek information on dairy cattle production-related information. This could be due to dairy cattle farming has the high risk of insect-pests and diseases attacks, sensitive to weather effects and require intensive care. This result is in line with Smollo *et al.* (2016) who reported that smallholder dairy farmers interact with experts and systems via voice call or SMS through mobile phones to access animal husbandry information hence improving livestock system. Furthermore, all of the respondents communicated on dairy cattle market-related information used only voice call (100%) to contact extension agents. This result indicates that voice call was the only preferable mode in communicating dairy cattle market-related information. This could be due to voice call is fast and easy to access market-related information to facilitate proper selling and buying of dairy cattle and their products. According to Crandall (2012), most farmers, regardless of age, sex, or location, tend to prefer making calls than using SMS because calls consume less money to get a final response.

Further, results in Table 20 also shows that 3% and 97% of the respondents had used SMS and voice call to communicate dairy cattle weather-related information with extension

agents, respectively. The result indicates that voice call was mostly used and SMS was rarely used to access dairy cattle weather-related information, which could be due to the majority of farmers, have difficulties in using SMS due to elderly and education level. This result is in line with Etwire *et al.* (2017) that text messages are sometimes not self-explanatory or elaborate; hence, some illiterate farmers are unable to process and to utilize some of the information received through SMS.

Table 20: Mobile phones modes that respondents used to communicate dairy cattle-related information (n=73)

Dairy cattle-related variable	**Mode of mobile phone used**						
	SMS	**Call**	**SMS and Call**	**Voice**	**Picture**	**Video**	
	(%)	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**ρ -value**
Dairy cattle production-related information	8.6	91.4	0	0	0	0	
Dairy cattle market-related information	0	100	0	0	0	0	
Dairy cattle weather-related information	3.0	97.0	0	0	0	0	
Overall mode used	**4.8**	**95.2**	**0**	**0**	**0**	**0**	0.000**

Note: **Statistically significant at 0.01

Overall, mobile phones mode used to communicate dairy cattle-related information with extension agents as shown in Table 20. Of the 73 respondents few, 4.8% of the respondents had used SMS only and most, 95.2% they had voice call only. This result indicates that voice call was the preferable mode in communicating dairy cattle-related information. This could be because voice call is fast and easy to access production, market and weather information to facilitate proper dairy cattle management and marketing. This result is in line with Kwakwa (2012) study in Ghana, who reported that voice call was the most frequently used service by respondents because it requires simple procedures which

even those with a low level of education can easily learn and use. However, both SMS together with the voice call, voice messaging, picture and video mode was never used to communicate on dairy cattle-related information. Dairy cattle-related information was statistically significant at $\rho \leq 0.001$, implying that was highly associated with the mobile phone modes used to communicate agricultural information with extension agents.

4.3.6.1 Chicken production-related information that respondents communicated using mobile phone with extension agents

Of the 113 respondents who had used mobile phones to communicate chicken-related information with extension agents as shown in Table 21, chicken production-related information was ranked the highest. The results show that information communicated was on chicken disease treatment, on chicken vaccination, on improved chicken breeding stock and on chicken disease control methods. Others communicated on chicken parasite control methods, on chicken feeding techniques, on improved chicken breeding techniques and on chicken house construction.

In addition, information on availability of chicken farm equipment, on chicken storage techniques, on chicken labour availability and chicken meat and eggs post-harvest handling were communicated. This shows that information on chicken disease treatment, vaccination and on improved chicken breeding stock was highly needed by the majority of chicken keepers while information on storage techniques, chicken labour and post-harvest handling of meat and eggs was least needed. This result could be attributed to farmers' awareness on prevention of chicken disease to reduce chicken mortality and benefit of using improved chicken breeds to improve chicken performance and productivity capacity of meat and eggs.

However, the low use of mobile phones could be attributed to lack of awareness of improved storage and post-harvesting techniques for eggs and meats thus farmers selling live bird and eggs directly to wholesalers and consumers and availability of farm labour in locality. The result is in line with those of Ofuoku *et al.* (2007) who reported that farmers used mobile phones to exchange information with veterinarian on health problems, request for medications and sources of veterinary medications mostly at a time when they were scarce. Jemberu *et al.* (2015) in their study in Tanzania reported that 70% of the respondents use mobile phones on accessing information on poultry diseases and their control. Likewise, farmers in Jalingo Local Government Area, Taraba State, Nigeria, needed information on poultry diseases, prevention and cure (Tikwe *et al.*, 2015).

Poultry farmers needed information on the specification of medications, availability of day old chicks, parasites and disease control and methods of vaccination (Chah *et al.*, 2015). In Tanzania, reported that information on poultry disease management and on improved poultry breeds, medication, nutrition, diseases and market opportunities for meat and eggs was highly needed by poultry farmers (Msoffe and Ngulube, 2015; Malapela *et al.*, 2016). Similarly, chicken keeper participants in FGD reported that, they use mobile phones to call extension agents for information on vaccination and other medicine to prevent chicken diseases and to vaccinate chicken when they have got diseases (Bumbwisudi *Shehia*, June 13, 2016). However, other chicken keeper participants in FGD contrary with others that, they always kept chicken but they do not know who is their veterinary doctor when chicken get sick and the medicine to use and how to treat their birds, which led to death of the chicken (Kizimbani *Shehia*, June 15, 2016).

About three-quarters, 74.8%, of the respondents had used mobile phones rarely to communicate chicken production- related information and 17.8% had used mobile phone

on monthly basis, while few, 7.4%, had used mobile phones on weekly to daily basis. The results of chi-square test revealed that all selected chicken production-related information were statistically significant associated at $\rho \leq 0.001$, implying that chicken production-related information influenced the use of mobile phones to communicate agricultural information with extension agents.

Table 21: Chicken production-related information that respondents communicated using mobile phones (n=113)

Chicken production-related	Mobile phones use				Frequency of use mobile phone		
	Yes n(%)	No n(%)	Rank	ρ-value	Seldom n(%)	Often n(%)	Always n(%)
Chicken diseases treatment	85(75.2)	28(24.8)	1	0.000**	59(52.2)	16(14.2)	10(8.8)
Chicken vaccination	82(72.6)	31(27.4)	2	0.000**	55(48.7)	19(16.8)	8(7.1)
Improved chicken breeding stock	74(65.5)	39(34.5)	3	0.000**	55(48.7)	13(11.5)	6(5.3)
Chicken diseases control methods	73(64.6)	40(35.4)	4	0.000**	41(36.3)	18(15.9)	14(12.4)
Insect-pests control methods	68(60.2)	45(39.8)	5	0.000**	53(46.9)	13(11.5)	2(1.8)
Chicken feeding techniques	67(59.3)	46(40.7)	6	0.000**	57(50.4)	8(7.1)	2(1.8)
Improved breeding techniques	61(54.0)	52(46.0)	7	0.000**	40(35.4)	15(13.3)	6(5.3)
Chicken house construction	35(31.0)	78(69.0)	8	0.000**	35(31.0)	0(0.0)	0(0.0)
Chicken farm equipment	30(26.5)	83(73.5)	9	0.000**	27(23.9)	3(2.7)	0(0.0)
Chicken credit availability	26(23.0)	87(77.0)	10	0.000**	26(23.0)	0(0.0)	0(0.0)
Chicken storage techniques	23(20.4)	90(79.6)	11	0.000**	16(14.2)	7(6.2)	0(0.0)
Chicken labour availability	17(15.0)	96(85.0)	12	0.000**	17(15.0)	0(0.0)	0(0.0)
Chicken post-harvesting handling	11(9.7)	102(90.3)	13	0.000**	7(6.2)	4(3.5)	0(0.0)
Total frequency use of mobile phones					**488(74.8)**	**116(17.8)**	**48(7.4)**

**Note: ****Statistically significant at 0.01

4.3.6.2 Chicken market-related information communicated using mobile phones with extension agents

Of the 113 respondents who had used mobile phones to communicate chicken-related information with extension agents as shown in Table 22, chicken market-related

information was ranked highest. The results show that information communicated was on chicken market price, on purchasing chicken medicine, on purchasing day-old-chicks, on selling chicken eggs and on purchasing chicken vaccination. Furthermore, others was on sale of chicken, on purchasing chicken feeds, on bargaining chicken market price, on chicken transportation costs, on purchasing chicken farm equipment and on selling chicken manure. This result indicates that majority of poultry farmers were highly needed information on chicken market price, buying of chicken medicine and on buying of day-old-chicks and information on chicken transportation costs, on buying of chicken farm equipment and on selling of chicken manure was less required. This result could be attributed to farmers' knowledge and experiences on market prices of chicken in different markets so as to select the best market place for selling chicken and eggs as well as understand the importance of treating chicken diseases to reduce chicken mortality and improve chicken health and access to improved day-old-chicks for vigorous growth with higher kilograms of chicken.

However, the low use of mobile phones could be attributed to high cost of transportation and chicken equipment such as drinkers, feeders and brooders and chicken manure mainly used by farmers to fertilizing their farms and locally sold to the crop farmers. This is in line with Lekopanye and Meenakshi (2017) who reported that effective use of ICT such as mobile phones will boost livestock sales and hence improve farmers' livelihoods. Mobile phone was regarded by Syiem and Raj (2015) as the most widely used ICT tool for the purpose of marketing of produce. Stable market prices for sale of eggs encourage poultry farmers to increase their production since they are assured of selling their eggs at a good price, while market price fluctuation was a constraint to increasing layers production (Aromolaran *et al.,* 2013). Due to villages' remoteness and poor communications to

market places, farmers usually lack information about current market prices (Courtois and Subervie, 2013).

Table 22: Chicken market-related information that respondents communicated using mobile phone (n=113)

Chicken market-related information	Mobile phones use				Frequency of use mobile phone		
	Yes	No			Seldom	Often	Always
	n(%)	n(%)	Rank	ρ-value	n(%)	n(%)	n(%)
Know chicken market price	81(71.7)	32(28.3)	1	0.000**	55(48.7)	15(13.3)	11(9.7)
Purchase chicken medicines	76(67.3)	37(32.7)	2	0.000**	47(41.6)	20(17.7)	9(8.0)
Purchase day old chicks	75(66.4)	38(33.6)	3	0.000**	61(54.0)	14(12.4)	0(0.0)
Sale chicken eggs	73(64.6)	40(35.4)	4	0.000**	44(38.9)	12(10.6)	17(15.0)
Purchase chicken vaccination	72(63.7)	41(36.3)	5	0.000**	60(53.1)	12(10.6)	0(0.0)
Sale chicken	65(57.5)	48(42.5)	6	0.000**	42(37.2)	18(15.9)	5(4.4)
Purchase chicken feeds	62(54.9)	51(45.1)	7	0.000**	46(40.7)	11(9.7)	5(4.4)
Bargain chicken market price	55(48.7)	58(51.3)	8	0.000**	55(48.7)	0(0.0)	0(0.0)
Chicken transportation costs	13(11.5)	100(88.5)	9	0.000**	13(11.5)	0(0.0)	0(0.0)
Buy chicken farm equipment	11(9.7)	102(90.3)	10	0.000**	11(9.7)	0(0.0)	0(0.0)
Sale chicken manure	1(0.9)	112(99.1)	11	0.122^{ns}	1(0.9)	0(0.0)	0(0.0)
Total frequency use of mobile phones					**435(74.5)**	**102(17.5)**	**47(8.0)**

Note: **Statistically significant at 0.01, ns = not statistically significant at 0.05

Also during the FDG Broilers keeper participants reported that, they were not using mobile phones to seek information for transportation for marketing of chicken and litter because buyers went direct to their farms with transport and also vegetable farmers brought fresh wood shavings to them for litter and they clean d the chicken house and carried away the used litter to manure their farms and payed them 1000 TZS per 50 kg bag of used litter (Mfenesini *Shehia*, June 16, 2016).

Regarding the frequency of use of mobile phone to communicate chicken market-related information with extension agents as shown in Table 22, 74.5% of the respondents had rarely used mobile phones to communicate chicken market-related information, and 17.5% said they had used mobile phone on monthly basis, while few, 8% of the respondents had

used mobile phones on a weekly and daily basis to communicate chicken market-related information. The chi-square test results show that most selected chicken market-related information were highly statistically significant associated at $\rho \leq 0.001$, implying that chicken market-related information influenced the use of mobile phones to communicate agricultural information with extension agents.

However, information on sale of chicken manure was not statistically significant associated at $\rho \leq 0.122$, implying that sale of chicken manure information was not influenced the use of mobile phones to communicate agricultural information in the study area. The possible reason for that could be majority of farmers was using chicken manure to fertilize their farms instead of selling it.

4.3.6.3 Chicken weather-related information that respondents communicated using mobile phones with extension agents

Of the 113 respondents who had used mobile phones to communicate chicken-related information with extension agents, chicken weather-related information ranked highest (Table 23). The results show that information communicated was on period of high feed intake, on period of high water intake, on alert on climatic change and on period of chicken vaccination. Still, others were on peak period of diseases infestation, on peak period of insect-pest outbreak, on peak period of high temperature, onset of rainfall and on peak period of high humidity. This result indicates that majority of poultry farmers highly needed information on feed intake, on period of water intake, on alert on climatic change and chicken vaccination, while little information was needed on peak period of disease infestation, parasites attacks and high temperature, onset of rainfall and on peak period of high humidity was less needed. The implication of this result could be attributed to

farmers' knowledge and awareness on the importance of feed intake, water intake and vaccination for improve chicken health, eggs and meat production and effect climatic changes in reduce chicken performance. However, the low use of mobile phones could be attributed to majority of farmers using traditional herbs to treat chickens against various diseases and parasite attack and lack of knowledge on the effects of high temperature in inducing several parasites and diseases and low production of eggs. This result is in line with those of Uzokwe and Bakare (2013) who reported that environmental conditions affecting the performance and health productivity of a chicken includes temperature, relative humidity, sunshine prevailing at a given time, light, housing system and ventilation.

Table 23: Chicken weather-related information communicated using mobile phone with extension agents (n=113)

Chicken weather-related information	Mobile phones use				Frequency of use mobile phone		
	Yes	No			Seldom	Often	Always
	n(%)	n(%)	Rank	ρ-value	n(%)	n(%)	n(%)
Period of high feed intake	31(27.4)	82(72.6)	1	0.000**	26(23.0)	5(4.4)	0(0.0)
Period of high water intake	24(21.2)	89(78.8)	2	0.000**	21(18.6)	3(2.7)	0(0.0)
Alert on climatic change	6(5.3)	107(94.7)	3	0.000**	6(5.3)	0(0.0)	0(0.0)
Period of chicken vaccination	6(5.3)	107(94.7)	3	0.000**	2(1.8)	4(3.5)	0(0.0)
Peak period of diseases infestation	4(3.5)	109(96.5)	5	0.008**	3(2.7)	1(0.9)	0(0.0)
Peak period of insect-pest attack	4(3.5)	109(96.5)	5	0.008**	2(1.8)	2(1.8)	0(0.0)
Peak period of high temperature	4(3.5)	109(96.5)	5	0.002**	4(3.5)	0(0.0)	0(0.0)
Knowing onset of rainfall	2(1.8)	111(98.2)	8	0.028*	1(0.9)	1(0.9)	0(0.0)
Peak period of high humidity	2(1.8)	111(98.2)	8	0.000**	2(1.8)	0(0.0)	0(0.0)
Total frequency use of mobile phones					**67(80.7)**	**16(19.3)**	**0(0.0)**

Note: *Statistically significant at 0.05, ** Statistically significant at 0.01,

Results in Table 23 show that80.7% of the respondents had communicated rarely chicken weather-related information and 19.3% had communicated on monthly basis and none of the respondents had communicated on weekly and daily basis. The chi-square results revealed that all chicken weather-related information was statistically significant

associated at $\rho \leq 0.001$ implying that chicken weather-related information influenced the use of mobile phones to communicate agricultural information with extension agents in the study area.

In summary, findings on mobile phones use in communicating chicken-related information with extension agents, majority of the chicken keepers needs production information on chicken diseases treatment, chicken vaccination and improved chicken breeding stock, on marketing information farmers were highly needed to access information on chicken and eggs market price, buying of chicken medicine and on buying of day-old-chicks, whereas weather forecast information highly needed was on high feed intake, on period of high water intake, on alert on climatic change and on chicken vaccination which are vital to manage diseases effects and improve meat and eggs production. In generally, chicken keepers were rarely used mobile phones communicated chicken-related information. However, most of the chicken-related information was statistically significant associated with the use of mobile phones in communicating agricultural information with the exception of selling of chicken manure therefore, the null hypothesis is accepted.

4.3.6 Mobile phone modes that respondents used to communicate chicken keeping-related information with extension agents

Of the 113 respondents who used mobile phones communicated on chicken-related information with extension agents as shown in Table 24, found that 30.1%, 69.6% and 0.3% had used mobile phone SMS, voice call and both SMS together with voice call modes to communicate on chicken production-related information with extension agents, respectively. The result indicates that voice call was highly used on seeking chicken production-related information. This could be due to chicken farming facing various

challenges in production such as insect-pests and diseases and need immediate action to solve the problem. This is in line with Ofuoku *et al.* (2007), who reported that voice communications are immediately useful and easily accessible service among the poultry farmers in rural population. Furthermore, 6.2% and 93.8% of the respondents had used mobile phones SMS and voice call mode to communicate chicken market-related information with extension agents, respectively. The result indicates that voice call was highly used on sourcing chicken-related information than SMS. This result could be due to chicken enterprise requiring timely marketing to reduce production costs and avoid spoilage of eggs. This result contrary with Irungu *et al.* (2015) who reported that voice messages and SMS assisted timely accessing of market prices, reaching clients, sharing production information and money transactions.

Further, all of the respondents had used only voice call (100%) to communicate chicken weather-related information to the extension agent. This result indicates that voice call was the only mode of communication used in chicken weather-related information, whereas other modes were never used to communicate chicken weather-related information, This could be due to majority of the farmers having difficulties in reading and writing SMS and operating mobile phone functions caused by lack of knowledge and skills to operate the modes, which is in line with Howland *et al.* (2015) who reported that low use of mobile phone for sending and receiving SMSs could be due to farmers, familiarized to oral and visual communication rather than reading and writing SMSs, taking, sending of pictures, voice and video. According to Gichamba and Lukandu (2012), farmers can interact with experts and systems via SMS to receive weather updates and information in best practices on various sectors of agriculture.

Overall, mobile phones mode used to communicate chicken-related information with extension agents as shown in Table 24, found that 17.5% of the respondents had used SMSs only, followed by 82.3% who had used voice call and few, 0.2% of the respondents had used both SMSs together with the voice call. This result indicates that voice call was the most preferred means of communication on chicken-related information in the study area. This could be due to the benefit of using voice call to increased access to market information and assist to reduce the effect of insect-pests and diseases attacks, weather variability such as hottest and coldest that increase mortality rate, reduce meat and eggs production and farmers' incomes.

Table 24: Mobile phone modes that respondents used to communicate chicken-related information (n=113)

Chicken-related variable	**Mode of mobile phone used**						
	SMS	**Call**	**SMS and Call**	**Voice**	**Picture**	**Video**	
	n(%)	**n(%)**	**n(%)**	**n(%)**	**n(%)**	**n(%)**	**ρ -value**
Chicken production-related information	30.1	69.6	0.3	0	0	0	
Chicken market-related information	6.2	93.8	0	0	0	0	
Chicken weather-related information	0	100	0	0	0	0	
Overall mode used	**17.5**	**82.3**	**0.2**	**0**	**0**	**0**	0.000**

**Note: ****Statistically significant at 0.01

However, voice messaging, picture and video messaging mode were never used in communicating chicken-related information. According to Kameswari *et al.* (2011) farmers were not able to use video and picture modes for sending video clips and still photographs to the experts for seeking advice due to their limited technological skills. According to Onyeneke *et al.* (2016), short messaging services and calls were used by the farmers in communicating poultry information. Chicken-related information was

statistically significant at $\rho \leq 0.001$, implying that was highly associated with the mobile phone modes used to communicate agricultural information with extension agents.

In summary, all five selected mobile phone modes of communications were used to communicate crop- and livestock-related information in the study area. However, their use was differently depending on the type of farming enterprise and information needed. In order for farmers to benefit greatly from use of mobile phones to communicate agricultural information, application of voice call and SMS should be mostly considered and other modes such as voice messaging, picture and video messaging, although were poorly used should be also promoted their use because have relatively advantage to enable easily understanding of the information content to all group of farmers if properly used. Saravanan and Bhattacharjee (2014), Fafchamps and Minten (2012) and Ganesan *et al.* (2013) reported that various mobile phone tools have been deployed in agricultural extension services to deliver messages to agricultural communities like SMS, voice call, video and voice recorder. This result is in line with what diffusion of innovation theory (Rogers, 1983) and technology acceptance model (Davis, 1989) emphasizes that complexity in terms of perceived ease of use and in terms of relative advantage and compatibility as perceived usefulness has significant influences on the acceptance or rejection of innovations.

On testing the null hypothesis II (Ho_2), most of the crop- and livestock-related information were highly statistically significant associated at $\rho \leq 0.001$ with the exception of information on cassava market transportation costs at $\rho \leq 0.016$ and onset of rainfall on chicken keeping at $\rho \leq 0.028$, with the use of mobile phones to communicate agricultural information with extension agents. Implying that had influence on the use of mobile phones in the study area. Hence, they rejected null hypothesis II (Ho_2) which stated that,

there is no statistically significant association of the crop-and livestock-related information and the use of mobile phones to communicate agricultural information with extension agents. However, access to credit information on cassava production and sale of chicken manure information were not statistically significantly associated $\rho \leq 0.172$ and $\rho \leq 0.122$, respectively, with the use of mobile phones to communicate agricultural information with extension agents. Implying the variables were not influenced the use of mobile phones in the study area. Thus, access to credit information on cassava production and sale of chicken manure failed to reject the null hypothesis II ($Ho:_2$).

4.4 Institutional Support Mechanisms Influencing the Use of Mobile Phones to Communicate Agricultural Information with Extension Agents

To achieve the fourth objective of the study, frequency counts and percentage values were used to assess the institution supports provided and ranked them as highest whereas chi-square test was used to determine the statistically significant association of institutional supports provided and the use of mobile phones to communicate agricultural information. Of the 383 respondents, 54.3% reported that institutional support was provided, while 45.7% of the respondents reported that they never received any institutional supported on the use of mobile phones to communicate and access of agricultural information. This means that more than half of the respondents had received institutional support of one type or another that could encourage and promote their use of mobile phones to communicate agricultural information. According to Mtega and Ronald (2013), lack or inadequate institutional support limited access to information services in rural areas.

There was a difference supports provided between organizations to facilitate the use of mobile phones in communicating agricultural information in the study area, such as

awareness creation, existence of policies, regulations, free airtime and monthly subscription fees, sustainable network and infrastructure to enable them effectively use of mobile phones as shown in Table 25. Of the 208 respondents who reported receiving institutional support, about 43(20.7%) of the respondents had reported support provided by the governmental organizations, of whom, 53.5% and 46.5% had said supportwas provided from Ministry responsible for Communication and TCRA, respectively. Moreover, 90(43.3) of the respondents had received support from non-governmental organizations 81.1% and 18.9% of the respondents had received support specifically from TAHA and UWAMWIMA, respectively. Still, 39(18.8) of the respondents had received support from International organizations specifically the World Bank. Yet, 89(42.8) of the respondents received support from mobile phone companies including Zantel (87.6%) and Tigo (12.4%).

Table 25: Providers of institutional support to facilitate mobile phone use for communicating agricultural information (n=208)

Organization	Institution	Frequency n	Percentage %	Support provided
Governmental	Ministry of Communication	23	53.5	Awareness, policies and regulation, budget for infrastructure and sustainable network
	TCRA	20	46.5	
	Total	**43**	**20.7**	
Non-governmental Organization	TAHA	73	81.1	Awareness, free airtime and monthly subscription fee.
	UWAMWIMA	17	18.9	
	Total	**90**	**43.3**	
International organization	World Bank(CMS)	39	18.8	Awareness, free mobile phone handset and free airtime.
Mobile phones companies	Zantel	78	87.6	Awareness, free airtime, sustainable network and budget for infrastructure
	Tigo	9	12.4	
	Total	**89**	**42.8**	

4.4.1 Nature of institutional support provided to farmers on use of mobile phones to communicate agricultural information

To ascertain the provision of institutional support to respondents towards the use of mobile phones in communicating agricultural information, respondents were asked to indicate "Yes" or "No", if the support provided to them among the list of nine selected options of support did influence their use of mobile phones in communicating agricultural information. Of the nine responses the provision of loan for purchasing mobile phone was not selected by the respondents. This indicated that there was no informal or formal institution providing loans to farmers for buying mobile phones in the study areas to support mobile phones use. Of the 208 respondents, who received institution support as presented in Table 26, most 97.6% reported that they were made aware on the use of mobile phones to communicate agricultural information and ranked it first priority. The result is in line with Olaniyi *et al.* (2013) who reported that both governmental and non-governmental agencies need to promote the awareness and access to digital ICT tools among the farmers for improved production. Furthermore, FGD participants reported that, Zantel and UWAMWIMA conducted special training sessions to extension agents and farmers to introduce and influence the use of mobile phones specifically on use of Z-Kilimo through their mobile phones to get access to agricultural information (Kizimbani *Shehia*, June 15, 2016).

Furthermore, 53.4% the respondents had reported received free mobile phone airtime to enable them easily use of mobile phone to access agricultural information and ranked as a second. This result could be attributed to empower respondents on the use of mobile phone to communication agriculture information and facilitate regularly access to agricultural information through the provision of hotlines to better increase productivity and access to

market information for selling their agricultural produces. The results contradict with those of Egbule *et al.* (2013) study in Delta State, Nigeria who reported that, majority, 98.4% of the respondents noted that they were not provided with mobile phone or airtime for information dissemination. Similar findings were revealed by participants during FGD that, Zantel and Tigo provide agricultural information for free in the mobile phones and provide a special number to access with information (Kizimbani *Shehia*, June 15, 2016).

Table 26: Nature of institutional support to influence mobile phones use to communicate agricultural information (n=208)

Institutional support	Received n(%)	Did not received n(%)
Awareness creation of mobile phone use in agriculture	203(97.6)	5(2.4)
Provision of free mobile phone airtime	111(53.4)	97(46.6)
Existence of sustainable mobile phones networks	100(48.1)	108(51.9)
Provision of free monthly subscription fee for mobile phone use in agriculture	51(24.5)	157(75.5)
Provision of free mobile phone handsets	37(17.8)	171(82.2)
Existence of regulations for mobile phones use in agriculture	33(15.9)	175(84.1)
Existence of policy for mobile phone use in agriculture	31(14.9)	177(85.1)
Provision of special budget for mobile phones networks	24(11.5)	184(88.5)
Provision of loans for mobile phones purchasing	0(0.0)	208(100.0)

Furthermore, 48.1% of the respondents reported that they had been supported with the provision of sustainable mobile phones network in their area, especially Zantel and Tigo and ranked than as third priority. This result is in line with Angello and Wema (2010) who reported that poor ICT infrastructure greatly affects all areas of agricultural development, including training, extension services, marketing, documentation and dissemination of related information. According to Lekopanye and Meenakshi (2017), poor mobile communication network signal limits farmers on the use of mobile phones

and sometimes they have to travel to nearby areas where there is a communication network to use their mobile phones which increases the communication cost and is time consuming. Yet, FGD participants revealed that, now they enjoyed Zantel network and received calls easily than before because there is a wide network coverage everywhere (Dole *Shehia*, June 13, 2016).

Moreover, 24.5% the respondents had reported receiving free monthly subscription fee to facilitate them to easily use mobile phone to access agricultural information of the different crops and from different markets and ranked as a forth priority. This result could be attributed to assisting farmers financially to manage the cost of mobile phone communication as well as increasing their use in accessing and sourcing production, weather and market information. The result is in line with Haruna *et al.* (2013) who reported that, high cost of subscription were ranked as constraints to effective usage of mobile phone among farmers for seeking agricultural extension information. Similarly, FGD participants reported that, TAHA and UWAMWIMA provided their contact numbers to farmers and monthly subscription fees to facilitate communication with other vegetable farmers. Farmers who subscribed to TAHA were given free airtime through a special number to enable them to access information on marketing of vegetables (Chuini *Shehia*, June 14, 2016).

Still, 17.8% of the respondents reported to had been provided with free mobile phone airtime to communicate agricultural information, specifically on cassava yields and ranked it as fifth priority. This encouraged farmers to increase ownership and acceptance use of mobile phones to communicate agricultural information. This is in line with Temba *et al*. (2016), who reported that the relative low costs of buying and maintaining mobile phones,

especially in urban areas facilitated the frequent use of mobile phones. Similarly, a Key Informant interview participant reported that:

> *There was only one small project supported by The World Bank in the Ministry of Agriculture which dealt with cassava and provided farmers with airtime and mobile phones to facilitate communication of cassava production yield information* (SMS crop production, June 3, 2016).

Yet, 15.9% and 14.9% of the respondents, respectively had provided support with the existence of regulations and policies on the use of mobile phones to communicate agricultural information and ranked as the six and seventh priority. This could be attributed to facilitate establishment and utilization of well-defined strategies, policies, regulations and programmes to improve implementation of mobile based agricultural extension programmes and increase the readiness of farmers towards use of mobile phone in agricultural extension services. This result is in line with Mutunga and Waema (2016) who reported that the success of mobile phone use by farmers was partly attributed to the institutional policies and regulations that encouraged its implementation. The policies and programmes implemented in support of rural telephone services are critical aspects to support environment for rural ICT initiatives (Ofuoku *et al.,* 2007).

Similarly, 11.5% of the respondents had reported that the existence of special budget for mobile phones infrastructure could increase distribution of mobile phones coverage in rural area and ranked it the eighth priority. This result could be attributed to opportunities to expand mobile phone infrastructure in rural areas, to lower cost of using them. This result is in line with Akpabio *et al.* (2007) who reported that poor ICT infrastructure development effected extension agents' utilization of ICT to disseminate agricultural information to farmers. According to Lekopanye and Meenakshi (2017), lack of ICT infrastructure in rural areas and high cost of ICT services drive livestock keepers to use

unproductive traditional ways of farming. Mobile phone infrastructure in both rural and urban Tanzania was growing faster thus providing increasing opportunities to use mobile phone services (Mtega and Msungu, 2013). Similarly, FGD participants confirmed that, The Ministry of Communication and Infrastructure should develop a policy and provide budget to influence distribution of mobile phones in the country to promote its use in rural area (Bumbwisudi *Shehia*, June 13, 2016).

4.4.2 Respondents' opinions on the usefulness of the institutional support provided.

Of the 208 respondents who received institutional support, 8.7% said support provided was not helpful, followed by 37.0% who said that support provided in one way or another was helpful. However, 36.5% of the respondents said support provided was definitely helpful and 17.8% of the respondents said it was very helpful. This indicates that the institutional support provided to the respondents in the study areas was helpful and could have influenced the use of mobile phones in communicating agricultural information by extension agents (Table 27).

Table 27: Respondents' decisions on the helpfulness of institutional support provided (n=208)

Decision	Frequency n	Percentage %
Not helpful	18	8.7
Somehow helpful	77	37.0
Helpful	76	36.5
Very helpful	37	17.8
Total	**208**	**100**

4.4.3 Institutional support factors influencing the respondents on use of mobile phones to communicate agricultural information with extension agents

On testing the null hypothesis III (Ho_3), chi-square test was used to determine the statistically significant association of institutional support factors that includes awareness

creation, free mobile phone handset, free airtime, free monthly subscription fees, budget for network infrastructure, sustainable mobile phone network, existence of policy and existence of regulations and the use of mobile phones to communicate agricultural information with extension agents (Table 28). Of the 208 respondents who had received institutional support, more than two third, 64.9% reported that they had used mobile phones to communicate agriculture information with extension agents. This result indicates that provision of institution support has major contribution to facilitate and encourage farmers to use mobile phones to communicate agricultural information. Provision of institution supports was statistically significant associated at $\rho \leq 0.001$, implying that it influenced the use of mobile phones to communicate agricultural information with extension agents.

Based on individual supports that farmers provided to promote their use of mobile phones to communicate agricultural information, more than two third, 64% of those respondents who had been provided with awareness of using mobile phone in agriculture they had used mobile phones to communicate agricultural information with extension agents. However, awareness creation was statistically significant associated at $\rho \leq 0.001$, implying that it influenced the use of mobile phones to communicate agricultural information with extension agents. This result indicates that majority of the respondents in the study area had awareness on the use mobile phones to communicate and access agricultural information such as production, market and weather related information which could have contributed to encourage more farmers to use mobile phones to communicate agricultural information. This is in line with Olumba and Rahji (2014) who reported that awareness promotes demand and force for rapid adoption and spread of agricultural innovations.

Furthermore, all of the respondents who had been provided with free mobile phone handsets had used mobile phones to communicate agricultural information. Provision of free mobile phone handset was statistically significant associated at $\rho \leq 0.001$, implying that it influenced the use of mobile phones to communicate agricultural information with extension agents. This indicates that provision of free mobile phone handsets increases the number of farmers to own and use mobile phones to communicate and access agricultural information and knowledge with extension agents could be contributed to increase production and farmers' incomes. According to Mtega and Ronald (2013), high cost of ICTs has limited accessibility of information services in rural areas.

Table 28: Institutional support factors influencing respondents use of mobile phones to communicate agricultural information (n=208)

Variables	Used mobile phones n(%)	Did not used n(%)	χ^2	ρ -value
Provision of institution support	135(64.9)	73(35.1)	55.165	0.000**
Awareness creation of mobile phone use in agriculture	130(64.0)	73(36.0)	47.268	0.000**
Provision of free mobile phone handsets	37(100.0)	0(0.0)	45.232	0.000**
Provision of free mobile phone airtime	69(62.2)	42(37.8)	13.437	0.000**
Provision of monthly subscription fee for mobile phone use in agriculture	51(100.0)	0(0.0)	64.976	0.000**
Provision of special budget for mobile phones network infrastructures	15(62.5)	9(37.5)	2.304	0.129 ns
Existence of sustainable mobile phones network	57(57.0)	43(43.0)	4.878	0.027*
Existence of policy for mobile phone use in agriculture	16(51.6)	15(48.4)	0.227	0.634 ns
Existence of regulations for mobile phones use in agricultures	15(45.5)	18(54.5)	0.062	0.804 ns

Note: *Statistically significant at 0.05, **Statistically significant at 0.01, ns = not statistically significant at $\rho > 0.05$, χ^2 Chi-square value.

Furthermore, results in Table 28 indicate that 62.2% of the respondents who had been provided with free airtime had used mobile phones to communicate agricultural information. Provision of free airtime was statistically significant associated at $\rho \leq 0.001$,

implying that it influenced the use of mobile phones to communicate agricultural information with extension agents. This result indicates that majority of farmers enabled to afford the cost of running mobile phones communication that could be attributed to frequently use to communicate agricultural information for improve production and productivity. Okeke *et al.* (2015) recommended that farmers should be encouraged to access and utilize ICTs by supporting them financially and materially.

Moreover, of all the respondents who had been provided with free monthly subscription fee had used mobile phones to communicate agricultural information. However, provision of free monthly subscription fee was statistically significant associated at $\rho \leq 0.001$, implying that it influenced the use of mobile phones to communicate agricultural information with extension agents. This result indicates to enhance the use and lower the cost of use mobile phones to the respondents which encouraged communication of agricultural information and reduced dependence of interpersonal oral contacts to access and share agricultural knowledge. According to FAO (2014) in Africa, family farmers spend between 11% and 27% of their monthly household incomes on mobile telephone use.

Still, more than three quarter, 62.5% of the respondents who had reported on the existence of special budget for mobile phones network infrastructures had used mobile phones to communicate agricultural information. However, provision of special budget for mobile phones network infrastructures was not statistically significant associated at $\rho \leq 0.129$, implying that it did not influence the use of mobile phones to communicate agricultural information by extension agents. This result indicates that distribution of network infrastructures is crucial in managing mobile phone use so much attention should be given

on the provision of special budget to increase distribution of mobile phones network infrastructures in rural areas that could be attributed to reach all categories of people living in rural area to benefit from accessing mobile phone services to shares and access to agricultural knowledge. According to Ahuja (2011) study in India, the government has also realized that with availability of vital ICT infrastructure it can improve the lives of the rural and underprivileged section of the society, especially those living below the poverty line.

Yet, more than half, 57% of the respondents who had reported the existence of sustainable mobile phones network infrastructure indicated to had used mobile phones to communicate agricultural information. However, the existence of sustainable mobile phones network infrastructure was statistically significant associated at $\rho \leq 0.027$, implying that it influenced the use of mobile phones to communicate agricultural information with extension agents. This result indicates that a sustainable network acts as potential to bridge the information divide existing in rural area between farmers and extension agents. According to Egbule *et al.* (2013), reported that availability of networks in the rural areas, have enhanced the use of mobile phones by rural dwellers who are predominantly farmers.

Similarly, as shown in Table 28, more than half, 51.6% of the respondents who had reported the existence of policy for mobile phone use in agriculture they had used mobile phones communicated agricultural information. However, the existence of policy for mobile phone use in agriculture was not statistically significant associated at $\rho \leq 0.634$, implying that it did not influence the use of mobile phones to communicate agricultural information with extension agents. This result indicates there is a limited policy guideline to support use of mobile phones in agricultural communication and farmers have not been

gaining up to the expected benefits from mobile phones use to increase agricultural production. According to Agwu *et al.* (2008) there is a need to have a National Agricultural Extension Policy on the use of ICTs with major emphasis on access, availability and use.

Additionally, 45.5% of the respondents who had been reported on the existence of regulations for mobile phone use in agriculture they used mobile phones to communicate agricultural information. However, the existence of regulations for mobile phone use in agriculture was not statistically significant associated at $\rho \leq 0.804$, implying that it did not influence the use of mobile phones to communicate agricultural information by extension agents. This result indicates there was no well-defined regulation for mobile phone use in agricultural extension services of using mobile phones to communicate agricultural information between extension agents and farmers.

In summary, on testing the null hypothesis III ($Ho:_3$) on Table 28, the chi-square test results of selected institutional support factors indicated that awareness creation, free mobile phone handset, free mobile phone airtime and free monthly subscription fee were highly statistically significant associated at $\rho \leq 0.001$ with the exception of sustainable mobile phone network at $\rho \leq 0.027$with the respondents' use of mobile phones to communicate agricultural information with extension agents. Implying that had influence on the use of mobile phones in the study area and hence, hence leading to reject the null hypothesis III ($Ho:_3$) which stated that, there is no statistically significant association of the institutional support provision and the use of mobile phones to communicate agricultural information with extension agents.

However, some institutional support factors tested found that had no statistically significant association with the use of mobile phones to communicate agricultural

information with extension agents were provision of special budget for mobile phones network infrastructure, existence of policy and existence of regulations for mobile phone use in agricultural communication. These factors failed to reject the null hypothesis III ($Ho:_3$). This result is in line with the diffusion of innovation theory which emphasizes that opportunities of the innovation to the member of social system have an influence on the acceptance and use of the innovation. This result is in line with what Diffusion of Innovation Theory and Technology Acceptance Model emphasized that socio-economic acceptance, opportunities and constraint of innovation influenced the users' acceptance or rejection of use the innovation as perceived ease to use and perceived usefulness.

The implication of these results is that, if the respondents were aware, given free mobile phone handsets, free airtime and free monthly subscription their chance of using mobile phones to communicate agricultural information with extension agents could also be increased. Hence, institutional support factors can influence and increase the number of farmers using mobile phones for seeking agricultural information. Furthermore, it is anticipated that provision of sustainable mobile phone network could lead to increased network coverage and increased use of mobile phone technology among the farming communities at a lower cost.

4.5 Challenges Facing Respondents on the Use of Mobile Phones to Communicate Agricultural Information with Extension Agents

To address the fifth objective of the study, the respondents were asked to indicate challenges that constrained them in using mobile phones to communicate agricultural information with extension agents. The four point Likert Scale (LS), from high (4), moderate (3), low (2) and none (1) are used to determine the magnitude of the challenges.

According to Ezeh (2013), Likert Scale is a tool used to make explicit decision on the feelings attached to a particular observed phenomenon from possible factors or variables. The challenges associated with the use of mobile phones were categorized into four groups as network challenges, operational challenges, human challenges and electricity challenges. Each response on Likert Scale was given a numerical value to reflect on the degree of agreement with the set statement. Therefore, a mean score of 2.50 derived from (4+3+2+1=10/4=2.50), thus a mean score below 2.50 was considered low, meaning that the challenge did not affect the use of mobile phones to communicate agricultural information with extension agents, and mean score of 2.50 and above was considered high and limited the use of mobile phones to communicate agricultural information with extension agents.

Based on the network challenges as shown in Table 29, respondents mentioned that there were only minor or non-existence network challenges on the use of mobile phones to communicate agricultural information with extension agents. All of the mean scores of network challenges were lower than the cut-off point of 2.50, meaning that network challenges did not significantly affect the use of mobile phones. This indicates that, there was enough telecommunication infrastructure and network coverage in the study areas that provides better signal/recipient to support farmers' use of mobile phones to communicate agricultural information with extension agents. The study results agree with those of Dankyi *et al.* (2007) in Ghana who reported that, most of the respondents indicated they had a fairly good mobile phone infrastructure. According to Agwu *et al.* (2008), lack of communication infrastructure and poor communication network were the serious constraints on the use of ICTs in India.

Furthermore, results of operation challenges in Table29 show that, high costs of mobile phones use ($\overline{x}$ = 3.46), high cost of buying mobile phone handset ($\overline{x}$ = 3.12), lack of technical support on use of mobile phones ($\overline{x}$ = 2.53), lack of training on mobile phone use in agriculture ($\overline{x}$ = 2.50), lack of policy on mobile phone use in agriculture ($\overline{x}$= 2.67) and high mobile phone calls taxes ($\overline{x}$ = 3.28), had the highest scores, that constrained the use of mobile phones to communicate agricultural information with extension agents. The findings are in line with those of Gichamba and Lukandu (2012), who reported that large proportion of the population cannot afford a mobile phone or any other mobile device that can be used for agricultural information. High tariff deductions from telecommunication companies were the major constraints on using mobile phones (Akinola, 2017). On the other hand, according to a study by Nyamba and Mlozi (2012), 29.4% of the respondents reported that mobile phones were too expensive in terms of buying and running costs, while Chhachhar *et al*. (2016) reported that the rate of mobile call was not considered expensive and people especially poor farmers were using it frequently in remote areas of developing countries.

As far as human challenges on using mobile phones to communicate agricultural information with extension agents as concerned, results show that, lack of know-how of mobile phone technology ($\overline{x}$ = 2.82) and low incomes of mobile phone users ($\overline{x}$ = 2.66), were the major constraints of using mobile phones to communicate agricultural information. This means that respondent' low incomes and lack of training on mobile phone technology and practical exposure to use of mobile phone applications was the major human limitations on the use of mobile phones to communicate agricultural information. This is in line with those of Okeke *et al.* (2015) who reported that inadequate capital for farmers and insufficient knowledge of ICTs including mobile phones affect the use of mobile phones. Likewise, according to Abdulwaheed *et al.* (2016) in Nigeria, access to training on mobile phone use might be an important factor to build farmers'

capacity, knowledge and skills which in turn can influence farmers positively on the use of mobile phones in agricultural communication.

Table 29: Challenges that limit respondents to use mobile phones to communicate agricultural information (n=383).

Challenges	Variables	Mean	SD
Network challenges	Inadequate mobile phone infrastructure	2.17	1.056
	Poor mobile phone network coverage	2.24	0.981
	Poor mobile phone signals	2.39	0.991
Operational challenges	High costs of mobile phone use	3.46*	0.774
	High cost of mobile phone maintenance	2.45	0.999
	High cost of purchasing mobile phone handset	3.12*	1.007
	Lack of technical support on mobile phone use	2.53*	1.045
	Lack of policies on mobile phone use in agriculture	2.50*	1.213
	Lack of training on mobile phone use in agriculture	2.67*	1.179
	High mobile phone call tariffs	3.28*	0.957
	High costs of mobile phone repairs	2.18	0.980
Human challenges	Gender differences on mobile phone use	1.63	0.880
	Lack of education (reading, writing)	2.01	1.155
	Lack of technical know-how on use of mobile phone	2.44	0.977
	Lack of know-how on mobile phone	2.82*	0.963
	Fear of technological changes	2.15	1.064
	Old age (>60years)	1.85	1.040
	Mobile phone language	2.43	1.132
	Fear of mobile phone use	1.70	1.017
	Low income of mobile phone users	2.66*	1.069
	Lack of legal framework for mobile phone use	2.38	1.200
Electricity challenges	Frequent power cut off	2.11	0.980
	Lack of electricity	2.64*	1.167
	Erratic power supply	2.33	1.052
	High cost of electricity installation	3.00*	1.102
	High cost of electric bills	2.89*	1.151

***Decision rule:** Mean score ($\overline{x}$) ≥ 2.50 = *Major challenge; Mean score ($\overline{x}$) < 2.50 = minor challenge.

As per challenges associated with availability of electricity, results shown in Table 29 revealed that, lack of electricity ($\overline{x}$ = 2.64), high cost of electricity installation ($\overline{x}$ = 3.00) and high costs of electric bills ($\overline{x}$ = 2.89) were the highest constraints affecting farmers on

the use of mobile phones in the study area. This implies that lack of access to electricity, cost of installation and cost of payment electric bill restricted farmers in frequently using mobile phones since they are unable to recharge their mobile phone batteries which is inhibits communication of agricultural information by using mobile phones. This was also noted by Falola and Adewumi (2012), who reported that lack of access to electricity supply restricted farmers to recharge their mobile phone batteries. In Tanzania, frequent power cuts is known to affect the use of mobile phones in agriculture (Mwakaje, 2010). And in rural areas, people often use battery chargers equipped with solar power facilities, others have power generators while others have to visit nearby towns for recharging their mobile phones (Mtega and Msungu, 2013).

Overall, all of 383 respondents, 49.1% they had been reported that challenges were not seriously affected the farmers' use of mobile phones to communicate agricultural information with extension agents, followed by few, 13% who reported that challenges were moderately affected, and 47.5% they had been reported that prevailing challenges were seriously limited their use of mobile phone to communicate agricultural information (Table 30).

Table 30: Overall challenges affecting respondents to use of mobile phones to communicate agricultural information with extension agents.

Level of challenges	**Frequency n**	**Percentage %**
Low 26 – 64 (less serious challenges)	188	49.1
Moderate 65 (mild challenges)	13	3.4
Higher 66 – 104 (serious challenges)	182	47.5
Total	**383**	**100**

This result indicates that more than half of the respondents were not seriously affected by the existing challenges that could be an opportunity to them on using available mobile phones services to increase their communication of agricultural information with

extension agents. This result is in line with what diffusion of innovation theory which emphasizes that constraint of innovation to the member of social system has an influence on the acceptance or rejection of the use of innovation.

4.5.1 Significance of the challenges affecting respondents use of mobile phones to communicate agricultural information with extension agents

On testing the null hypothesis IV (Ho_4), chi-square test was used to determine the statistically significant association of the challenges including network challenges, operational challenges, human challenges and electricity challenges and the use of mobile phones to communicate agricultural information with extension agents. As shown in Table 31, the chi-square test results revealed that all selected network challenges were highly statistically significant associated at $\rho \leq 0.001$ with the use of mobile phones to communicate agricultural information.

Table 31: Network challenges affect respondents use of mobile phones to communicate agricultural information with extension agents (n=383).

Variable	Not exist n (%)	Low n (%)	Moderate n (%)	High n (%)	χ^2	ρ -value
Inadequate mobile phones telecommunication infrastructures						
Used mobile phones	48(26.4)	38(20.9)	61(35.5)	35(19.2)	27.562	0.000**
Did not use mobile phones	89(44.3)	57(28.4)	40(19.9)	15(7.5)		
Poor mobile phone network coverage						
Used mobile phones	39(21.4)	43(23.6)	73(40.1)	27(14.8)	24.042	0.000**
Did not use mobile phones	74(36.8)	61(30.3)	57(28.4)	9(4.5)		
Poor mobile phone signal/recipients						
Used mobile phones	33(18.1)	42(23.1)	77(42.3)	30(16.5)	11.728	0.008**
Did not use mobile phones	61(30.3)	53(26.4)	68(33.8)	19(9.5)		

Note: **Statistically significant at $\rho \leq 0.01$, χ^2 Chi-square value

The implication of the result in (Table 31) is that inadequate mobile phones telecommunication infrastructures, poor mobile phone network coverage and poor mobile

phone signal/recipients highly limited the use of mobile phones in communicating agricultural information. This result is in line with those of Syiem and Raj (2015) in India, Nyamba and Mlozi (2012) in Tanzania and Gichamba and Lukandu (2012) in Kenya, all of whom reported that poor network coverage and low connectivity were major problems limiting the use of mobile phones to communicate agricultural information especially in the rural areas.

Furthermore, for operational challenges as shown in Table 32, the chi-square test results revealed that operational challenges that had statistically significant association with the use mobile phone was on high costs of mobile phones use at $\rho \leq 0.001$, high cost of purchasing mobile phone handset at $\rho \leq 0.028$, lack of technical support on use mobile phone at $\rho \leq 0.042$, lack of policies on mobile phone use in agriculture at $\rho \leq 0.027$ and high mobile phone call tariffs at $\rho \leq 0.001$.

This result indicated that high cost of mobile phones use, high cost of purchasing mobile phone handset, lack of technical support on use mobile phone, lack of policies on mobile phone use in agriculture and high mobile phone call tariffs had an implication on the effective use of mobile phones in communicating agricultural information with extension agents. However, the chi-square results in Table 32 show that there was no statistically significant association with use of mobile phones on high cost of mobile phone maintenance, lack of training on mobile phone use and high costs of repaired technical faults. This implies that variables did not limit the use of mobile phones to communicate agricultural information in the study area. According to Ofuoku *et al.* (2007), high cost of mobile phones, was not considered a serious constraint because there are relatively cheap ones these days that are easily affordable. Likewise, Adejoh *et al.* (2017), notes that inadequate capital is also a major problem in the use of mobile phone in communicating agricultural information.

Table 32: Operational challenges affect respondents use of mobile phones to communicate agricultural information to extension agents (n=383).

Variable	Not exist n(%)	Low n(%)	Moderate n(%)	High n(%)	χ^2	ρ -value
High costs of mobile phones use						
Used mobile phones	7(3.8)	14(7.7)	72(39.6)	89(48.9)	20.083	0.000**
Did not use mobile phones	6(3.0)	14(7.0)	40(19.9)	141(70.1)		
High cost of mobile phone maintenance						
Used mobile phones	33(18.1)	45(24.7)	73(40.1)	31(17.0)	7.468	0.058^{ns}
Did not use mobile phones	47(23.4)	66(32.8)	57(28.4)	31(15.4)		
High cost of purchasing mobile phone handset						
Used mobile phones	21(11.5)	19(10.9)	70(38.5)	72(39.6)	9.073	0.028*
Did not use mobile phones	22(10.9)	25(12.4)	50(24.9)	104(51.7)		
Lack of technical supports on use mobile phone						
Used mobile phones	35(19.2)	41(22.5)	58(31.9)	48(26.4)	8.229	0.042*
Did not use mobile phones	43(21.4)	67(33.3)	56(27.9)	35(17.4)		
Lack of policies on mobile phone use in agriculture						
Used mobile phones	61(33.5)	25(13.7)	40(22.0)	56(30.8)	0.192	0.027*
Did not use mobile phones	54(26.9)	51(25.4)	34(16.9)	62(30.8)		
Lack of training on mobile phone use						
Used mobile phones	38(20.9)	29(15.9)	51(28.0)	64(35.2)	4.286	0.232^{ns}
Did not use mobile phones	55(27.4)	38(18.9)	42(20.9)	66(32.8)		
High mobile phone call tariffs						
Used mobile phones	27(14.8)	13(7.1)	62(34.1)	80(44.0)	20.851	0.000**
Did not use mobile phones	9(4.5)	15(7.5)	49(24.4)	128(63.7)		
High costs of repaired technical faults						
Used mobile phones	57(31.3)	50(27.5)	58(31.9)	17(9.3)	0.600	0.896^{ns}
Did not use mobile phones	61(30.3)	62(30.8)	59(29.4)	19(9.5)		

Note: *Significant at ρ≤ 0.05, **Significant at ρ≤ 0.01, ns = not statistically significant at ρ> 0.05, χ^2 Chi-square value

Further, chi-square test results on human challenges as shown in Table 33 revealed that human challenges had statistically significant association on the use mobile phones. These included gender differences, fear of technological changes, fear of use of mobile phones and low income of mobile phone users. This means that challenges limited the use of mobile phones to communicate agricultural information with extension agents.

Table 33: Human challenges affecting respondents use of mobile phones to communicate agricultural information with extension agents (n=383).

Variable	Not exist n(%)	Low n(%)	Moderate n(%)	High n(%)	χ^2	ρ -value
Gender differences on use mobile phones						
Used mobile phones	125(68.7)	30(16.5)	21(11.5)	6(3.3)	10.051	0.018*
Did not use mobile phones	107(53.2)	46(22.9)	40(19.9)	8(4.0)		
Lack of education (reading and writing)						
Used mobile phones	39(21.4)	43(23.6)	73(40.1)	27(14.8)	0.661	0.882^{ns}
Did not use mobile phones	96(47.8)	40(19.9)	26(12.9)	39(19.4)		
Lack of technical know-how on use mobile phone						
Used mobile phones	42(23.1)	55(30.2)	57(31.3)	28(15.4)	1.981	0.576^{ns}
Did not use mobile phones	36(17.9)	62(30.8)	73(36.3)	30(14.9)		
Lack of know-how of mobile phone technology						
Used mobile phones	21(11.5)	49(29.9)	72(39.9)	40(22.0)	6.132	0.105^{ns}
Did not use mobile phones	20(10.0)	47(23.4)	67(33.3)	67(33.3)		
Fear of technological changes						
Used mobile phones	77(42.3)	47(25.8)	46(25.3)	12(6.6)	15.057	0.002*
Did not use mobile phones	63(31.3)	48(23.9)	51(25.4)	39(19.4)		
Elderly						
Used mobile phones	100(54.9)	36(19.8)	28(15.4)	18(9.9)	1.543	0.672^{ns}
Did not use mobile phones	99(49.3)	48(23.9)	31(15.4)	23(11.4)		
Mobile phone use language						
Used mobile phones	52(28.6)	53(29.1)	41(22.5)	36(19.8)	4.761	0.190^{ns}
Did not use mobile phones	51(25.4	53(26.4)	38(18.9)	59(29.4)		
Fear of use mobile phones						
Used mobile phones	123(67.6)	31(17.0)	20(11.0)	8(4.4)	12.275	0.006**
Did not use mobile phones	113(56.2)	33(16.4)	26(12.9)	29(14.4)		
Low income of mobile phone users						
Used mobile phones	34(18.7)	45(24.7)	63(34.6)	40(22.0)	11.328	0.010**
Did not use mobile phones	33(16.4)	58(28.9)	43(21.4)	67(33.3)		
Lack of legal framework of mobile phone use						
Used mobile phones	67(36.8)	29(15.9)	46(25.3)	40(22.0)	1.618	0.655^{ns}
Did not use mobile phones	69(34.3)	32(15.9)	45(22.4)	55(27.4)		

Note: *Statistically significant at $\rho \leq 0.05$, **Statistically significant at $\rho \leq 0.01$, ns = not statistically significant at 0.05, χ^2 Chi-square value.

Moreover, the chi-square test results for electricity challenges as shown in Table 34 show that there is a statistically significant effect on lack of electricity, erratic power supply and

high costs of electric bills at ρ≤ 0.001on the use of mobile phones. This indicated that the lack of electricity, erratic power supply, high cost of electricity installation and high costs of electric bills affect the use of mobile phones to communicate agricultural information in the study area that could be the reason of low use of mobile phones to communicate agricultural information in the study area since mobile phone communication rely on power supply for charging the mobile batteries.

Table 34: Electricity challenges affecting respondents' use of mobile phones to communicate agricultural information with extension agents (n=383).

Variable	Not exist n(%)	Low n(%)	Moderate n(%)	High n(%)	χ^2	ρ -value
Frequent power cuts						
Used mobile phones	56(30.8)	48(26.4)	61(33.5)	17(9.3)	6.833	0.077^{ns}
Did not used mobile phones	75(37.3)	65(32.3)	45(22.4)	16(8.0)		
Lack of electricity						
Used mobile phones	39(21.4)	43(23.6)	73(40.1)	27(14.8)	13.923	0.003**
Did not used mobile phones	60(29.9)	36(17.9)	40(19.9)	65(32.2)		
Erratic power supply						
Used mobile phones	41(22.5)	45(24.7)	66(36.3)	30(16.5)	19.225	0.000**
Did not used mobile phones	63(31.3)	68(33.8)	34(16.9)	36(17.9)		
High cost of electricity installation						
Used mobile phones	21(11.5)	20(11.0)	51(28.0)	90(49.5)	7.692	0.053^{ns}
Did not used mobile phones	39(19.4)	32(15.9)	47(23.4)	83(41.3)		
High costs of electric bills						
Used mobile phones	25(13.7)	15(8.2)	69(37.9)	73(40.1)	30.747	0.000**
Did not used mobile phones	51(25.4)	34(16.9)	31(15.4)	85(42.3)		

Note: **Statistically significant at ρ≤ 0.01, ns = not statistically significant at ρ> 0.05, χ^2 Chi-square value.

However, Table 34 shows high cost of electricity installation at ρ ≤ 0.053 and frequently power cuts at ρ = 0.077 off were not statistically significant associated with the mobile phone use to communicate agricultural information. This result implies that high cost of electricity installation and frequent power cuts did not affect the use of mobile phones to communicate agricultural information. The result is contrary to Adewumi *et al.* (2013) who reported that majority of the respondents face an epileptic power supply as major constraint to the use of ICTs in the study area.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

It is evident that various means and methods of communication are utilized to communicate and disseminate agricultural knowledge to farmers for improving agricultural production and productivity. Farmers need to be equipped with the up-to-date agricultural information to meet their demands for achieving high production and productivity. Extension agency also needed to put more emphasis to improve farmers' skills and knowledge to increase access and use of agricultural technologies for improving farming practices. Currently, mobile phones have been proven as an effective and efficient means of communicating and disseminating agricultural information to the farmers all over the world. Therefore, conclusions and recommendations of this study presented aimed at improving the use of mobile phones to communicate agricultural information. Despite these conclusions and recommendations, to ensure effective and efficient use of mobile phones as a means of communicating and disseminating of agricultural information those prevailing limitations should be resolved as recommended and further study should be conducted to explore the full potential of mobile phone use in extension services delivery.

5.1 Conclusion

Conclusively, study findings indicated that mobile phones have been inadequately used by farmers in communicating agricultural information to improve production and productivity due to various reasons as articulated in conclusions. Hence, the conclusions of the study findings presented here based on five major areas of study objectives.

In conclusion, among other factors, the use of mobile phone to communicate agricultural information in the study area found to be highly influenced by social and economic factors

of the farmers. The essential socio-demographic determinants were farmers' household size, average monthly income, type of farming practices, farming experiences and being the membership to SACCOS that enabled them to afford the use of mobile phones to communicate agricultural information. On the other hand, sex, age and education level limited use of mobile phones to communicate agricultural information, since the majority of farmers were male and older who had informal to formal primary education that cannot make effective use of mobile phones for improving production and productivity.

The study finding concluded that mobile phones use to communicate crop- and livestock-related information with extension agents in the study area was differed among the farmers, although both crop farmers and livestock keepers used mobile phones to seek advice from extension agents. The most important differentiation between them was depending on the type of farming practices, specific circumstances and purpose of the information demanded. This existing difference mainly observed between those who involved in livestock keeping and those involved in crop farming, whereas livestock keepers were more used mobile phones to communicate agricultural information. Further, study result shows that mobile phone helps farmers to interact with extension agents to acquire the variety of production, market and weather-related information per their needs although their frequency of use was low.

Conclusively, various mobile phone modes had been used in communicating agricultural information in the study area. The selection of mode to use was dependent on the type of crop grown or livestock kept and the specific information required to be communicated at a particular time. The preferable mode used by the farmers was the voice call due to easy to operate, quickly to respond and enable direct interaction with extension agents and

followed by use of SMSs. However, study findings further showed that some of the modes were in limited use by the farmers which was SMS together with voice call, voice messaging, pictures and video modes may be due to elderly, education, knowledge, skills and ability of farmers to interact and operate the mobile phone to write, record, send and receive SMS, voice messaging, videos and pictures as well as the type and capacity of mobile phones that they owned and used.

Moreover, the study findings concluded that farmers have the different level of awareness on use of mobile phones to communicate agricultural information through provision of various institutional supports from different institutions such as governmental and non-governmental organizations, international organizations and mobile phone companies to promote effective use of mobile phones to communicate agricultural information in the study area. However, farmers acknowledge on the support provided was helpful but their mobile phones use was not satisfactory as the support provided, may be due to lack of strategic intervention from district extension services and institutional support providers specifically on the enhancing mobile phones use in agricultural communication.

It can also be concluded that mobile phone use in communicating agricultural information in the study area faced a variety of challenges that limit their effective and efficient use although farmers continued to use mobile phones. The challenges such as network, human, operation and availability of electricity affecting farmers differently and have had higher implication on the mobile phones use. The most important constraints affecting farmers from using mobile phones was network infrastructures, higher call tariff and access to electricity services this lead to the low use of mobile phones for improving production and productivity. The critical existence of any of these challenges, farmers could not afford to

use and access to mobile phones services. However, farmers acknowledged that prevailing challenges was not much inhibited their use of mobile phone services to communicate agricultural information.

5.2 Recommendations

Therefore, based on the findings of this study, the following recommendations are made.

1. The District Agricultural Office in *Magharibi* A should train smallholder farmers to use mobile phones to communicate agricultural information with extension agents to increase farmers' production and productivity.

2. The *Magharibi* A District Agricultural Office should partner with mobile phone service providers to establish mobile phone agricultural information system (hotline) where farmers can ask and get answers for their farming problems.

3. The policy makers should create enabling policies and regulations that provide better participation of mobile phone service providers, agricultural extension service delivery and farmers to use mobile phone in communicating agricultural information.

4. The Government of Zanzibar should improve rural infrastructure particularly electricity installation and mobile phone network at the lower costs and reduce call tariffs to increase mobile phone use in rural area.

5. Farmers should change the way of communicating agricultural information and doing farming activities through the use of mobile phones to access timely and relevant information on agricultural production, marketing and weather updates.

5.3 Theoretical Implication

The author concluded that the use of DTI of Rogers' (1983, 2013), AST of DeSanctis and Poole (1994) and TAM of Davis' (1989) was a viable in researching use of mobile phones technology innovation in agriculture communication since all theories entailed with perception, belief and behavior change of individual or organization toward interaction, acceptance and use of the technology. Since DOI concerned with how innovation is accepted by social group and becomes part of the existing social system, TAM concerned with acceptance and use of new information system and how people accept and use the technology, whereas AST concerned with the use of information technology in a groups and organizations for their work create perception about the role and utility of the technology and on how can be applied to their activity. Hence, application the DOI, TAM and AST confirmed that mobile phones technology was accepted and used by the farming community in the study area and have a positive impact in communicating agricultural information as an appropriate means to overcome the shortage of BEOs and agricultural information barriers for the improvement of agricultural production and productivity.

5.4 Area for Further Research

This study recommends that further study be conducted to determine farmers and other agricultural stakeholders (such as fellow farmers, input suppliers, agro-dealers, marketers and meteorological sections, etc) use of mobile phones to communicate agricultural information with extension agents. This will provide better understanding on how farmers and other agricultural stakeholders use mobile phones communicate agricultural information with extension agents.

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APPENDICES

Appendix 1: Interview schedule for farmers

Interview schedule Number:……

ASSESSMENT OF THE USE FARMERS' USE OF MOBILE PHONES TO COMMUNICATE AGRICULTURAL INFORMATION WITH EXTENSION AGENTS IN *MAGHARIBI* DISTRICT, ZANZIBAR

This questionnaire is designed to collect information to investigate the use of mobile phones for communicating agricultural information by extension agents and farmers. Your responses will be treated as confidential.

Please, kindly respond to all items in these questionnaires. Put *(√)* alongside the options that are most applicable in the spaces provided.

District……..... Shehia……...Village……..

SECTION 1

1.0. Socio-demographic characteristics of the farmers

1.1. Personal information

Gender	Age	Marital status	Education Level
1. Male ☐ 2. Female ☐	1. 20–35 years ☐ 2. 36–55 years ☐ 3. > 55 years ☐	1. Single ☐ 2. Married ☐ 3. Divorced ☐ 4. Widowed ☐ 5. Widower ☐	1. No formal education ☐ 2. Primary education ☐ 3. Secondary education ☐ 4. Tertiary education ☐

1.2. House household information and major occupation

Household type	Household size	Major Occupation
1. Nuclear family ☐ 2. Extended family ☐	1. < 5 persons ☐ 2. 6 – 10 persons ☐ 3. > 10 persons ☐	1. Farming activities ☐ 2. Livestock keeping ☐ 3. Government employee ☐ 4. Private company employee ☐ 5. Business ☐

1.3. Membership of social group and Land ownership

Membership of social group	Land ownership	Land size	Source of land
1. Cooperativesociety □ 2. Farmers association□ 3. Farmer group □ 4. SACCOS □ 5. None □	1.Owned land □ 2.Didn't own land □	1. <1 acre □ 2. 1-3 acres □ 3. >3 acres □	1. Rented □ 2. Borrowed □ 3. Inherited □ 4. Bought □ 5. Government □

1.4. Type of farming practices and incomes information

Farming practice	Sources of incomes	Average monthly income
1. Crop growing □ 2. Livestock keeping □ 3. Mixed farming □	1.Crops selling □ 2.Livestock products selling □ 3.Livestock selling □ 4.Government employee □ 5.Private company employee □ 6.Business □	1. <100,000TZS□ 2. 100, 001 - 500,000TZS□ 3. > 500,001TZS□

1.5. List at least five (5) major crops you grow

Type of crop	Methods of crops growing		Land size (acre)			Crops growing experience				Reason for crops growing		
	1. Mono cropping	2. Inter cropping	1. <1 acre	2. 1-3 acres	3. >3 acres	1. <2 years	2. 2-5 years	3. 6-10 years	4. >10 years	1. Subsistence	2. Commercial	3. Both
1.……	□	□	□	□	□	□	□	□	□	□	□	□
2.……	□	□	□	□	□	□	□	□	□	□	□	□
3.……	□	□	□	□	□	□	□	□	□	□	□	□
4.……	□	□	□	□	□	□	□	□	□	□	□	□
5.……	□	□	□	□	□	□	□	□	□	□	□	□

1.6. List at least five (5) major livestock you have

Type of livestock	Method of livestock keeping			Land size (acre)			Livestock keeping Experience				Reason for livestock keeping		
	1. Intensive	2. Semi intensive	3. Extensive	1. <1 acre	2. 1-3 acres	3. >3 acres	1. <2 years	2. 2-5 years	3. 6-10 years	4. >10 years	1. Subsistence	2. Commercial	3. Both
1……	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2……	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3……	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
4……	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
5……	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

SECTION 2

2.0. Mobile phone ownership and use

When did you own mobile phone?	How many handsets do you have?	Type of mobile phone	Mobile phone capacity
1. <2012 ☐ 2. 2012 ☐ 3. 2013 ☐ 4. 2014 ☐ 5. 2015 ☐	1. 1 handset ☐ 2. 2-3 handsets ☐ 3. >4 handsets ☐	1. Ordinary ☐ 2. Smartphone ☐ 3. Both ☐	1. Photo shoot ☐ 2. Video record ☐ 3. Voice record ☐

2.1. Mobile phone service providers and daily expenses

Mobile phones Service provider	Daily cost of use mobile phones	Source of funds for mobile phones use
1. Zantel ☐ 2. TIGO ☐ 3. Vodacom ☐ 4. Airtel ☐	1. <5,00TZS per day ☐ 2. 5,01 -1,0,00TZS per day ☐ 3. 1,001-2,000TZS per day ☐ 4. > 2, 001TZS per day ☐	1. Him/herself ☐ 2. Children ☐ 3. Husband/wife ☐ 4. Sister/brother ☐ 5. Parents ☐ 6. Family member ☐ 7. Friends ☐

2.2. Mobile phones use to communicate agricultural information with extension agents

Use of mobile phones	Mobile phone use Experiences	Mobile phone language used	Use of mobile phone
1. Use ☐ 2. Do not use ☐	1. <2 years ☐ 2. 2 – 5 years ☐ 3. 6 - 10 years ☐ 4. >10 years ☐	1. Kiswahili ☐ 2. English ☐ 3. Both languages ☐	1. Making calls ☐ 2. Receiving calls ☐ 3. Sending SMSs ☐ 4. Receiving SMSs ☐ 5. Sending pictures ☐ 6. Receiving pictures ☐ 7. Sending video ☐ 8. Receiving video ☐ 9. Sending voice ☐ 10. Receiving voice ☐

2.3. How frequency use of mobile phones to communicate agricultural information with extension agents?

1. Daily ☐
2. Weekly ☐
3. Monthly ☐
4. When needed ☐
5. Never ☐

2.4. Who assist you to use mobile phones to communicate agricultural information with extension agents?

1. Him/herself ☐
2. Children ☐
3. Husband/wife ☐
4. Sister/brother ☐
5. Parents ☐
6. Family member ☐
7. Friends ☐
8. Neighbors ☐
9. Fellow farmers ☐

2.5. Who else do you communicate agricultural information with mobile phones?

1. Family members □
2. Friends □
3. Neighbors □
4. Fellow farmers □
5. Farmers associations □
6. Credits and loans organizations □

2.6. How frequency use mobile phones to communicate agricultural information to fellow farmers?

1. Daily □
2. Weakly □
3. Monthly □
4. When needed □
5. Never □

2.7. Mobile phone use to communicate crop- and livestock-related information with extension agents

2.7.1. Do you grow cassava? Yes □, No □. (If Not go to plantain growing)

Total area grown	**Cultural method**	**Experience in growing**	**Reason for growing**
1. <1 acre □ 2. 1-3 acres □ 3. >3 acres) □	1. Mono cropping □ 2. Inter cropping □	1. <2 years □ 2. 2 - 5 years □ 3. 6 - 10 years □ 4. >10 years □	1. Subsistence □ 2. Commercial □ 3. Both □

2.7.2. Do you use mobile phone to communicate cassava- related information with extension agents? Yes □, No □. (If Not go to plantain growing)

Activity	Practices	Response		Frequency of use			
		Yes	No	When needed	Monthly	Weekly	Daily
Farming practices	1. Land preparation	□	□	□	□	□	□
	2. Access to farm tools	□	□	□	□	□	□
	3. Access to farm labour	□	□	□	□	□	□
	4. Selection of planting materials	□	□	□	□	□	□
	5. Preparation of planting materials	□	□	□	□	□	□
	6. Planting methods	□	□	□	□	□	□
	7. Access to manure	□	□	□	□	□	□
	8. Manure application methods	□	□	□	□	□	□
	9. Weed control methods	□	□	□	□	□	□
	10. Insect pests control methods	□	□	□	□	□	□
	11. Disease control methods	□	□	□	□	□	□
	12. Harvesting methods	□	□	□	□	□	□
	13. Post-harvest methods	□	□	□	□	□	□
	14. Storage methods	□	□	□	□	□	□
	15. Access to credits	□	□	□	□	□	□
Marketing information	1. Access to market price	□	□	□	□	□	□
	2. Bargaining market price	□	□	□	□	□	□
	3. Market transport costs	□	□	□	□	□	□
	4. Purchase planting materials	□	□	□	□	□	□
	5. Purchase farm manure	□	□	□	□	□	□
	6. Purchase farm tools	□	□	□	□	□	□
	7. Sale crop produces	□	□	□	□	□	□
	8. Sale planting materials	□	□	□	□	□	□
Weather information	1. Proper time for planting	□	□	□	□	□	□
	2. Proper time for harvesting	□	□	□	□	□	□
	3. Onset of rainfall	□	□	□	□	□	□
	4. Alert to climatic changes	□	□	□	□	□	□
	5. Alert to insect-pests outbreak	□	□	□	□	□	□
	6. Alert to diseases outbreak	□	□	□	□	□	□
	7. Alert to drought occurrence	□	□	□	□	□	□
	8. Alert to flood occurrence	□	□	□	□	□	□

2.7.3. Mobile phone mode used to communicate cassava related information with extension agents

Activity	Practices	Mode of use					
		SMS	SMS and Call	Call	Voice message	Picture	Video
Farming practices	1. Land preparation	□	□	□	□	□	□
	2. Access to farm tools	□	□	□	□	□	□
	3. Access to farm labour	□	□	□	□	□	□
	4. Selection of planting materials	□	□	□	□	□	□
	5. Preparation of planting materials	□	□	□	□	□	□
	6. Planting methods	□	□	□	□	□	□
	7. Access to manure	□	□	□	□	□	□
	8. Manure application methods	□	□	□	□	□	□
	9. Weed control methods	□	□	□	□	□	□
	10. Insect pests control methods	□	□	□	□	□	□
	11. Disease control methods	□	□	□	□	□	□
	12. Harvesting methods	□	□	□	□	□	□
	13. Post-harvest methods	□	□	□	□	□	□
	14. Storage methods	□	□	□	□	□	□
	15. Access to credits	□	□	□	□	□	□
Marketing information	1. Access to market price	□	□	□	□	□	□
	2. Bargaining market price	□	□	□	□	□	□
	3. Market transport costs	□	□	□	□	□	□
	4. Purchase planting materials	□	□	□	□	□	□
	5. Purchase farm manure	□	□	□	□	□	□
	6. Purchase farm tools	□	□	□	□	□	□
	7. Sale crop produces	□	□	□	□	□	□
	8. Sale planting materials	□	□	□	□	□	□
Weather information	1. Proper time for planting	□	□	□	□	□	□
	2. Proper time for harvesting	□	□	□	□	□	□
	3. Onset of rainfall	□	□	□	□	□	□
	4. Alert to climatic changes	□	□	□	□	□	□
	5. Alert to insect-pests outbreak	□	□	□	□	□	□
	6. Alert to diseases outbreak	□	□	□	□	□	□
	7. Alert to drought occurrence	□	□	□	□	□	□
	8. Alert to flood occurrence	□	□	□	□	□	□

2.7.4. Do you grow plantain? Yes □, No □. (If Not go to dairy cattle)

Total area grown	Cultural method	Experience in growing	Reason for growing
1. <1 acre □ 2. 1-3 acres □ 3. >3 acres) □	1. Mono cropping □ 2. Inter cropping □	1. <2 years □ 2. 2 - 5 years □ 3. 6 - 10 years □ 4. >10 years □	1. Subsistence □ 2. Commercial □ 3. Both □

2.7.5. Do you use mobile phone to communicate plantain- related information with extension agents? Yes □, No □. (If Not go to dairy cattle)

Activity	Practices	Response		Frequency of use			
		Yes	No	When needed	Monthly	Weekly	Daily
Farming practices	1. Land preparation	□	□	□	□	□	□
	2. Access to farm tools	□	□	□	□	□	□
	3. Access to farm labour	□	□	□	□	□	□
	4. Selection of planting materials	□	□	□	□	□	□
	5. Preparation of planting materials	□	□	□	□	□	□
	6. Planting methods	□	□	□	□	□	□
	7. Access to manure	□	□	□	□	□	□
	8. Manure application methods	□	□	□	□	□	□
	9. Weed control methods	□	□	□	□	□	□
	10. Insect pests control methods	□	□	□	□	□	□
	11. Disease control methods	□	□	□	□	□	□
	12. Harvesting methods	□	□	□	□	□	□
	13. Post-harvest methods	□	□	□	□	□	□
	14. Storage methods	□	□	□	□	□	□
	15. Access to credits	□	□	□	□	□	□
Marketing information	1. Access to market price	□	□	□	□	□	□
	2. Bargaining market price	□	□	□	□	□	□
	3. Market transport costs	□	□	□	□	□	□
	4. Purchase planting materials	□	□	□	□	□	□
	5. Purchase farm manure	□	□	□	□	□	□
	6. Purchase farm tools	□	□	□	□	□	□
	7. Sale crop produces	□	□	□	□	□	□
	8. Sale planting materials	□	□	□	□	□	□
Weather information	1. Proper time for planting	□	□	□	□	□	□
	2. Proper time for harvesting	□	□	□	□	□	□
	3. Onset of rainfall	□	□	□	□	□	□
	4. Alert to climatic changes	□	□	□	□	□	□
	5. Alert to insect-pests outbreak	□	□	□	□	□	□
	6. Alert to diseases outbreak	□	□	□	□	□	□
	7. Alert to drought occurrence	□	□	□	□	□	□
	8. Alert to flood occurrence	□	□	□	□	□	□

2.7.6. Mobile phone mode used to communicate plantain-related information with extension agents.

Activity	Practices	Mode of use					
		SMS	SMS and Call	Call	Voice message	Picture	Video
Farming practices	1. Land preparation	□	□	□	□	□	□
	2. Access to farm tools	□	□	□	□	□	□
	3. Access to farm labour	□	□	□	□	□	□
	4. Selection of planting materials	□	□	□	□	□	□
	5. Preparation of planting materials	□	□	□	□	□	□
	6. Planting methods	□	□	□	□	□	□
	7. Access to manure	□	□	□	□	□	□
	8. Manure application methods	□	□	□	□	□	□
	9. Weed control methods	□	□	□	□	□	□
	10. Insect pests control methods	□	□	□	□	□	□
	11. Disease control methods	□	□	□	□	□	□
	12. Harvesting methods	□	□	□	□	□	□
	13. Post-harvest methods	□	□	□	□	□	□
	14. Storage methods	□	□	□	□	□	□
	15. Access to credits	□	□	□	□	□	□
Marketing information	1. Access to market price	□	□	□	□	□	□
	2. Bargaining market price	□	□	□	□	□	□
	3. Market transport costs	□	□	□	□	□	□
	4. Purchase planting materials	□	□	□	□	□	□
	5. Purchase farm manure	□	□	□	□	□	□
	6. Purchase farm tools	□	□	□	□	□	□
	7. Sale crop produces	□	□	□	□	□	□
	8. Sale planting materials	□	□	□	□	□	□
Weather information	1. Proper time for planting	□	□	□	□	□	□
	2. Proper time for harvesting	□	□	□	□	□	□
	3. Onset of rainfall	□	□	□	□	□	□
	4. Alert to climatic changes	□	□	□	□	□	□
	5. Alert to insect-pests outbreak	□	□	□	□	□	□
	6. Alert to diseases outbreak	□	□	□	□	□	□
	7. Alert to drought occurrence	□	□	□	□	□	□
	8. Alert to flood occurrence	□	□	□	□	□	□

2.7.7. Do you keep dairy cattle? Yes □, No □. (If Not go to chicken)

Types of dairy cattle kept	Stock size	Method of keeping	Total area used	Experience in keeping	Reason for keeping
1. Local Z□ 2. Cross □ 3. Exotic □	1. ……. 2. ……. 3. …….	1. Intensive □ 2. Semi int. □ 3. Extensive□	1. <1 acre □ 2. 1-3 acres□ 3. >3 acres □	1. <2 years □ 2. 2 - 5 years □ 3. 6 - 10 years□ 4. >10 years □	1. Subsistence □ 2. Commercial □ 3. Both □

2.7.8. Do you use mobile phone to communicate dairy cattle - related information with extension agents? (If Not go to chicken)

Activity	Practices	Response		Frequency of use			
		Yes	No	When needed	Monthly	Weekly	Daily
Farming practices	1. Dairy shed construction	☐	☐	☐	☐	☐	☐
	2. Dairy feeding techniques	☐	☐	☐	☐	☐	☐
	3. Dairy farm equipments	☐	☐	☐	☐	☐	☐
	4. Improved dairy breed stock	☐	☐	☐	☐	☐	☐
	5. Improve dairy breeding techniques	☐	☐	☐	☐	☐	☐
	6. Dairy insect-pest control methods	☐	☐	☐	☐	☐	☐
	7. Dairy diseases control methods	☐	☐	☐	☐	☐	☐
	8. Dairy diseases treatments	☐	☐	☐	☐	☐	☐
	9. Dairy vaccination	☐	☐	☐	☐	☐	☐
	10. Dairy milking techniques	☐	☐	☐	☐	☐	☐
	11. Dairy post-harvest handling	☐	☐	☐	☐	☐	☐
	12. Dairy storage techniques	☐	☐	☐	☐	☐	☐
	13. Access to dairy labour	☐	☐	☐	☐	☐	☐
	14. Access to dairy credits	☐	☐	☐	☐	☐	☐
Marketing information	1. Access to dairy market price	☐	☐	☐	☐	☐	☐
	2. Bargaining dairy market price	☐	☐	☐	☐	☐	☐
	3. Dairy market transport costs	☐	☐	☐	☐	☐	☐
	4. Purchase dairy feeds	☐	☐	☐	☐	☐	☐
	5. Purchase dairy medicines	☐	☐	☐	☐	☐	☐
	6. Purchase dairy vaccination	☐	☐	☐	☐	☐	☐
	7. Purchase dairy farm equipments	☐	☐	☐	☐	☐	☐
	8. Purchase dairy animals	☐	☐	☐	☐	☐	☐
	9. Sale dairy animals	☐	☐	☐	☐	☐	☐
	10. Sale dairy milk	☐	☐	☐	☐	☐	☐
	11. Sale dairy manure	☐	☐	☐	☐	☐	☐
Weather information	1. Onset of rainfall	☐	☐	☐	☐	☐	☐
	2. Period of high feed intake	☐	☐	☐	☐	☐	☐
	3. Period of high water intake	☐	☐	☐	☐	☐	☐
	4. Alert to climatic changes	☐	☐	☐	☐	☐	☐
	5. Peak period of disease infestation	☐	☐	☐	☐	☐	☐
	6. Peak period of insect-pests attack	☐	☐	☐	☐	☐	☐
	7. Alert to dairy vaccination period	☐	☐	☐	☐	☐	☐
	8. Alert to high temperature period	☐	☐	☐	☐	☐	☐
	9. Alert to high humidity period	☐	☐	☐	☐	☐	☐

2.7.9. Mobile phone mode used to communicate dairy cattle-related information with extension agents

Activity	Practices	Mode of use					
		SMS	SMS and Call	Call	Voice message	Picture	Video
Farming practices	1. Dairy shed construction	□	□	□	□	□	□
	2. Dairy feeding techniques	□	□	□	□	□	□
	3. Dairy farm equipments	□	□	□	□	□	□
	4. Improved dairy breed stock	□	□	□	□	□	□
	5. Improve dairy breeding techniques	□	□	□	□	□	□
	6. Dairy insect-pest control methods	□	□	□	□	□	□
	7. Dairy diseases control methods	□	□	□	□	□	□
	8. Dairy diseases treatments	□	□	□	□	□	□
	9. Dairy vaccination	□	□	□	□	□	□
	10. Dairy milking techniques	□	□	□	□	□	□
	11. Dairy post-harvest handling	□	□	□	□	□	□
	12. Dairy storage techniques	□	□	□	□	□	□
	13. Access to dairy labour	□	□	□	□	□	□
	14. Access to dairy credits	□	□	□	□	□	□
Marketing information	1. Access to dairy market price	□	□	□	□	□	□
	2. Bargaining dairy market price	□	□	□	□	□	□
	3. Dairy market transport costs	□	□	□	□	□	□
	4. Purchase dairy feeds	□	□	□	□	□	□
	5. Purchase dairy medicines	□	□	□	□	□	□
	6. Purchase dairy vaccination	□	□	□	□	□	□
	7. Purchase dairy farm equipments	□	□	□	□	□	□
	8. Purchase dairy animals	□	□	□	□	□	□
	9. Sale dairy animals	□	□	□	□	□	□
	10. Sale dairy milk	□	□	□	□	□	□
	11. Sale dairy manure	□	□	□	□	□	□
Weather information	1. Onset of rainfall	□	□	□	□	□	□
	2. Period of high feed intake	□	□	□	□	□	□
	3. Period of high water intake	□	□	□	□	□	□
	4. Alert to climatic changes	□	□	□	□	□	□
	5. Peak period of disease infestation	□	□	□	□	□	□
	6. Peak period of insect-pests attack	□	□	□	□	□	□
	7. Alert to dairy vaccination period	□	□	□	□	□	□
	8. Alert to high temperature period	□	□	□	□	□	□
	9. Alert to high humidity period	□	□	□	□	□	□

2.7.10. Do you keep chicken? Yes □, No □. (If Not go to institution support)

Types of chicken kept	Stock size	Method of keeping	Total area used	Experience in keeping	Reason for keeping
1. Layers □ 2. Broilers □ 3. Local □	1. ……. 2. ……. 3. …….	1. Intensive □ 2. Semi int. □ 3. Extensive□	1. <1 acre □ 2. 1-3 acres□ 3. >3 acres □	1. <2 years □ 2. 2 - 5 years □ 3. 6 - 10 years□ 4. >10 years □	1. Subsistence □ 2. Commercial □ 3. Both □

2.7.11. Do you use mobile phone to communicate chicken - related information with extension agents? Yes □, No □. (If Not go to institution support)

Activity	Practices	Response		Frequency of use			
		Yes	No	When needed	Monthly	Weekly	Daily
Farming practices	1. Chicken shed construction	□	□	□	□	□	□
	2. Chicken feeding techniques	□	□	□	□	□	□
	3. Chicken y farm equipments	□	□	□	□	□	□
	4. Improved chicken breed stock	□	□	□	□	□	□
	5. Improve chicken breeding techniques	□	□	□	□	□	□
	6. Chicken insect-pest control methods	□	□	□	□	□	□
	7. Chicken diseases control methods	□	□	□	□	□	□
	8. Chicken diseases treatments	□	□	□	□	□	□
	9. Chicken vaccination	□	□	□	□	□	□
	10. Chicken post-harvest handling	□	□	□	□	□	□
	11. Chicken storage techniques	□	□	□	□	□	□
	12. Access to chicken labour	□	□	□	□	□	□
	13. Access to chicken credits	□	□	□	□	□	□
Marketing information	1. Access to dairy market price	□	□	□	□	□	□
	2. Bargaining chicken market price	□	□	□	□	□	□
	3. Chicken market transport costs	□	□	□	□	□	□
	4. Purchase chicken feeds	□	□	□	□	□	□
	5. Purchase chicken medicines	□	□	□	□	□	□
	6. Purchase chicken vaccination	□	□	□	□	□	□
	7. Purchase chicken farm equipments	□	□	□	□	□	□
	8. Purchase day-old-chicken	□	□	□	□	□	□
	9. Sale chicken	□	□	□	□	□	□
	10. Sale chicken eggs	□	□	□	□	□	□
	11. Sale chicken manure	□	□	□	□	□	□
Weather information	1. Onset of rainfall	□	□	□	□	□	□
	2. Period of high feed intake	□	□	□	□	□	□
	3. Period of high water intake	□	□	□	□	□	□
	4. Alert to climatic changes	□	□	□	□	□	□
	5. Peak period of disease infestation	□	□	□	□	□	□
	6. Peak period of insect-pests attack	□	□	□	□	□	□
	7. Alert to chicken vaccination period	□	□	□	□	□	□
	8. Alert to high temperature period	□	□	□	□	□	□
	9. Alert to high humidity period	□	□	□	□	□	□

2.7.12. Mobile phone mode used to communicate chicken-related information with extension agents

Activity	Practices	Mode of use					
		SMS	SMS and Call	Call	Voice message	Picture	Video
Farming practices	1. Chicken shed construction	☐	☐	☐	☐	☐	☐
	2. Chicken feeding techniques	☐	☐	☐	☐	☐	☐
	3. Chicken y farm equipments	☐	☐	☐	☐	☐	☐
	4. Improved chicken breed stock	☐	☐	☐	☐	☐	☐
	5. Improve chicken breeding techniques	☐	☐	☐	☐	☐	☐
	6. Chicken insect-pest control methods	☐	☐	☐	☐	☐	☐
	7. Chicken diseases control methods	☐	☐	☐	☐	☐	☐
	8. Chicken diseases treatments	☐	☐	☐	☐	☐	☐
	9. Chicken vaccination	☐	☐	☐	☐	☐	☐
	10. Chicken post-harvest handling	☐	☐	☐	☐	☐	☐
	11. Chicken storage techniques	☐	☐	☐	☐	☐	☐
	12. Access to chicken labour	☐	☐	☐	☐	☐	☐
	13. Access to chicken credits	☐	☐	☐	☐	☐	☐
Marketing information	1. Access to dairy market price	☐	☐	☐	☐	☐	☐
	2. Bargaining chicken market price	☐	☐	☐	☐	☐	☐
	3. Chicken market transport costs	☐	☐	☐	☐	☐	☐
	4. Purchase chicken feeds	☐	☐	☐	☐	☐	☐
	5. Purchase chicken medicines	☐	☐	☐	☐	☐	☐
	6. Purchase chicken vaccination	☐	☐	☐	☐	☐	☐
	7. Purchase chicken farm equipments	☐	☐	☐	☐	☐	☐
	8. Purchase day-old-chicken	☐	☐	☐	☐	☐	☐
	9. Sale chicken	☐	☐	☐	☐	☐	☐
	10. Sale chicken eggs	☐	☐	☐	☐	☐	☐
	11. Sale chicken manure	☐	☐	☐	☐	☐	☐
Weather information	1. Onset of rainfall	☐	☐	☐	☐	☐	☐
	2. Period of high feed intake	☐	☐	☐	☐	☐	☐
	3. Period of high water intake	☐	☐	☐	☐	☐	☐
	4. Alert to climatic changes	☐	☐	☐	☐	☐	☐
	5. Peak period of disease infestation	☐	☐	☐	☐	☐	☐
	6. Peak period of insect-pests attack	☐	☐	☐	☐	☐	☐
	7. Alert to chicken vaccination period	☐	☐	☐	☐	☐	☐
	8. Alert to high temperature period	☐	☐	☐	☐	☐	☐
	9. Alert to high humidity period	☐	☐	☐	☐	☐	☐

SECTION 3

3.0. Institutional support influence the use of mobile phones to communicate agricultural information

3.1. Is there any institutional supports provided to influence your use of mobile phones to communicate agricultural information? Yes □, No □.

3.2. If Yes, which institution that provide support to use mobile phones to communicate agricultural information?

Institutions	**Institution name**
1. Government organizations □	1. ……
2. Non-governmental organizations □	2. ……
3. International organizations □	3. ……..…..
4. Mobile phone companies □	4. ……

3.3. What are the supports provided to enable you to use mobile phones to communicate agricultural information?

1. Awareness creation on using mobile phones to communicate agriculture information □
2. Provision of free mobile phones handset □
3. Provision of free mobile phones airtime □
4. Provision of monthly subscription fee for mobile phones use □
5. Provision of loans for purchasing mobile phones □
6. Provision of budget for mobile network infrastructures □
7. Provision of mobile phones telecommunication network □
8. Formulation of policies for mobile phone use in agriculture □
9. Regulations for mobile phone use in agriculture communication □

3.4. Are the supports provided help you in using mobile phones to communicate agricultural information?

1. Very helpful □
2. Helpful □

3. Somehow □
4. Not helpful □

SECTION 4

4.0. Challenges faced farmers limit the use of mobile phones to communicate agricultural information

4.1. What are the challenges that limit you in using mobile phone to communicate agricultural information?

Challenge	Limitation	Magnitude of challenge			
		Not exist	Low	Moderate	Higher
Network challenges	1. Inadequate mobile phones telecom infrastructures	□	□	□	□
	2. Poor mobile phone network coverage	□	□	□	□
	3. Poor mobile phone signal/recipients	□	□	□	□
Operational challenges	1. High costs of mobile phones use	□	□	□	□
	2. High cost of mobile phone maintenance	□	□	□	□
	3. High cost of purchasing mobile phone handset	□	□	□	□
	4. Lack of technical supports on use mobile phone	□	□	□	□
	5. Lack of policies on mobile phone use in agriculture	□	□	□	□
	6. Lack of trainings on mobile phone use in agriculture	□	□	□	□
	7. High mobile phone calls tariffs	□	□	□	□
	8. High costs of repair technical faults	□	□	□	□
Human challenges	1. Gender differences on use mobile phones	□	□	□	□
	2. Lack of education (reading and writing)	□	□	□	□
	3. Lack of technical know-how on use mobile phone	□	□	□	□
	4. Lack of know-how of mobile phone technology	□	□	□	□
	5. Fear of technological changes	□	□	□	□
	6. Elderly	□	□	□	□
	7. Mobile phone language	□	□	□	□
	8. Fear of use mobile phones	□	□	□	□
	9. Low income of mobile phone users	□	□	□	□
	10. Lack of legal framework of mobile phone use	□	□	□	□
Electricity challenges	1. Frequent power cut off	□	□	□	□
	2. Lack of electricity	□	□	□	□
	3. Erratic power supply	□	□	□	□
	4. High cost of electricity installation	□	□	□	□
	5. High costs of electric bills	□	□	□	□

>>>>>>>>Thank you for your cooperation<<<<<<<<

Appendix 2: Interview Guide for Focus Group Discussion

Date …… Time…….

District …….. Shehia……..……

No.	Items	
1.	Do you use mobile phone to communicate agricultural information with extension agents? Yes □, No □.	□
2.	i. If No., Why……	□
3.	If, Yes. What types of related information do you communicate with extension agents? (cassava, plantain, dairy cattle or chicken)	□
4.	Which information do you communicated on? i. Production…….. ii. Market…… iii. Weather……..	□
5.	How frequency does you use mobile phones to communicate cassava, plantain, dairy cattle and chicken related information with extension agents? (daily, weekly, monthly or when needed) i. Cassava…….. ii. Plantain…….. iii. Dairy cattle…… iv. Chicken……..	□
6.	Which mobile phones modes do you use to communicate cassava, plantain, dairy cattle and chicken related information with extension agents? (SMS only, Call and SMS, Voice massage, Picture or video) i. Production…….. ii. Market…… iii. Weather……..	□
7.	Are there any institution support provided on using of mobile phones to communicate agricultural information to extension? Yes □, No □.	□
8.	If Yes, What are the institutions provide supports on using mobile phones? i. Government……... ii. NGOs…… iii. International organization...……...	□

	iv. Mobile phone companies……...	
9.	What are the supports provided from each institution you mentioned? (awareness, free airtime, free mobile phones, loans, free monthly subscription, sustainable network, budget for network infrastructures, policies and regulations) i. Government…….. ii. NGOs…..…….. iii. International organization…..…….. v. Mobile phone companies……..……	□
10.	Are the supports given helpful to you? i. Very helpful……... ii. Helpful……... iii. Somehow helpful…….…….. iv. Not helpful…….....……...	□
11.	Have you faced any challenges upon using mobile phones to communicate agricultural information with extension agents? Yes □, No □.	□
12.	If Yes, what are those challenges that limit your effective use of mobile phones? (network, operation, human or electricity)	□
13.	Mention the challenges faced you based on: i. Network challenges…… ii. Operation challenges……..... iii.Human challenges…….. iv.Electricity challenges…….	□
14.	What is your opinion for improve use of mobile phones in communicating agriculture information with extension agents?	□

>>>>>>>>***Thank you for your cooperation***<<<<<<<<

Appendix 3: Checklist for Key Informants (DADO and SMSs)

Name…….Sex: Male □, Female □.

Title……Mobile No…..…..…….

Organization……..... District……..

No.	Items	
1.	Do you use mobile phones to communicate agricultural information with farmers? Yes □, No □.	□
2.	i. If No. Why……	□
3.	If, Yes. What types of crops or livestock related information you communicate using mobile phones? (cassava, plantain, dairy cattle or chicken)	□
4.	What is the information communicate on production, market and weather information with farmers? i. Production…… ii. Market…….. iii. Weather……	
5.	How frequency does you use mobile phones to communicate crops or livestock related information with farmers? (daily, weekly, monthly or when needed) i. Production…….. ii. Market…… iii. Weather……..	□
6.	Which mobile phones modes do you use to communicate crops or livestock related information with farmers? (SMS only, Call only, SMS	□

	together with Call, voice massage, picture or video mode) i. Production…….. ii. Market…… iii. Weather…...……...	
7.	Are there any institution support provided to enable using of mobile phones to communicate agricultural information with farmers? Yes □, No □.	□
8.	If Yes, which institutions provide supports? i. Government……... ii. NGOs……. iii. International organization...…….. iv. Mobile phone companies……..	□
9.	What are the supports provided to enable use of mobile phones to communicate with farmers? (awareness, free airtime, free monthly subscription fee, free mobile phones, loans to purchase mobile phones, sustainable network, budget for network infrastructures, policies and regulation).	□
10.	Are the supports provided helpful on using mobile phones to communicate agricultural information with farmers? v. Very helpful…….. vi. Helpful……... vii. Somehow helpful……. viii. Not helpful…….....……...	□
11.	Have you faced any challenges upon using mobile phones to communicate agricultural information with farmers? Yes □, No □.	□
12.	If Yes, what are those challenges that limit your effective use of mobile phones? (network, operation, human or electricity)	□
13.	Mention the challenges faced you based on: i. Network challenges……... ii. Operation challenges……. iii. Human challenges…….. iv. Electricity challenges…….	□

14.	What is your opinion for improve use of mobile phones to communicate agriculture information with farmers?	□

>>>>>>>>***Thank you for your cooperation***<<<<<<<<