UNIVERSITY OF KWAZULU-NATAL

THE ROLE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY IN IMPROVING FOOD SECURITY IN KWAZULU-NATAL

By

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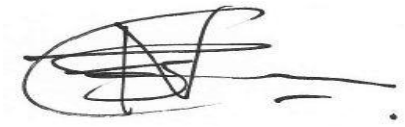
Signed: 

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Glossary of Acronyms

ICT	Information Communication and Technology
GIS	Geographic Information Systems
HFIAS	Household Food Insecurity Access Scale
PA	Precision Agriculture
DoA	Department of Agriculture
GDP	Gross Domestic Product
MDG	Millennium Development Goal
SDG	Sustainable Development Goals
DNA	Deoxyribonucleic Acid
UN	United Nations
SSA	Sub Saharan Africa
WTO	World Trade Organisation
FAO	Food and Agriculture Office
RFID	Radio-frequency identification
KMS	Knowledge Management Systems
IK	Indigenous Knowledge
KZN	KwaZulu-Natal

Abstract

This thesis explored the role of Information and Communications Technology in improving food security. The study was conducted in the South African context and is based on KwaZulu-Natal Province. It investigated the factors that impacted and contributed towards the adoption and diffusion of Information and Communications Technology amongst smallholder farmers. The study aimed to contribute to reducing food insecurity in South Africa using Information and Communications Technology. The outcome of this study highlighted important factors that need to be taken into account when considering ICT's influence in food security.

This exploratory research study took an interdisciplinary approach combining the disciplines of Information Systems and Agriculture and making use of quantitative methods of analysis. Data from a sample of 533 smallholder farmers and 41 agricultural extension officers from the four local municipalities in the district municipality of iLembe were collected using a questionnaire.

This study makes use of the five main constructs from Rogers Diffusion of Innovation (DOI) theory, Hofstede's cultural dimensions theory and the technology acceptance model (TAM) to develop a model to better understand the role of ICTs in food security in KwaZulu-Natal. The key findings that emerged in the South African context were that ICT's play an important role in reducing food insecurity. The study also puts forward the proposition that ICT adoption in food security is associated with culture, perceived usefulness and perceived ease of use of the ICT innovation. However, there were no associations found with the constructs, attributes of innovation and nature of the social system.

The growing population of people living in extreme hunger worldwide has become a matter of global concern. The World Bank highlights the importance of smallholder farming in increasing the productivity levels in the agricultural sector that in turn has the potential to stimulate economic growth in other sectors of a the economy of a country. It is in attempts to stimulate increased productivity of smallholder farmers and hence reducing food insecurity that ICT's are being incorporated in farming practices. It is this gap in literature that this research makes a contribution. While the literature points to many studies relating to ICT adoption and diffusion, the role of ICT's in food security has not been studied in detail. Furthermore, there have not been any studies that looked at the relationship between smallholder farmers and extension officers in relation to ICT's. A further gap in the literature highlighted there were no recent studies that investigated specific ICT's such as GIS and Knowledge Management Systems and their role on food security. This study made the following unique contribution to the existing body of knowledge:

- The identification of constructs that influence ICT adoption in food security amongst smallholder farmers in KwaZulu-Natal
- The identification of the determinants of ICT's in food security in KwaZulu-Natal
- The study provides empirical evidence regarding ICT influence on Food Security
- The development of a proposed theoretical model for understanding diffusion and adoption of ICT's and its role on food security

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CHAPTER 1

INTRODUCTION

An introduction of Information and Communications Technology and Food Security

"The communications revolution has given millions of people both a wider and more detailed understanding of the world. Because of technology, ordinary citizens enjoy access to information that formerly was available only to elites and nation-states. One consequence of this change is that citizens have become acutely conscious of environmental destruction, entrenched poverty, health catastrophes, human rights abuses, failing education systems, and escalating violence. Another consequence is that people possess powerful communication tools to coordinate efforts to attack those problems."

(Bornstein, 2007, p. 7)

1.1 Introduction

On 16 January 2014, the Food Safety Authority of Ireland made a startling announcement that it had found that beef burgers contained traces of equine DNA and in some cases filler products and readymade meals were found to contain horse meat ranging from 29% to 100% (van Vark et al., 2013). This revelation which David Cameron (The Guardian, 2013) referred to as a "very shocking story" caused panic in the food retail industry to an extent that big food retail chains such as Burger King switched their suppliers as a precautionary measure. This scandal spread beyond the Irish borders affecting other countries in the EU. This scandal is not the first of its kind as food safety related issues have been the subject of concern in society (Fish, Lobley, & Winter, 2013). In the 1980's the Italian food industry underwent a revolution after a methanol wine scandal in which it was found that methanol was mixed into a low priced wine (Brunori, Malandrin, & Rossi, 2013). The existence of numerous food recalls in countries where high standards of food safety are implemented (USDA, 2014) are an example of measures taken to control these scandals. These standards do not always translate into compliance as can be seen in the horsemeat scandal. Meat species substitution and adulteration are not limited to the developed world and are also commonplace in Africa.

This problem of food safety in Africa is compounded by the underdevelopment of compliance organisations and the consequent weakness in standards implementation. In 2013 in Kenya, it was reported that donkey meat was being passed off as beef (van Vark et al., 2013) and in South Africa, within the same week as the Kenyan revelation, a study revealed that 68% of samples from a total of 139 samples taken from retail outlets and butcheries in the country contained undeclared species such as

donkey, goat and water buffalo in the processed meat products (Cawthorn, Steinman, & Hoffman, 2013). The growing global population has had a ripple effect in terms of an increasing demand for meat products, and it is this demand and the large profits to be made that has led some suppliers to comprise compliance and standards (Jain, Kumar, & Singla, 2014; van Vark et al., 2013).

While the world is focused on the food safety aspect of food security brought on by these scandals, the real issue of concern should be hunger. High population growth is expected to continue unabated in underdeveloped nations of the world (Bruce & Pickett, 2014). It is these regions that are a cause for concern as they show indications of a lack of sufficient quantities of food. The population of Africa has the highest growth rates compared to other regions and is already showing signs of food insecurity (Bruce & Pickett, 2014). The 2015 review of the millennium development goals and the introduction of the sustainable development goals (United Nations, 2015c) recognises food insecurity in Sub-Saharan Africa as a significant concern. Almost 75 percent of the world population of people living in extreme hunger are situated in rural areas in developing countries. These extremely hungry people depend on agriculture directly or indirectly (Mann et al., 2009). Khan et al. (2014) estimates that the number of rural poor will by 2040, surpass the number of urban poor. The author expounds that the majority of farm production in this region is under rain fed agriculture, and with increasing exposure to climate change risks water storage is a critical issue.

Khan et al. (2014) expound that the seemingly perennial problem of food insecurity in Africa that is mainly due to poor crop production is likely to worsen due to the compounded problem of climate change. The authors suggest the introduction of technological innovations as a means of eradicating food insecurity.

In 2002 the UN Population survey projected that in 2050 Sub Saharan Africa would make up 17 percent of the global population. In the 2010 revision (United Nations, 2011), the estimates for this region had gone up to as much as 21 percent of the global population by 2050.

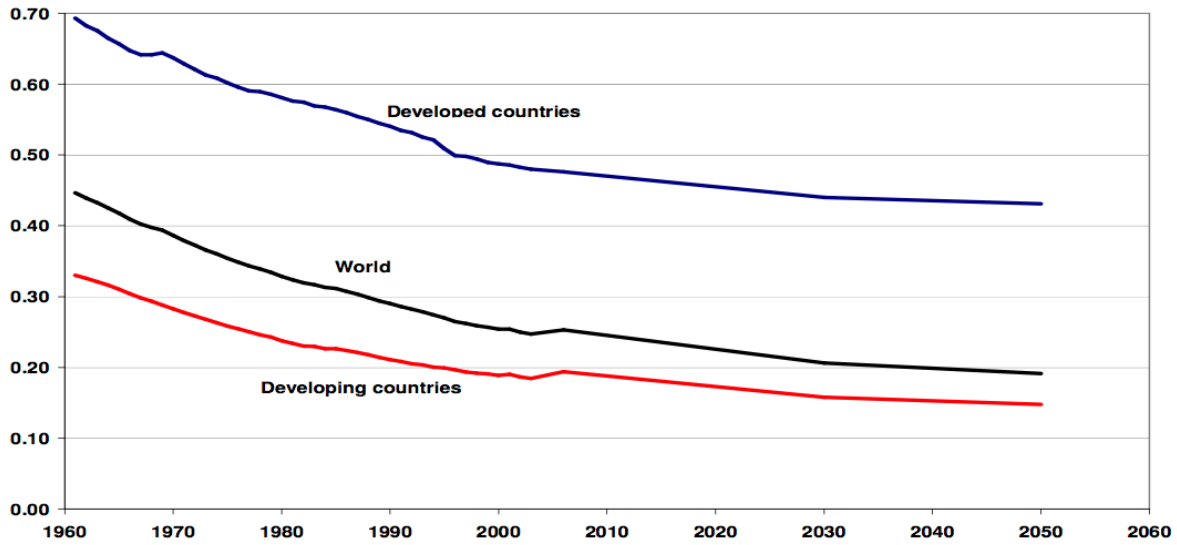


Figure 1: Arable land per capita (United Nations, 2012)

It is such food insecure regions, with their growing hunger trends and the constant decline in the accessibility of arable land (Figure 1) and poor crop yields as identified by Bruce and Pickett (2014), that have brought calls for food security to the centre stage of the world agenda. Agriculture production is a critical aspect of food security as it allows for rural populations to have much needed food resources and generate scarce income (World Bank, 2008b). In order to achieve global food security the manner in which food is grown, harvested, distributed and consumed has to become more efficient. Generally the notion of dwindling arable land globally can hold as true. This opinion can be counter argued when one looks at regions in world like sub-Saharan Africa that has vast unused land that has different degrees of potential for agricultural use. One of the main reasons land resources are not being used is the lack of both physical and technological infrastructure supporting it (United Nations, 2012). Information and communications technology (ICT) has been identified to be a potential contributor in achieving global food security (Bowman, Mensah, & Urama, 2014).

The application of ICTs in agriculture can optimize the farmer's production capabilities and can allow the farmer to get timely information to sustain and improve their farming activities. In agricultural activities, there is demand for timely information transfers between farmers and other key stakeholders such as agricultural extension officers. Information that would most likely be required to be shared between stakeholders includes data on crop diseases, farming practices, new innovations and technologies, disease control and market information. It is the potential for ICTs to facilitate a broader access to information and its support for knowledge sharing, hence positively impacting poverty reduction, that has encouraged governments to incorporate ICT use as part of their national policies (Ajani, 2014).

An example of an ICT are traceability systems; these are systems that enable consumers to know the contents of their food and where it comes from (van Vark et al., 2013). Traceability systems are becoming an important food safety requirement in many countries such as China that encouraged the implementation of dairy cattle radio frequency identification systems. In 2008 China reported a high number of infant hospitalisation with six infants dying from kidney related ailments, some of them attributable to kidney stones. It later became known that the chemical that was responsible for these infant hospitalisations was melamine that was found in milk powder that they had consumed. This tainted milk scandal in 2008 (Costa et al., 2013) raised great concern about food safety and motivated the use of traceability systems. Wognum, Bremmers, Trienekens, van der Vorst, and Bloemhof (2011) contend that transparency is important to regain consumer confidence that has suffered due to recent food safety scandals. The authors highlight the use of labels that help to trace the origins of food and their composition. Some companies even go a step further by using the label to direct consumers to additional information on their products via a link on the label to a website. Organisations such as the Food and Agricultural Organisation (FAO), the World Trade Organisation (WTO), and the European Union have been instrumental in providing guidelines with regards to traceability in the food and safety sector. A common recommendation is that the responsibility of traceability in this regard ultimately falls under the auspices of individual governments. Adoption of traceability systems is increased through mandatory regulatory enforcement, and it is here that governments can play an important role. This can be seen in the European Union region that introduced the General Food Law – 178/2002/EC that made traceability systems mandatory. In a study by Van der Vorst, van Beurden, and Folkerts (2003) which investigated the use of ICTs in traceability systems, the authors found that there were few ICT based systems developed specifically for traceability. Other findings were that there was a general use of ICTs such as bar code scanners and Radio Frequency Identification (RFID) systems. The study also revealed that there was sharing of information through the use of interconnected enterprise systems. The use of RFID tags can greatly improve transparency on the movement of products through the food supply chain. RFID technology can also allow for individual animals to be traced to their farm of origin including its consumption history as well as any health information pertaining to that animal in terms of medicines administered. RFID technology is gaining popularity and has been adopted in countries such as Canada and Australia. This technology, although promising, faces a barrier in terms of adoption by farmers, mainly due to the cost factor (Wognum et al., 2011).

This study investigates the role of ICTs in food security amongst smallholder farmers in KwaZulu-Natal; it also takes into account extension officers and non-governmental organizations. The research background is provided in the next section. The study variables are provided in section 1.3. The problem

statement, research questions and research objectives are described in sections 1.4, 1.5 and 1.6 respectively. The methodology followed in this study is described in section 1.7 and the significance of the study in section 1.8. The assumptions made in the study are identified in section 1.9 and the definition of terms in section 1.10. Sections 1.11 and section 1.12 present the structure of the thesis and the thesis writing conventions. Section 1.13 concludes the chapter.

1.2 Background and Context

The first of the United Nations Millennium Development Goals (MDG) is the reduction of extreme poverty and hunger. Target 1.C of this MDG specifically aims to half the number of people who are living in extreme hunger by 2015 (United Nations, 2010). The world is now celebrating meeting its MDG goal 1 of halving the number of people living below $1.25 a day, people who are classified as living in extreme poverty. While the target has been met, there are still 836 million people living in extreme poverty. The MDG goal 1 has now been followed by a new goal 1 of eradicating extreme poverty altogether. This goal is from the newly developed sustainable development goals (SDGs) that were recently adopted by the 193 United Nation member states at the beginning of the summit on Sustainable Development on 25 September 2015. Access to sufficient, safe and nutritious food is a fundamental requirement to the health of any society. The sharp increases in international staple food prices such as rice, maize, wheat and dairy products in 2007 and in the first quarter of 2008 presented a huge threat to the poor in respect of their health and productivity in society (World Bank, 2008a). It was this food crisis and the recent dwindling food production estimates towards the year 2050 (United Nations, 2012) which has helped bring international attention to agriculture and food security. The World Food Summit (1996, para 1) defines food security to be "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life." For the purposes of this study, food security was investigated from the aspect of food availability, which refers to having sufficient amounts of food available consistently. The study also investigated the issue of food safety as a part of food security through traceability systems.

In developing countries creating food secure societies has proven to be an on-going challenge (Masset, 2011). Ballantyne (2009) acknowledges the vital role that information plays in attaining food security and calls for interventions directed towards content creation. The author also advocates for the increased use of Information and Communication Technologies (ICTs). It is this relationship between food security and Information and Communications Technologies that Ballantyne (2009) discusses and that key authors identified earlier (Hoffman, 2000). Hoffman (2000) in his description of the advent of the Internet states that the Internet has changed society and the way in which things are done. The author compares the role of the Internet to that of print media and acknowledges not only its potential to reengineer business

processes but also the manner in which business is conducted. This research seeks to investigate how existing ICT tools such as geographic information systems and knowledge management systems can improve food security in KwaZulu-Natal.

1.3 The Study Constructs

This study makes use of constructs three theoretical frameworks (Rogers Diffusion of Innovation (DOI) theory, the technology acceptance model (TAM) and Hofstede's cultural dimensions theory. These models underpin the study and the preliminary literature provided the guide for the development of the research objectives and research question as outlined in section 1.5 and 1.6. No single model sufficiently covered all the aspects of this study, hence the decision to construct a hybrid theoretical perspective, blending the relevant variables from the three models, resulting in the proposed framework to interpret the data. The proposed framework would be incomplete if it did not account for factors affecting diffusion of ICTs, the role of culture and the reasons for adoption of ICTs by smallholder farmers in KwaZulu-Natal.

1.4 Problem Statement

The Sub Saharan region in Africa is considered to be one of the regions in the world whose inhabitants are highly undernourished. This has given rise to the global attention towards the elimination of extreme poverty and the attainment of food secure societies. The attempt at eliminating food insecurity in the region requires a multi-faceted solution and is best resolved through an interdisciplinary approach.

From a production perspective, South Africa can be considered to be food secure, but this is not the case when one considers access to food. This is primarily due to the fact that the high production rates in the country are largely attributed to multinational firms and are mainly meant for export purposes. This has created a situation where food insecurity exists amongst local populations. With the majority of populations in Sub-Saharan Africa living in rural areas and farming being an effective solution at eradicating food insecurity in local communities, the smallholder farmer has gained growing importance. The World Bank (2008b) estimates that of the 2.5 billion rural inhabitants that are involved in agriculture in developing countries, 1.5 billion of these people are composed of smallholder farmer households. The report by the bank also expounds that agricultural productivity is critical to the growth of an economy and in order to get increased agricultural productivity smallholder farming needs to be stimulated to increase its production. This 2008 report by the World Bank identifies smallholder farming as a possible avenue to eradicate rural poverty (World Bank, 2008b). A common characteristic trait of the smallholder farmer is their lack of knowledge and financial capacity in order to maximise their production. It is for this reason that extension services are of crucial importance in the success of smallholder farmer's. The extension

officer provides support to the smallholder farmer and an implicit influence may exist between the two due to their close working relationship.

Wakabi et al. (2015) contends that there is a lack of knowledge regarding ICT uses by citizens in the African context. Moreover, little awareness has been focused on the role ICTs can play in eliminating food insecurity in Africa and on specific technologies that are suitable for this function. In the iLembe district municipality of KwaZulu-Natal, there are no deliberate and coordinated ICT based innovations focusing on smallholder farmers. At the time of this study there was only one ICT based innovation under deployment with extension officers (the digital pen project). There is no knowledge on the ICT adoption factors by smallholder farmers or usage of ICTs amongst both smallholder farmers and extension officers in the district municipality.

This study investigates the extent to which ICTs are adopted by smallholder farmers and extension officers and the role ICTs play in improving food security. Furthermore, the study also identifies factors of ICT adoption in food security.

1.5 Research Questions

The preceding problem statement leads to the following primary research question underpinning this study: How does the adoption and diffusion of ICTs amongst smallholder farmers influence food security in KwaZulu-Natal?

1.5.1 Sub Questions

1 How does the level of education influence the smallholder farmers ability to adopt ICTs for farming practice in KwaZulu-Natal?
2 Why do smallholder farmers adopt ICTs in KwaZulu-Natal?
3 What factors influence ICT adoption in the application of knowledge management practices?
4 What are the smallholder farmer perceptions of ICT adoption in food security in KwaZulu-Natal?
5 Which of the constructs borrowed from the theoretical models of diffusion of innovation, technology acceptance model and Hofstede's model are direct determinants of the adoption of ICTs in food security in KwaZulu-Natal?

1.6 Research Objectives

The primary objective of this thesis is to identify constructs that are predictable in the adoption and diffusion of ICTs amongst smallholder farmers and will aid in the understanding of the role ICTs play on food security in KwaZulu-Natal. Focus is also placed on the statistical evaluation of a proposed

framework for determining the role of ICT adoption in Food Security in KwaZulu-Natal Province. Secondary objectives that are related to the main objective and enhance the study are as follows:

- To assist and guide policy makers in creating policy frameworks that take into consideration an understanding of ICT adoption and diffusion amongst smallholder communities in KwaZulu-Natal.
- To contribute to the scarce literature on ICT4D from an African perspective with a specific focus on food security and to the growing debate of the role of ICTs in food security.
- To evaluate the weighed importance of each identified construct that influences ICT adoption amongst smallholder farmers in KwaZulu-Natal province.

1.7 Research Methodology

The research is quantitative in nature. The analytical procedures were carried out using the statistical application SPSS 23.

This study takes a positivist approach and makes use of the survey technique that results in statistical analysis of the data observed. The statistical analysis yields empirical data that is much better understood (Schiffman & Kanuk, 1997). As a general rule suggested by Crowther and Lancaster (2012) this study adopted a deductive approach due to the positivist philosophy used. Furthermore, questionnaires were used as the data collection instruments.

Asendorpf et al. (2013) stress the importance of findings being replicable. The authors state that the reliability of a study is linked to the study findings being replicable and hence they state that "replicability of findings is at the heart of any empirical science". The research design chosen for this study is quantitative in nature. Webb and Campbell (1966, p. 3), suggests "Once a proposition has been confirmed by two or more independent measurement processes, the uncertainty of its interpretation is greatly reduced. The most convincing evidence comes through a triangulation of measurement processes". This study used a variation of triangulation as defined by Denzin (1970) who extended the idea of triangulation beyond its conventional definition. The study followed Denzin's definition of data triangulation, which also involved data collection from a variety of sources. This study borrows from this concept to validate findings by using two data collection instruments (questionnaires) on two different sampling frames (smallholder farmers and extension workers). A third questionnaire was also used. This third questionnaire was a Household Food Insecurity Access Scale (HFIAS) for the purposes of providing a baseline measurement of smallholder farmer household food security status.

The study is divided into four phases which link to specific chapters of the thesis (Figure 2). Phase one consists of the literature review of various concepts which form the study scope e.g. knowledge required for agricultural practices, ICTs, the smallholder farmer, the extension officer, non-governmental organizations, food security. Phase two consists of a discussion of various theoretical frameworks used in the study. Phase three of the research involves a description of the methods used in the study, the designing of the questionnaires and a description of the fieldwork that was undertaken to collect data. The final phase (phase four) consists of the analysis of the results and a determination of the role of ICTs on food security that in turn will be used to identify the role ICTs play on improving food security in KwaZulu-Natal.

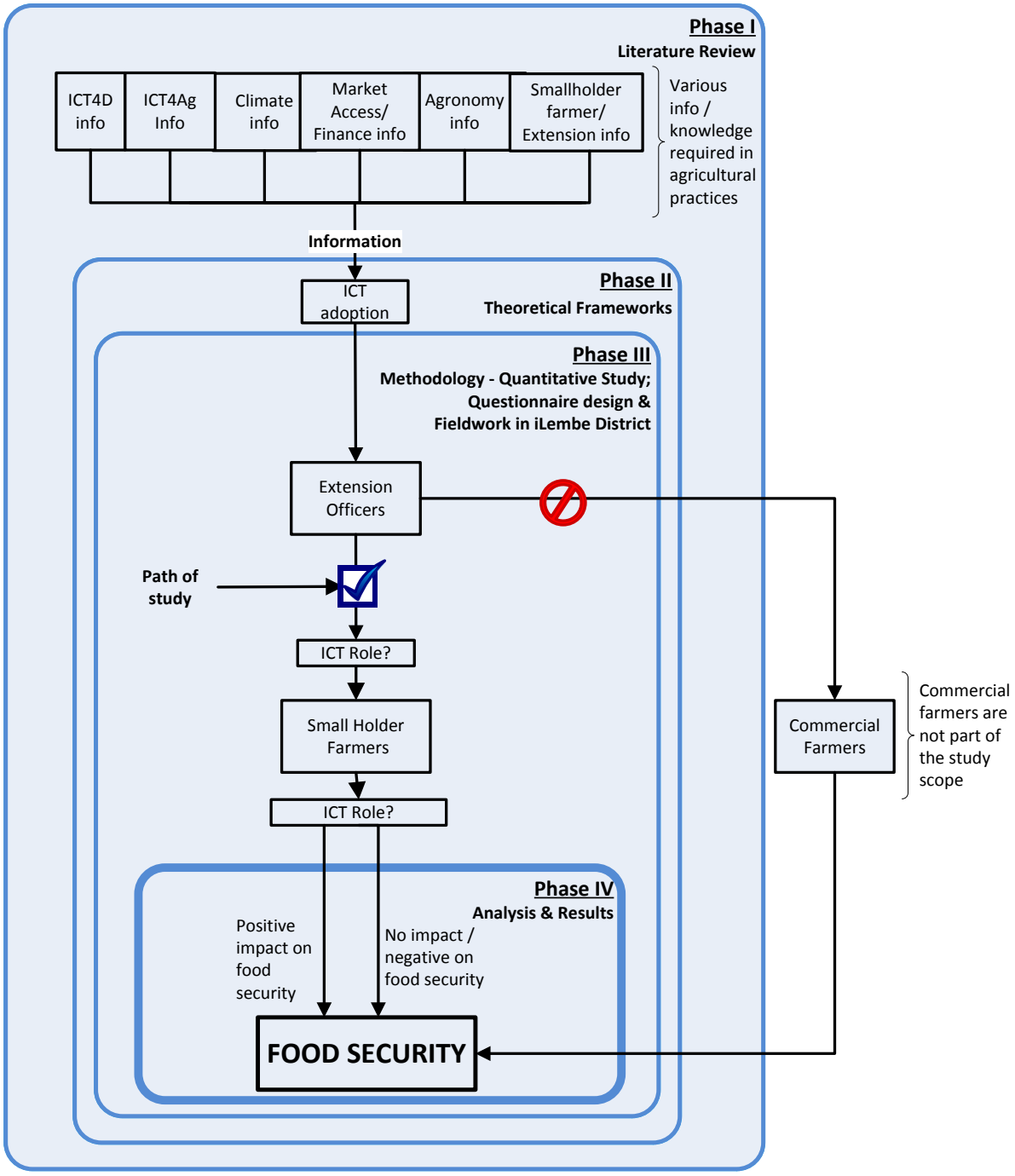


Figure 2: Overview of Research Strategy indicating each phase - The Role of Information and Communications Technology on Food Security in KwaZulu-Natal

1.8 Relevance of The Study

As discussed earlier ICTs and their use in various sectors of society has grown exponentially (Ballantyne, 2009; Igari, 2014; Katengeza, Okello, Mensah, & Jambo, 2014). It is this penetration and widespread use that gives ICTs their potential benefits. Knowledge and information has been identified as a key factor in reducing food insecurity (Yaghoobi & Sarani, 2011), this is another factor that underscores the importance of using ICTs in food security. A number of authors have discussed the benefits the advent of ICTs has brought (Kling, 1996; Rambowan, Lubbe, & Klopper, 2005). Much as the benefits of ICTs are well researched, little research has examined the role that ICTs play in food security within an African context. The World Bank (2008b) highlights the importance of smallholder farming in increasing the productivity levels in the agricultural sector that in turn has the potential to stimulate economic growth in other sectors of the economy. It is in attempts to stimulate increased productivity of smallholder farmers and hence reducing food insecurity that ICTs are being incorporated in farming practices. It is this gap in literature that this research will contribute to. The study will assist planners and policy makers by providing knowledge and information on the role ICTs play regarding food security. The study also aims to contribute to the attainment of the United Nations newly adopted Sustainable Development Goal 17 particularly focusing on goal 17's targets on technology. These targets attempt to promote the use of enabling technology by developing countries and enhance the capacity for innovation through the use of ICTs.

1.9 Structure of the Thesis

Below is a brief chapter-by-chapter roadmap of the thesis.

Chapter 1

This chapter introduces the study. It is in this chapter that the study will be laid out in terms of the context of the study. The chapter will also introduce the various theoretical frameworks that will be used. The approach the research will take in terms of the objectives of the study and how the study will achieve the objectives. The chapter ends by providing the reader with a brief explanation of how the thesis will be presented from chapter to chapter.

Chapter 2

In this chapter, the background of this study is provided through a review of literature that underpins this study. The chapter discusses literature around three main areas; ICT for development, ICT for agriculture, and the smallholder farmer. It is based on these discussions that revealed gaps in the literature and how the research questions were developed.

Chapter 3

This chapter provides a review of the theoretical frameworks used in this study. The chapter discusses Rogers Diffusion of Innovation (DOI) theory, the Technology Acceptance Model (TAM) and Hofstede's cultural dimensions theory. The chapter also provides an understanding as to the use of these specific theories in the study and provides a guide through which the study will be conducted.

Chapter 4

In this chapter, a description of the sampling frame is provided. The chapter further provides a discussion of the research design undertaken and other research techniques and procedures that were followed.

Chapters 5

The Presentation and discussion of findings related to the role of Information and Communications Technology in improving food security in KwaZulu-Natal are provided in this chapter. The chapter provides empirical evidence that help answer the research questions posed in chapter 1.

Chapter 6

This chapter revisits the research and provides key findings. The chapter draws out the implications of this study and provides recommendations. The limitations of this study are also stated in this chapter and suggestions for future research are proposed.

1.10 Thesis Write-Up Convention

The section discusses the writing format used. The section includes the use of acronyms, referencing and numbering of figures and tables.

- All acronyms will at their first use be written out in full. Thereafter the acronym will be used.
- In-text citation was used.
- Figures and tables are numbered sequentially in the order of their appearance in the thesis.
- The introduction section of each chapter in the thesis includes a diagrammatic representation of where that chapter is located (Pillay, 2012) in the entire thesis and which phase of the study it is associated with.

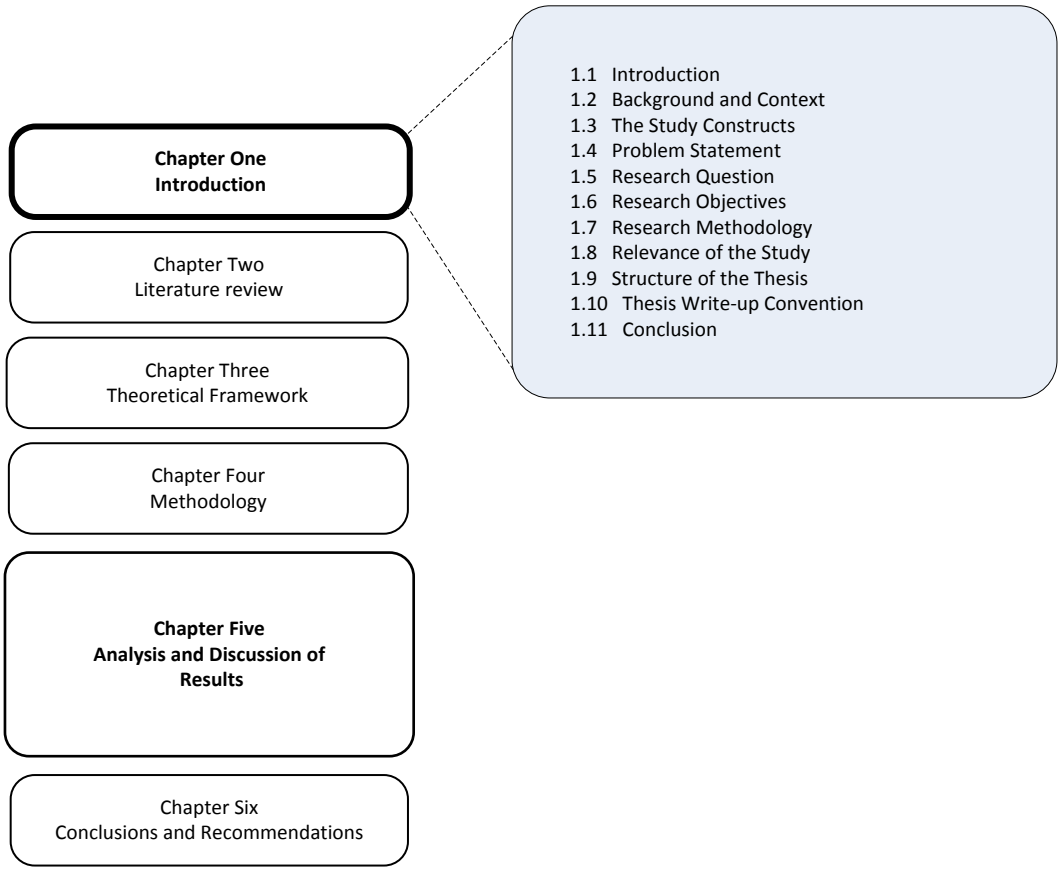


Figure 3: A graphic illustration of the overall thesis chapters and the composition of chapter one

ICT in this study broadly encompasses emerging and more established technologies.

1.11 Conclusion

ICTs are increasingly being recognised globally for their significant contribution to development. They are constantly changing the way information flows in society and hence impacting lives significantly. This chapter provided an overview of the thesis by providing a background of the study and introducing the research problem. The chapter also outlines the objectives of the research and the research questions to be used to achieve the outlined objectives. An overview of the methodology that was adopted in this study is also outlined in this chapter. In the next chapter, a detailed literature review is undertaken in which aspects that underpin the study are discussed.

CHAPTER 2

LITERATURE REVIEW

Understanding ICTs for food security

"Once you allow yourself to identify with the people in a story, then you might begin to see yourself in that story even if on the surface it's far removed from your situation. This is what I try to tell my students: this is one great thing that literature can do - it can make us identify with situations and people far away."

(Achebe & Bacon, 2000, p. 2)

2.1 Introduction

Since the advent of concepts such as globalisation and inclusiveness the world has come together more closely as one giving rise to a "global village". One tool that has necessitated the creation of this global village is the spread of Information and Communication Technologies (ICTs). ICTs have encouraged the rapid flow of information and expanded their reach. A review of a variety of literature which underpins this study with an aim to establish gaps in the knowledge of the role that ICTs play in the challenge of creating food secure societies is provided in this chapter (Lashgarara, Mirdamadi, & Hosseini, 2013; Masset, 2011). A long-standing issue has been the investigation into the role of ICTs on development, the role of these technologies on society and their reach across social classes. These technologies are thought to bring with them the potential of providing sustainable livelihoods, economic growth and contribution to freedom through open access to communication channels (Heeks, 2010; Kleine, 2013) and it is for this reason that ICTs role in development ought to be investigated.

A number of ICT innovations have been implemented in developing countries in Africa and Asia as they are widely considered to be catalysts of development (Flor & Cisneros, 2015; Isaya, 2015; Xia, 2010). Although there have been a number of great successes, these innovations have also come with substantial failure rates. The apparent high failure rates (Cheripelly & Chandri, 2015; Duncombe, 2015; Uimonen & Hellström, 2015) of these ICT innovations are actually normal when it comes to change initiatives (Heeks, 2010).

The literature review was initiated through the use of key words and terms to search a variety of online resources including databases such as EBSCOhost, Emeralds Insights, Google Scholar, ProQuest, NEXUS Database System and SABINET Online. This literature review also targeted journals, conference proceedings, and doctoral thesis and attempted to encompass a wide range of sources from authorities in the disciplines. The literature has attempted to incorporate the current discourse on the study area under discussion.

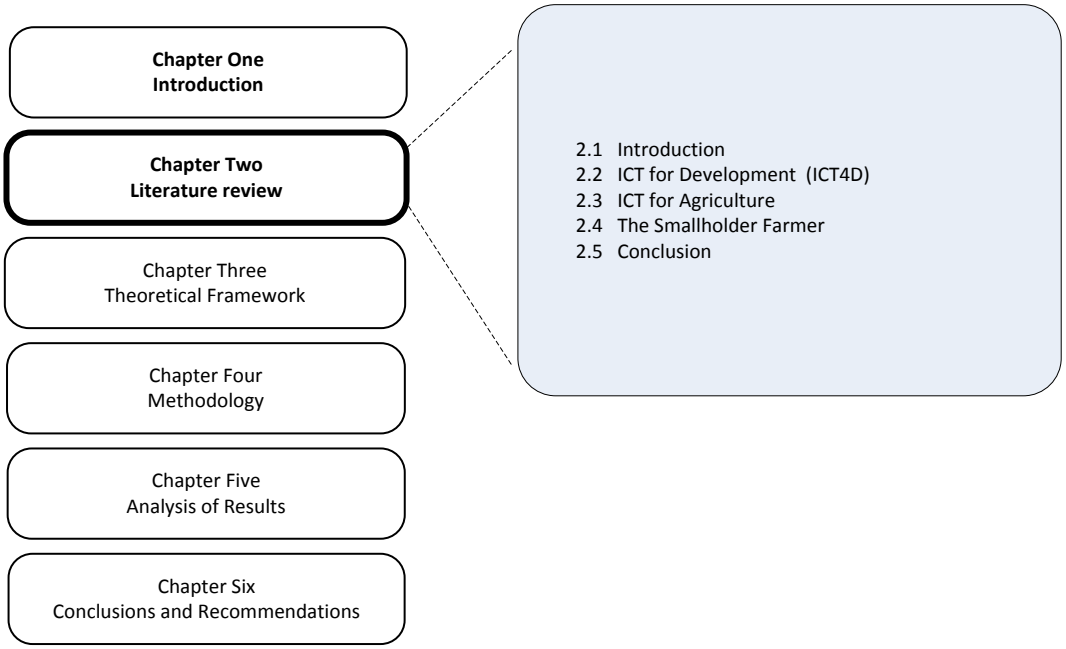


Figure 4: Chapter 2 within the overall research strategy - Phase 1 of the Study

2.2 ICT for Development (ICT4D)

2.2.1 Understanding ICTs

This study borrows the definition of ICTs from Warburton, Cowan, and Bathgate (2013) who broadly defined ICTs as encompassing three aspects; firstly the informatics which constitutes the design, application and maintenance of information-processing systems, secondly the technologies themselves including the use and manipulation of the hardware and software components and lastly, the communication technologies which promote real time interaction and communication amongst and between individuals or groups. As can be seen from this definition, ICT is a broadly encompassing term. This study has, for the purposes of distinction, classified ICTs into two groups; established and emerging ICTs.

Established ICTs

Established ICTs in this study refer to the ICTs that have gained ground in a social system in which they exist and are considered to be old relative to their introduction to that social system. The mobile phone, radio, television and two-way radio are examples of what has been regarded as established ICTs that other authors refer to as old ICTs (Fawole & Olajide, 2012; Lashgarara et al., 2013; Saghir, Chaudhary, Muhammad, & Maan, 2013).

Mobile Phone

The introduction of mobile phones in Africa has seen its expansive use and its introduction on the continent benefits the use of superlatives as recommended by authors such as Munyua and Adera (2009). The rapid pace of adoption of mobile phones (Figure 5) and their perceived benefits have been described using terms such as staggering with some authors referring to mobile phones as having become an integral part of society (Pillay & Maharaj, 2010) and Jeffrey Sachs expounds that the mobile phone is "the single most transformative tool for development" (Economist, 2009). Mobile phone popularity and its rapid adoption is in part due to the poor existing infrastructure of fixed line telephones in Africa (Ncube, 2013). According to the World Bank the introduction of the mobile phone has seen high penetration rates globally (World Bank, 2013).

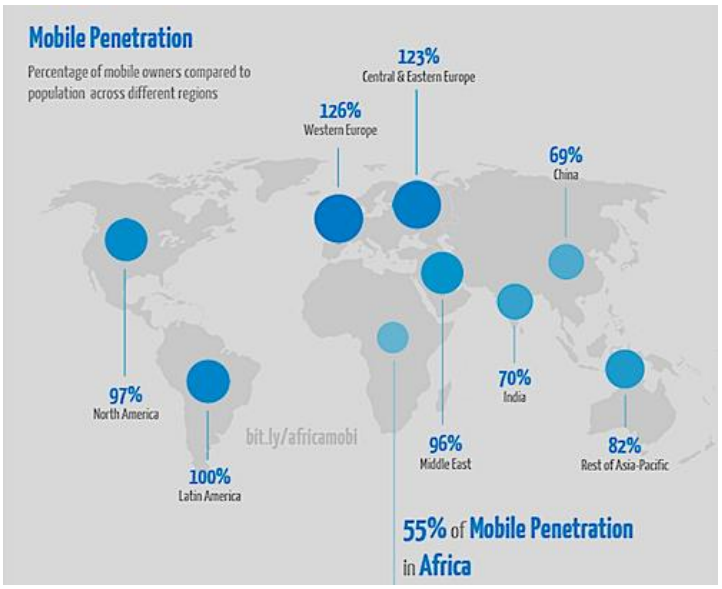


Figure 5: Global Mobile Phone Penetration (World Bank, 2013)

These high penetration rates globally have led to explosive subscription rates which as at 2013 were estimated at 6.8 billion subscriptions globally which is almost reaching the estimated world population of

7.1 billion (ITU, 2015). According to the latest United Nations specialized body on ICT statistics the International Telecommunications Union (ITU), mobile phone penetration globally per 100 inhabitants as of 2015 stands at 96.8% with developed countries at 120.6% and developing countries at 91.8% (ITU, 2015). One main driving factor in the high penetration of the mobile phone as compared to the fixed line telephone that has been in existence longer is as a result of the high infrastructural investment of the latter (Lee, Levendis, & Gutierrez, 2012). In this regard, the latest fixed line telephone statistics show a global penetration as of 2015 of 14.5% with developed countries at 39% and developing countries at 9.4% (ITU, 2015). The statistics show (Figure 6) that in 2002 a milestone achievement was reached when the number of mobile phone subscriptions reached the same number of fixed line subscriptions and thereafter the mobile phone penetration has continued to rise.

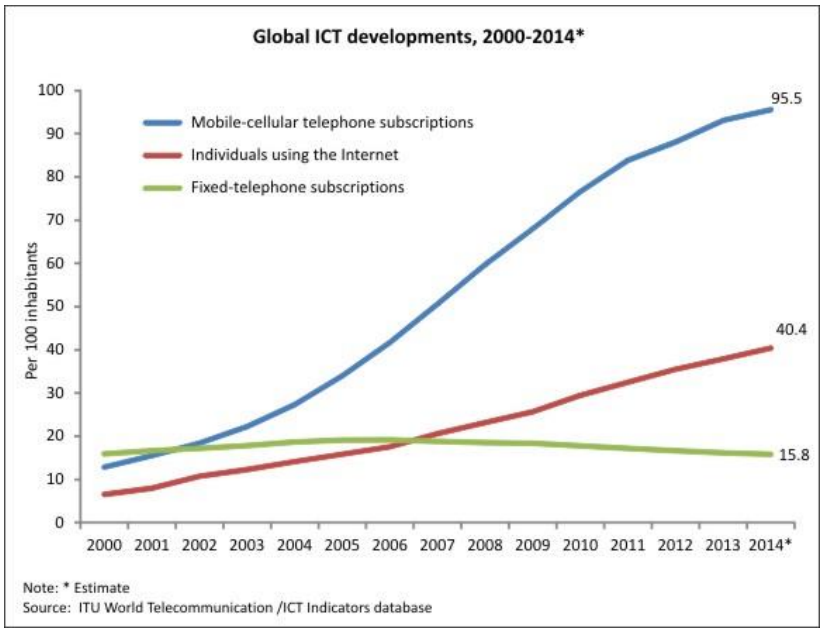


Figure 6: Global adoption of Mobile phones (ITU, 2015)

Radio

The radio is considered one of the oldest ICTs and for the purposes of this study is classified as an established ICT. The radio has been considered one of the favourite ICTs for a number of reasons and mainly due to it being an old ICT that has enjoyed high penetration rates. The penetration of the radio in varying communities allows for the transmitted message to be customised in the various languages of those communities thereby increasing its reach and relevance. Furthermore, the radio's popularity is due to its bottom up approach to content development that creates relevance to local communities as the content is created based on local issues. This approach is different to other ICTs that have a global

perspective related to its content (top down approach) which can have the risk of not being of relevance to local communities (Asiedu, 2012; Yuliasari, Saleh, Hubeis, & Sarwoprasodjo, 2014). Gagliardone (2015) argues that the implementation of the radio should not be based on assumptions but rather an investigation of the actors involved and the language. Some scholars (Girard, 2003; James, 2005; Minges, 2006) have advocated for this approach of blending ICTs to encourage adoption of new ICTs and Nassanga, Manyozo, and Lopes (2013) advocate for infrastructural support to enable ICT integration to allow for the blending of ICTs.

Television

In one of the early studies on the television, Gerbner and Gross (1976) expound that the television has brought about radical changes to the manner in which information dissemination takes place in society. They explain that unlike most other ICTs, especially new ICTs, the television requires no predispositions nor does it require any literacy of any level. The authors contend that it is actually the television that has the capability to create predispositions and views (Gerbner & Gross, 1976). It is this power of creating perceptions that shows the great level of influence television has on society. This influence is evident in studies where the television has a high penetration rate (Chhachhar, Osman, & Omar, 2012) in that society and in studies by Moon, Hossain, Kang, and Shin (2012) where the Korean government established a television channel to help encourage ICT adoption amongst rural and agricultural communities. In such studies respondents all state that the television is the preferred medium of communicating information such as farming information and therefore, is considered the most effective broadcasting ICT tool by some scholars (Chhachhar et al., 2012; Nazari & Hassan, 2011; Obidike, 2011). The main drawback in the penetration of the television is similar to the telephone which is related to investment capital. This problem is also compounded by the content of programmes available. Nazari and Hassan (2011) contend that there is a need for the creation of dedicated channels that air programming content that is relevant to rural populations.

Two Way Radios

The two-way radio commonly known as the “walkie talkie” or in the local South African language of isiZulu as the ova-ova has over the years seen a change in its application globally from a more military communication piece of hardware to a popular commercial and private communication tool (Maitra, 2014; Tamrat & Kachnowski, 2012). Bhatnagar (2015) who looked at improving service delivery to the poor, identified that the two-way radio played a significant role in reducing maternal mortality. Bleie and Lillevoll (2010) expound that the walkie-talkie has been used in the agricultural sector to herd livestock even before the more recently introduced mobile phone. The popularity of the walkie-talkie can be

attributed to the fact that this ICT tool is cheap compared to other ICTs. This is because it does not have monthly fees, is portable and provides instant communication.

Emerging ICTs

On the other hand, emerging ICTs are considered to be those that are new relative to their introduction to a particular social system and are yet to be recognized by most of the inhabitants of that social system. Other authors refer to these emerging ICTs as new ICTs (Lashgarara et al., 2013; Mistilis & Gretzel, 2014) and argue that these new ICTs have changed the manner in which collaboration in societies takes place (Carty, 2010).

Geographic Information Systems

Geographic information Systems (GIS) are technologies which provide an electronic visual representation of maps that are linked to information and can be used in analysing and interpreting relationships and patterns (Sinton & Lund, 2007). GIS applications are varied and are used in different organisations and industries from hydrology to military applications and many more (Cromley & McLafferty, 2011; Jovanović & Njeguš, 2013; Merem et al., 2011; Satyanarayana & Yogendran, 2013). Krämer and Peris (2014) in their study on facilities management identified some basic benefits of making use of GIS applications e.g. route-planning, location of equipment and distance calculation.

One industry where GIS technology is applied is in the agriculture sector. The mapping of geographic data and linking to information (Sinton & Lund, 2007) allows for the development of suitability maps indicating factors such as soil types, water availability and climate conditions (Feizizadeh & Blaschke, 2013). GIS technology implementation is not without challenges in agriculture with one of its biggest challenge's being the level of literacy required to use GIS technology and interpret its resulting data. Nkosi and Chikumba (2014) identified the need for training, computer skills, hardware, software and infrastructure as some of the challenges that need to be overcome when implementing GIS systems.

Knowledge Management Systems

Over the years knowledge in organisations has begun to be considered a strategic resource to the organisation so much so, that it is now even being considered more valuable than the firm's physical resources (Dalkir, 2013). Organisational knowledge has gained importance over the years and the advent of the Internet that has increased access to vast amounts of knowledge which has given rise for a need to manage the knowledge. Alavi and Leidner (2001) states that knowledge management is the process of capturing, organising and disseminating an organisation's knowledge resources in order to compete in

industry. Dalkir (2013) acknowledged a principal component of knowledge management systems in that they make use of both explicit and tacit knowledge. The implementation of IT systems to support knowledge management has given rise to knowledge management systems that have the capability to create online directories, conduct database information searches and share information (Dalkir, 2013).

Early Warning Systems

In a bid to promote the prevention of disasters or risks, early warning systems across various industries have begun to be promoted. These systems that take various forms have the primary role of alerting its users of possible looming risks. Rose and Spiegel (2012) analysed the causes of the 2008 financial crisis and concluded the need for early warning systems that not only predict potential risks or crisis but should also predict when a risk or disaster is likely to occur. A key aspect of early warning systems is that these systems should not only detect risks but should also alert the users of the impending risks. This is evident in the South African municipal monitoring and evaluation systems which are supposed to act as early warning systems, identifying problem areas in service delivery processes (The Presidency, 2011).

In agriculture, early warning systems are used to predict the likelihood of potential natural risks e.g. changes in climate conditions that can lead to disasters. These systems are being developed to help farmers build resilience against extreme climatic conditions (Boyd et al., 2013; Chung, 2012; Coffey et al., 2015; Venton, Fitzgibbon, Shitarek, Coulter, & Dooley, 2012). In order to make use of the opportunity provided by these systems, it is important to be able to meet the warnings with appropriate and timely responses which can be the difference between successful and failed systems implementations (Hillier & Dempsey, 2012).

2.2.2 Defining Development

The concept of development, as generally accepted, originates from Europe where other countries strive to emulate the achievements of European countries whose overall goal is based on the improvement of society (McMichael, 2011). The World Bank (2008b) estimates that of the 5.5 billion people in developing countries, 3 billion live in rural areas. The report also identifies agriculture as a strategic vehicle for stimulating development and providing income to 86 percent of the rural population. Key features of development, regulation and industrialization, have their benefits and drawbacks (Gereffi & Wyman, 2014; Mathews, 2011; Zabihi, Habib, & Mirsaeedie, 2013). Some scholars argue that development is a transformation process where local capacity is taken into consideration and innovations are based on this capacity rather than the notion that development can be transplanted and imposed on local societies using imported experts. It is the latter approach that the scholars point to as the reason most donor-recipient relationships towards aid projects fail (Fukuda-Parr & Lopes, 2013). Tscharntke et al.

(2012) asserts that the majority of poor people are located in rural areas and lack resources that they can use to generate a livelihood such as land. Despite there being no universal definition of rural development, it generally refers to the upliftment of people in rural areas (Kani, 2014; Kolawole, 2014). The concept of donor aid has also come under criticism by scholars (Browne, 2012; Doucouliagos & Paldam, 2011; Moyo, 2009) in that it does not encourage economic growth. The potential for economic growth is enhanced if local institutions are responsible for the development processes (Fukuda-Parr & Lopes, 2013).

Information resources are critical to the development process and are a significant contributor to the success of social and economic activities. A real problem faced by smallholder farmers is the distance between the places of productions and points of distribution (farms and markets), which translates into unproductive use of time. The problem of time to market has been partially resolved with the construction of an effective road infrastructure. However, the road infrastructure does not adequately address the issue of the availability of accurate and timely information on the status of the markets, which is critical for economic development (Hudson, 2013). ICTs have a vital function in the timely provision of this information.

In 2000, the United Nations adopted eight international development goals that became referred to as the Millennium Development Goals (MDG). Upon adoption of these goals each member state committed to striving towards achieving the goals (United Nations, 2015b). These MDGs were later reviewed in 2015 to determined achieving their targets of which the main target of halving the number of people living in extreme poverty was reached. There has been a subsequent adoption of a new set of targets referred to as the Strategic Development Goals that seek to further eradicate the remaining half of people living in extreme poverty globally. This study makes a contribution towards achieving this target of eradicating the remaining half of people living in extreme poverty. The study further seeks to contribute towards the SDG goal 17 that encourages innovation, information sharing and capacity building, the diffusion of technologies to developing countries, and the use of ICTs for development.

Kani (2014) contends that sustainable rural development should go beyond improving the quality of life of rural dwellers and take into consideration the three aspects of the environment, society and economy. The author identifies infrastructural, economical, organizational-conveniences, social-cultural and environmental issues as obstacles to sustainable development following that hierarchy. One of the suggested solutions Kani (2014) provides for these obstacles is the provision of essential services to rural communities and including the residents as cooperating partners.

2.2.3 The Role of ICTs in Rural Development

With over 50 percent of developing countries populations being in rural areas (World Bank, 2008b) it is of vital importance to make use of all available tools and approaches to uplift the lives of these populations. An attempt by the United Nations to uplift people living in extreme poverty is seen in their Millennium Development Goals. These goals sought to half the people living in extreme poverty. One of the ways the United Nations attempted to achieve this was through the utilisation of Information Communications Technologies (ICTs). This attempt to make use of ICTs to achieve halving hunger is seen in goal 8 target 8.F which states that "In cooperation with the private sector, make available benefits of new technologies, especially information and communications" (United Nations, 2015b). With the adoption of new targets by the United Nations in 2015 referred to as Sustainable Development Goals (SDG), the United Nations has again incorporated the use of ICTs in their goals. Goal 17 of the United Nations Sustainable Development Goals attempts to strengthen global partnerships with the use of ICTs to achieve sustainable development. The mainstreaming of the use of ICTs by the United Nations is a sign of the importance ICTs are thought to have in the development process.

Hardy (1980) work was a pioneering study that investigated the role of the telephone as a contributing factor in achieving economic growth. Since then a number of studies have sought to show relations between ICTs and economic development. Innovations such as the Village Phone (VP) project by Grameen Telecom in Bangladesh through its sister organisation Grameen Bank provided small loans to villagers to become a Village Phone owner and provide telecommunication services to neighbours and adjacent villages. Grameen phone translates to "Rural phone" and this concept proved to be a great success in empowering villagers and providing connectivity to over 30 percent of the rural population from 1997 when the innovation was launched to 2002. By the end of 2010, the Grameen phone through the Village Phone project, had almost 300,000 women 'Village Phone' owners ('telephone ladies') providing phone services to fellow villagers extending over 61 districts from a total of 64 districts in the country (Alam, Yusuf, & Coghill, 2010). The Village Phone owners raised an average annual net income of approximately USD 624 – 700 (Bangladesh GDP per capita is USD 262) with their phones which they bought using a loan of about $200 (Forestier, Grace, & Kenny, 2002; Iqbal Quadir, 2000). The great success of the Grameen project is testament to the economic development opportunities ICTs can bring to society when correctly harnessed and in the words of Iqbal Quadir the innovator of the Village Phone concept that later developed into the Grameen phone "connectivity is productivity" (Iqbal Quadir, 1999).

On the African continent, the harnessing power of ICTs has also seen encouraging strides being made towards achieving development goals in a number of ICT led projects. The M-Pesa (M-standing for mobile and pesa means Money in Swahili) project is an initiative that was launched in Kenya. It is a

financial services application that offers cashless electronic money transfers and micro financing to its users. M-Pesa offers its users the ability to transfer, withdraw, deposit money and also pay for goods. This innovation has helped to bring financial services to poor rural communities that they are ordinarily excluded from (Dupas, Green, Keats, & Robinson, 2014). The use of ICT innovations such as M-Pesa has helped to lower the cost of doing business, hence increasing its demand (Karamchandani, Kubzansky, & Lalwani, 2011). The system has also allowed its users to save on travelling time to branches where financial services are offered by bringing the services to their mobile phones (Jack & Suri, 2011). These cases show that ICTs have an important developmental role to play in the lives of the rural poor by enhancing their quality of life (Elder, Emdon, Fuchs, & Petrazzini, 2013; Galagedara, Salman, Mahmud, & Ahmad, 2014; Hassen & Svensson, 2014; Venkatesh, Sykes, & Venkatraman, 2014).

2.2.4 ICT Adoption and Diffusion

Over the years written media penetration and distribution has dropped drastically and has been replaced by electronic media. Globalisation has precipitated dramatic changes in the manner in which societies are organised and has in turn affected technology and reframed the communication processes. Central to the concept of globalisation is the concept of integration; which has favoured electronic media developments that encourage communication. One of the biggest benefits ICTs have brought is they have eliminated the challenge of physical distance between places hence driving the global village concept, bringing people together regardless of their location.

Since the 19th century, the world has seen an explosive increase in the adoption rates of ICTs. This has mainly been due to the shift of these ICTs from commercial use to more personal use at a domestic level. The springing up of small technology companies after the break-up of Bell systems in the 1980s has also contributed to increased ICT innovations (Schwartz & Leyden, 2003). The shift in focus by technology firms from voice transmission to data transmission as alluded to by Schwartz and Leyden (2003) has allowed for the support of various internet supported technologies. It is this and factors such as the ever increasing processing power and the reduction in cost of technology (Moore, 1995), that has led to the explosive adoption rates of the Internet (Figure 7) since the early 1990s.

Although the world generally has seen a boom in the adoption of ICTs (Figure 7), developing countries are still experiencing low adoption rates of ICTs (Khan, Hossain, Hasan, & Clement, 2012; Touray, Salminen, & Mursu, 2013). An argument that is put forward regarding poor adoption rates is that there is no demand for ICT services from poor communities. This has been disproven by the huge success of ICT based projects like the Village Phone by Grameen phone of Bangladesh and the M-Pesa financial services platform in Kenya.

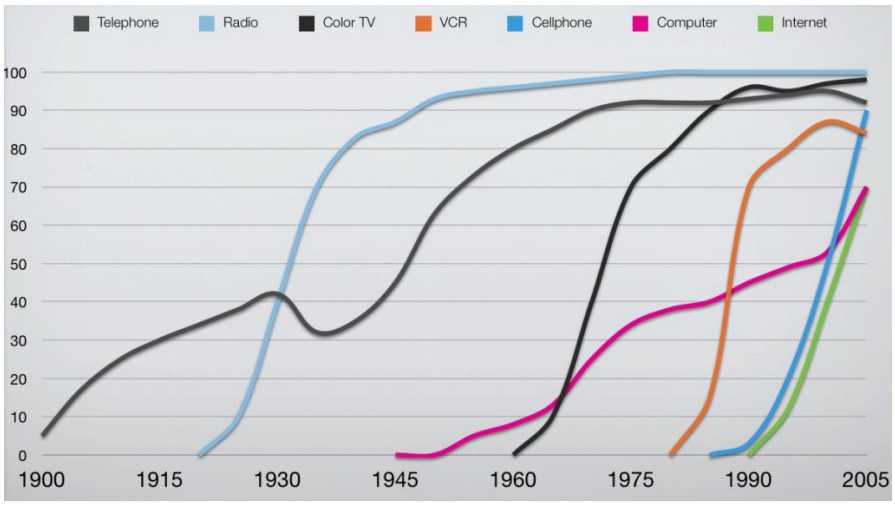


Figure 7: Speed of Information Communication Technology Adoption is Increasing (Brandon Croke, 2011)

Currently the global active mobile-broadband subscription stands at 47.2 per 100 inhabitants and the mobile phone subscription stands at 96.8 per 100 inhabitants (ITU, 2015). These high penetration rates, especially for mobile phones and the global reduction in the price of technology even though processing power keeps increasing in devices (Moore, 1995) suggests a trend of global interconnectivity using mobile devices. An observation of the Internet from the 1990s to date reveals a trend in the type of traffic that has traversed it over the years. During the initial period from 1990 that was characterised by low bandwidth, the majority of Internet traffic was email (text) and pictures. However, the beginning of the 21st century saw the majority of traffic shift to video (Figure 8). This has been made possible by the availability of high bandwidths through the dramatic drop in the cost of technology and the increase in the processing power of ICTs.

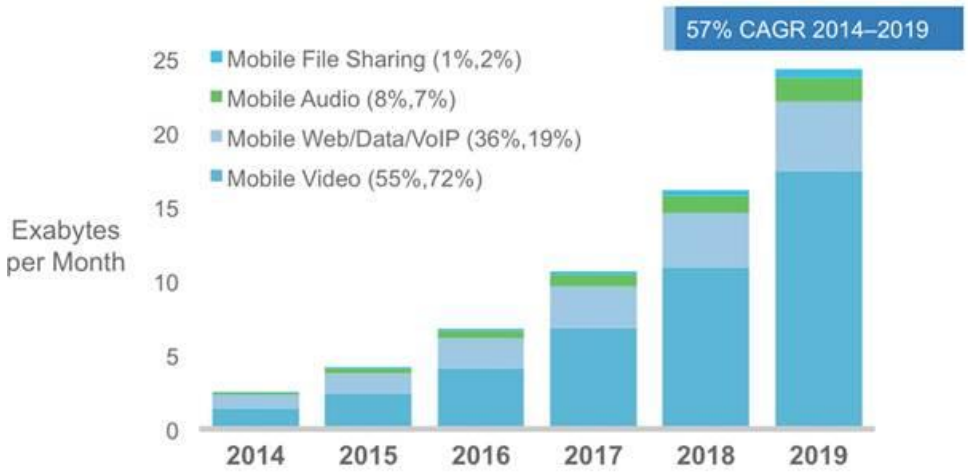


Figure 8: Global Mobile Traffic (Cisco, 2015)

With a mobile phone penetration rate of 91.8 per 100 inhabitants in developing countries (ITU, 2015) combined with a global increase in demand for high bandwidth data transmission activities over the years, (Schwartz & Leyden, 2003) and the explosive adoption of the internet (Figure 7), suggests an increase in the adoption of Internet platforms that support multimedia transmission rather than the traditional voice and text transmission. This shift in ICT trends has the potential to impact ICT for development projects such as the SMS clinic finder project pioneered in Uganda by Grameen foundation, which is a text message based information portal on clinics (Nchise, Boateng, Shu, & Mbarika, 2012).

2.2.5 Digital Inclusiveness

Globalisation has been the main driving force that has promoted digital inclusiveness. The Broadband Commission for Digital Development was setup by the International Telecommunications Union (ITU) in 2010 in an attempt to involve multiple stakeholders in promoting digital inclusiveness through broadband diffusion. In order to face current development challenges, there is need to use technology platforms such as the Internet in an attempt to create a digitally inclusive society exposing everyone within that social system to the benefits that these technologies bring. Broadband technology not only provides social benefits such as the provision of speedy accurate information on services e.g. clinic finder project (Nchise et al., 2012) in Uganda but also brings financial benefits e.g. Qiang, Rossotto, and Kimura (2009). Qiang et al. (2009) contributes to the conversation on the economic benefits of broadband by showing that an increase in 10 percent broadband penetration translates to a 1.38 increase in GDP for developing countries. It is these economic and social benefits, that developing nations have become attracted to and attempt to tap into.

Determining the level of e-readiness before an ICT innovation deployment is carried out is important (Kashorda & Waema, 2014; Rezai-Rad, Vaezi, & Nattagh, 2012) and can help guide the choice of ICT innovation to implement. The e-readiness assessment focuses on the assessment of ICT infrastructure, user training and support service provision. A number of authors (Ssekakubo, Suleman, & Marsden, 2011; Touray et al., 2013) have identified infrastructure as a critical barrier to successful ICT innovation implementation. The Economist Intelligence Unit (EIU, 2010) which ranks global nations on their readiness to implement ICTs and harness their benefits for social and economic gains rank South Africa at number 41 globally. The ranking involves an assessment of the quality of ICT infrastructure and the ability of people to harness its benefits. Out of the seventy countries that took part in the 2010 assessment, South Africa was given a score of 5.61 out of a total of 10 points. Although the country has dropped slightly from a 2009 score of 5.68, it was still ranked in 1st place amongst African states. This is a positive sign regarding the countries readiness to adopt various ICT innovations.

2.2.6 Technological Leapfrogging

The ability to be able to move from one place or stage to another without having to move through each and every stage in between is referred to as Leapfrogging. Usually this is necessitated by the need to advance to a better place, position or status. This concept has been adopted in the technology industry, particularly in the ICT sector where there has been a move from landline telephony to GSM mobile phones in most countries and personal computers to mobile devices. Napoli and Obar (2013) cautions that as the idea of leapfrogging also included a perceived move to better technology platforms, it is important to ensure this is actually the case. A South African study (Hyde-Clarke & Van Tonder, 2011) showed that technology leapfrogging is not the be all and end all but rather should be considered as a conduit through which developmental aims can be achieved. They argued that as much as people believe that leapfrogging in the direction of mobile technology has the potential of reaching more users and hence increasing developmental benefits, few actually use this technology for that purpose. The study showed that the majority of users of mobile technologies in South Africa use them for social media. This presents an opportunity or an idea of the direction ICT developmental platforms can take (shift to data intensive platforms e.g. social networks, online video as opposed to the traditional text based) to take advantage of the existence of this audience. Fu, Pietrobelli, and Soete (2011) argued that a technology backward country can more easily leapfrog to a technology if the foreign technology is easy to adopt. The authors identified the Internet as one of the means through which technology can be diffused and contended that for there to be successful technology transfer, both indigenous and foreign interventions should be used side by side.

2.2.7 ICTs and Globalisation

A key aspect of ICTs is the ability to be scalable. These technologies allow for communication to take place to larger numbers than would be possible to fit people physically in the same space such as a room. ICTs have made possible the virtual connection of people even in the remotest areas of societies. With the ever increasing influence of globalisation which has changed the way people interact be it socially or economically, ICTs have an important role to play in this new world and can be considered to be coterminus with globalisation. Globalisation is facilitated to a significant extent by ICTs although faces the challenge of lacking access to ICTs and poor political will (Simba, 2004). Simba (2004) identifies innovation and competition as integral to globalisation. It is this rapid innovation and competition that Rohman (2013) refers to as the cause of a decline in the ICT sector in Europe as developing countries are rapidly catching on to the technologies as they are being more exposed through globalisation and are innovating to suit their needs.

Globalisation is also influencing these technologies towards encouraging collaboration unlike older ICTs which were more broadcast oriented like the radio. A common trend these days is governments shifting towards e-government as a means of providing services to its people. Concepts such as e-learning, e-health and e-banking are now part of society. The tools are readily available e.g. mobiles phones and social media platforms.

2.3 ICT for Agriculture

Rural development has many complex facets and mainly involves agricultural development. Agricultural development involves changes in two main areas; the type of crop and the manner in which the crop is grown (Barlett, 2013). Barlett (2013) argues that true change in the agricultural sector will come only when institutions related to farmers and their activities lead the change. Timely information is a critical aspect of the agricultural process and the information assists in the successful production processes, postharvest activities and distribution to markets. Singh, Sankhwar, and Pandey (2015) in a study of the role of ICT in agriculture, agree that ICTs contribute to rural development through improving agricultural processes such as crop production, processing and markets. These positive contributions of ICTs in agricultural processes, in turn improve the quality of life of the rural farmer and their contribution towards creating food secure communities.

2.3.1 Understanding Food Security

In order to create a food secure household or community, poverty has to be addressed and eradicated. The opposite of food security is a situation in which food is not available or available in insufficient quantity and quality (not balanced in diet). Food insecurity is closely related to poverty and unemployment, and

since the 1970s food price hikes caused by the oil crisis, the issue of food insecurity has been a great concern globally (Godfray et al., 2010). Godfray et al. (2010) indicates that in order to eradicate the problem of food insecurity, it will require a multifaceted approach. Climate change to a significant extent, is the cause of food insecurity (Campbell, 2014; Howard & Sterner, 2014; Wheeler & von Braun, 2013) and this is especially so in Africa where farmers are mostly reliant on rain for irrigation. It is estimated that one in four people in Africa suffer from food insecurity. This situation is estimated to increase by such an extent, that by the year 2020, 65% of the total number of people suffering from hunger will due to climate change will be in Sub Saharan Africa (Lal, 2015). As Godfray et al. (2010) argued that a multifaceted approach is required in the eradication food insecurity, ICTs contribution towards it's eradication has gained global attention and scrutiny. As the United Nations and the world in general, is celebrating achieving the MDG 1 of reducing the number of people living in extreme poverty by half, it is important to take note that Sub Saharan Africa still holds the majority of people living in extreme poverty (United Nations, 2013).

2.3.2 ICTs and Food Security

The recent announcements by the United Nations with regards to the reduction in people living below the minimum income of $1.25 a day are welcome. A deeper look at these figures reveals that this development is mostly due to the Chinese and the Indian economic boom that lifted millions of its people out of extreme poverty. It is mainly due to these two countries, that the global number of people living in extreme poverty was positively impacted and the MDG target 1 reached. This boom especially in China, also fuelled global trade as China's demand for raw materials increased. While the data provided by the United Nations (2015c) reveals welcome news in the reduction of the number of people living in extreme poverty, there are still 836 million people globally still living in extreme poverty. The majority of these people are in the Sub Saharan region of Africa which also has the highest incidence of hunger. The agricultural sector has been recognised as the single highest employer globally providing a huge source of employment in rural communities. The World Bank (2008b) stated in their World Development Report of 2008 that three out of every four people living in developing countries rely directly or indirectly on agriculture for their livelihoods. In an attempt to create food secure communities, a focus has been on the smallholder farmer who is responsible for feeding the majority of poor communities in developing countries (United Nations, 2015c; World Bank, 2008b).

According to Disley (2013) the world's stability should take centre stage when strategizing in the fight against extreme poverty and that the United Nations must incorporate this approach in the creation of the sustainable development goals. The author argues that the millennium development goals were entirely focused on the elimination of poverty and did not take into consideration issues of sustainability of

natural resources such as land. This approach results in putting pressure on the earth's resources and can cause irreversible damage to the earth. Ecosystem damage, acidification of the ocean, coupled with water shortages and extreme weather can cause an eventual negative impact on food security. Foley et al. (2011) concurs and notes that agricultural practices have to transform and encompass the twin challenges of food security and sustainability of the earth for the purpose of providing resources for current and future generations. Godfray et al. (2010) also agrees with the viewpoint of sustainable agricultural practices while controlling greenhouse emissions and avoiding destroying biodiversity as a trade-off for food production.

Since 1972 when the Earth Resources Technology Satellite was launched the age of spatial global land observations and monitoring began. The past 43 years has seen remote sensing become an integral part of agriculture and food security initiatives of governments and various organisations globally. Over the years the advancement of technology has improved the ability to observe the earth. It is this integral role technology is now playing in the agricultural sector, that ICTs have now become an important aspect in the quest to create food secure communities. Shiferaw, Kebede, Kassie, and Fisher (2015) argue that economic incentives are not the main barrier to agricultural technology adoption but rather it is the lack of information and lack of access to credit facilities. The advent of these emerging ICT based innovations that are targeted at contributing to creating food secure societies brings with them questions that need to be answered. Questions such as are these innovations trickling down to the farmer on the ground? Is there any targeted coordination to make this valuable data that is made available by organisations that work in partnership with governments such as the Group on Earth observations? Is there any understanding of the motivations of ICT adoption for food security? These are now pertinent questions that need answers.

2.3.3 Global ICT Trends for Food Security

Over the years a number of ICT initiatives have been launched in the agricultural sector in support of food security. Various United Nations organisations promote good land administration and the concept of responsible and sustainable farming practices. Global ICT initiatives include the Global Agricultural Monitoring (GEOGLAM) initiative that was created for the purpose of improved agricultural information. The key function of GEOGLAM is to use satellite data to develop and distribute farming information to various stakeholders. The Global Open Data for Agriculture and Nutrition initiative provides global support for food security through the provision of agricultural and nutritionally relevant data. The use of geospatial information is having a significant impact on efficiency of input usage and hence results in an overall input and cost saving. In the previous generation, farm mechanisation was an era of transformation towards agribusiness. Now, the use of remote sensing technology is generating valuable data that will be the basis of the agricultural revolution of this generation. This data that is gathered is key

in improving resilience in farming and enhancing farmer production capabilities. The application of geospatial data that is generated from these ICTs can help improve resilience due to climate change, particularly natural disasters such as food shortages and droughts. This data is critical and used by early warning systems that provide spatial information that serves to warn of any food insecurity that has been identified. From a sustainability viewpoint, geospatial technologies contribute through support for precision farming that allows effective use of land, planning and management of resources. This support for sustainability is in line with the newly adopted United Nations sustainable development goal 17 under the technology target (United Nations, 2015a). Regulators and policy makers can use these technologies to assist in making evidence based decisions and policies by using the accuracy of the technologies to estimate forecasts and spearhead efforts at development efficiently. These ICT innovations can assist governments develop improved capacity to respond to crisis and in the development of early warning systems (Liao et al., 2010). At the smallholder level especially in developing countries, the challenge of utility and cost is concerning as these smallholder farmers do not have the knowledge to use these emerging ICTs and the finances to afford them. Alternatively, these individual smallholder farmers can come together to form cooperatives or farmer groups. This has the benefit of improving their combined financial ability and knowledge capacities in order to acquire these ICT innovations (Fischer & Qaim, 2014).

Some global trends have seen ICT based innovations such as the use of radio frequency identification (RFID). This ICT has become common practice for animal identification and tracking by farmers (Ruiz-Garcia & Lunadei, 2011). This ICT based innovation is now becoming more widely used in Europe where a number of ICT based innovations are now being made mandatory by laws such as the General Food Law – 178/2002/EC that has seen traceability systems become mandatory. What has been acknowledged globally is that the cost stands as a barrier to adoption of most ICT based innovations such as RFID technology and that there is need for the development of innovations that take cost into account.

2.3.4 ICTs for Food Security in Africa

ICTs have gained global attention and their importance in the development process has been highlighted by finding from authors such as Kim, Kelly, and Raja (2010) whom in a World Bank publication contends that in low and middle income countries broadband penetration has a direct impact on GDP. The author states that for every 10 percent increase in broadband penetration in these low and middle-income countries, there is a direct increase in the country's GDP by 1.38 percent. Kim et al. (2010) acknowledges the benefits of broadband technology economically and also cautions that economic and political factors have an impact on the rate of ICT innovation success. It is therefore prudent to be cautious that ICT innovation success rates will vary based on the environment in which they are implemented. It is because

of these varying conditions that an ICT innovation can succeed in one country and fail in another hence the need to avoid developing one size fits all ICT solutions but rather customize to each ICT solution to that particular environment.

Despite the scarce research on the role of ICTs in Africa in sectors such as service delivery (Wakabi et al., 2015) the research shows that ICT based innovations are moving fast mainly because of the ability of technological leapfrogging. The use of geospatial data is becoming more and more commonplace in Africa. Organisations such as the Gates foundation are helping make this accessible to these emerging technologies possible by providing support through research projects such as the STARS project (Spurring a Transformation for Agriculture through Remote Sensing). This project's objective is aimed at improving agricultural practices through the use of remote sensing technologies in the Sub Saharan African region. The project is focused towards smallholder farmers in Sub-Saharan Africa and the South Asia region and aims to empower them with this critical information for farming practices. With the availability of geospatial data, the challenge now is how to get this data to the farms to assist in making real time decisions that positively impact production or increase crop resilience.

In Kenya, which is heavily dependent on agriculture, the country has seen a great demand for extension services. With an estimation of about 5000 extension officers the country clearly cannot cope with the demand and has had to use innovative means to overcome this challenge. The country recently introduced e-extension services that aim to overcome the challenge of low staffing. With relatively high mobile phone and Internet penetration rates the country is leveraging on these technologies for the e-extension project and use a variety of technology platforms such as Whatsapp, and other messaging platforms to communicate with farmers in mass (BiztechAfrica, 2014).

Over the past two and a half decades there has been a number of agricultural ICT based initiatives that have been introduced in Africa and

Table 1 shows a brief summary of these innovations.

Survey of ICT-Based Agricultural Extension Programs in Africa				
Mechanism/Project	**Type of Information (Prices, Techniques, Inputs, Buyers/Sellers, General)**	**Country**	**Mechanisms (Voice, SMS, Internet)**	**Website**
Voice				

Allo Ingenier	General	Cameroon	Voice	http://www.irinnews.org/Report.aspx?ReportId=78408
Banana Information Line	Techniques (bananas)	Kenya	Text-to-speech	http://www.comminit.com
Southern Africa Development Q&A Service	General	South Africa	Voice	
National Farmer's Information Service (NAFIS)	General	Kenya	Voice	http://www.nafis.go.ke/termcond
T2M (Time to Market)	Prices, supply	Senegal	Voice, SMS, Internet	http://t2m.manobi.sn/
Millennium Information Centers and Community Parliaments	General	Kenya	Voice, SMS	
Question and Answer Service (QAS) Voucher System	General	Uganda	Voice (ask question), radio, internet	
Kenya Farmer's Helpline	Market prices, weather	Kenya	Voice	
Mechanism/Project	**Type of Information (Prices, Techniques, Inputs, Buyers/Sellers, General)**	**Country**	**Mechanisms (Voice, SMS, Internet)**	**Website**
Radio Dial-Up				
African Farm Radio Research Initiative (AFRRI)	General	Ghana; Malawi; Mali; Tanzania; Uganda	Radio	http://www.farmradio.org
Family Alliance for Development and Cooperation (FADECO)	General	Tanzania	Radio, SMS	http://www.hedon.info/FADECOTanzania
Freedom Fone	General	Zimbabwe	Voice, SMS, Internet	http://www.kubatana.net
Infonet Biovision Farmer Information Platform	Techniques	Kenya	Radio	

Information Network in Mande	Techniques	Mali	Radio	
Jekafo Guelekan System for Farmers in Sikasso	General	Mali	Radio	
The Organic Farmer	Techniques	Kenya	Radio, internet, magazine	www.organicfarmermagazine.org
Strengthening the Agricultural InformationFlow and Dissemination System	General	Zambia	Radio	
Mechanism/Project	**Type of Information (Prices, Techniques, Inputs, Buyers/Sellers, General)**	**Country**	**Mechanisms (Voice, SMS, Internet)**	**Website**
Internet				
Agriculture Research and Rural Information Network (ARRIN) Ndere Troupe	General	Uganda	Internet	http://www.iicd.org/projects/uganda-arrin
Agrovision	Techniques	Nigeria	Internet	http://www.eagriculture.org
Agricultural Sector Development Programme	General	Tanzania	Internet, SMS	http://www.ifad.org/operations/pipeline/pf/tan.htm
Collecting and Exchanging of Local Agricultural Content (CELAC)	General	Uganda	Internet, radio, email, SMS	http://celac.or.ug
CROMABU (Crops Marketing Bureau) Project	Prices/Buyers/Sellers	Tanzania	Telecenter (computers)	http://www.iicd.org/projects/tanzania-abis-cromabu
DrumNet (Solution)	Prices/Buyers/Sellers	Kenya, Uganda	Internet	http://www.drumnet.org/

Eastern Corridor Agro-market Information Centre (ECAMIC)	Prices	Ghana	Email, mobile phones	http://www.sendfoundation.org
E-commerce for Non-traditional Exports	Buyers, sellers	Ghana	Internet	http://www.iicd.org/projects/ghana-ecommerce/
E-commerce for women	Buyers, sellers	Ghana	Internet	
Enhancing Access to Agricultural Information using ICT in Apac District	Techniques	Uganda	Radio, mobile phones	http://www.comminit.com
Farmers' Internet Café	Buyers, sellers, general	Zambia	Internet	http://www.iicd.org/articles/iicdnews.2005-09-06.1315910878/
First Mile Project	Buyers, sellers	Tanzania	Internet	http://www.firstmiletanzania.net/
Fruiléma	Buyers, sellers	Mali	Internet, mobile phones	http://www.fruilema.com/ http://www.iicd.org/projects/mali-quality-fruilema
ICT for Shea Butter Producers	General	Mali	Computers	
Miproka	General	Burkina Faso	Interet (computers)	
Sene Kunafoni Bulon	Buyers, sellers	Mali	Internet (computers)	
Sissili Vala Kori	General	Burkina Faso	Internet (computers)	
TV Koodo: Market price information using web and national TV	Market prices	Burkina Faso	Internet, TV	
Virtual extension and research communication network	General	Egypt	Internet	
Mobile Money Transfers (SMS)				
Mobile Transactions Zambia	Cashless input voucher system	Zambia	Mobile scratchcards	http://www.mtzl.net<http://www.mtzl.net/default.asp?id=18

Mobile Phone Data Collection				
Integrating ICT for Quality Assurance and Marketing	Production quality, buyers	Zambia	Handheld computers	
Research on Expectations about Agricultural Production (REAP)	Weather, pests	Tanzania	Voice	
SMS-Based Extension and Price Information Services				
Agricultural Marketing and Information System for Malawi (MIS-Malawi)	Prices, Buyers, Sellers	Malawi	SMS, internet, radio	http://www.ideaamis.com
Agricultural Marketing Systems Development Programme (AMSDP)	Prices	Tanzania	SMS	http://www.ifad.org/english/operations/pf/tza/i575tz/index.htm
Agricultural Research Extension Network (ARENET)	General	Uganda	Internet	http://www.arenet.or.ug
Apps for Africa	Techniques, weather, buyers, sellers	Uganda	SMS	
CELAC	Techniques, weather, buyers, sellers	Uganda	SMS	
Esoko (formerly Tradenet)	Prices, buyers, sellers	Benin; Burkina Faso; Côte d'Ivoire; Ghana; Madagascar; Mali; Mozambique; Nigeria; Tanzania; Uganda; Cameroon	SMS, internet	http://www.esoko.com
Farmers Information Communication Management (FICOM)	Prices, buyers, sellers	Uganda	Voice, SMS, internet, radio	http://www.syngentafoundation.org
ICT Support for Agricultural Literacy	Market prices	Ghana	SMS	
Mechanism/Project	**Type of Information (Prices, Techniques, Inputs, Buyers/Sellers, General)**	**Country**	**Mechanisms (Voice, SMS, Internet)**	**Website**
"ICT for Improving Agriculture in Rwanda"	"General"	"Rwanda"	"SMS"	"http://www.spidercenter.org"

Informations sur les Marches Agricoles par Cellulaire (IMAC)	Prices	Niger	SMS	http://sites.tufts.edu/projectabc
InfoPrix Benin	Prices	Benin	SMS	http://www.onasa.org/
Infotrade Uganda	Prices	Uganda	SMS, internet	
Kenya Agricultural Commodities Exchange (KACE) MIS Project	Prices, buyers, sellers	Kenya	Voice, SMS, internet	http://www.kacekenya.com/
Livestock Information Network and Knowledge System (LINKS)	Prices, buyers, sellers	Kenya, Ethiopia, and Tanzania	SMS, internet	Kenya (www.lmiske.net), Ethiopia (www.lmiset.net), and Tanzania (www.lmistz.net)
Manobi	Prices	Senegal	SMS	http://www.manobi.net
Makuleke Project	Prices, buyers, sellers	South Africa	SMS	Http://www1.alcatellucent.com
Network of Market Information Systems and Traders' Organizations of West Africa (MISTOWA)	Prices, buyers, sellers	ECOWAS countries	Internet, radio, email, SM	www.mistowa.org, www.wa-agritrade.net
Regional Agricultural Trade Information Network (RATIN)	Buyers and Sellers	East Africa	Voice, internet	www.ratin.net
Vodacom Tanzania	Prices	Tanzania	SMS	
SMS Information Service	Prices, buyers, sellers	Zambia; Democratic Republic of Congo	SMS, internet	http://www.farmprices.co.zm/
Système d'Information des Marchés Agricoles (SIMA)	Prices	Niger	SMS	http://ictupdate.cta.int
"Trade at Hand"	Prices	Burkina Faso; Mali; Senegal; Mozambique; Liberia	SMS	http://www.intracen.org/trade-at-hand/
West African Agricultural Market Information System Network (RESIMAO/WAMIS-Net)	Prices, buyers, sellers	Benin; Burkina Faso; Côte d'Ivoire; Guinea; Niger; Mali; Senegal; Togo; Nigeria	Internet, radio, email, SMS	http://www.resimao.org/html/en
Women of Uganda Network (WOUGNET)	Prices	Uganda	SMS	

Xam Marsé	Prices, buyers, sellers	Senegal	SMS, internet	http://www.manobi.sn

Table 1: ICT-Based Agricultural Extension Programs in Africa adopted from Gakuru, Winters, and Stepman (2009, p. 4)

2.3.5 ICTs for Food Security in South Africa

In Africa agriculture plays an important role towards ensuring food secure communities. Smallholder farming contributes significantly to providing livelihoods to a majority of the population in Africa (World Bank, 2008b). A common characteristic trait of smallholder farmers is their limited resources. The advent of ICTs has now created opportunities to improve smallholder farmer production levels as they now can be exposed to much needed agricultural information for production and post-production information such as market access and marketing information (Munyua & Adera, 2009). The 2007/2008 global food price crisis contributed to the rise in food insecurity in South Africa with the worst affected provinces being KwaZulu-Natal (Jacobs, 2010). This increase in food insecurity in the country increased the need for interventions that would reduce food insecurity. One such intervention is the use of ICTs to transfer much needed agricultural information to smallholder farmers that would help them increase their production and resilience to climate shocks. Okello, Al-Hassan, and Okello (2010) identify South Africa as one of the countries in Africa that uses ICT based applications to transfer agricultural information to smallholder farmers. To an extent emerging ICTs are being used in South Africa, these include technologies such as GIS to support precision agriculture (PA). This technique is mainly being used for irrigation purposes that is in accordance with soil typology and types (Munyua & Adera, 2009). Munyua and Adera (2009) also state that with the influence of European Union standards on traceability, RFID technology is also being made use of in the livestock industry in order to keep track of the origins of animals.

A major challenge regarding ICTs in South Africa has been the lack of an integrated national ICT policy. This problem was identified by earlier authors (Van Audenhove, 2003) who noted that this situation resulted in the intertwining of programmes and policies. This has been evident during implementations of projects in coordinating them. The lack of an integrated policy is also evident from the number of ICT initiatives, the overlap in initiatives and the number of actors and stakeholders involved (Van Audenhove, 2003). This situation has continued and ICT policy currently is being influenced by the different initiatives being developed by the various government departments. The recently published National Integrated ICT Policy Green Paper by the Department of Communications (2014) is a positive move towards meeting the challenge of coordination and implementation of ICT based innovations.

2.3.6 ICTs for Food Security in KwaZulu-Natal

The potential for ICTs as a tool for information exchange between solution providers and problem holders has been acknowledged by a number of authors. In a study on the dissemination of information on climate change to rural women mussel harvesters in KwaZulu-Natal, Jiyane and Fairer-Wessels (2012) acknowledge the importance of ICTs in the transfer of information. The authors also acknowledge the importance of indigenous knowledge in creating resilience to climate change and identify the mobile phone as a possible ICT innovation to use to transmit information. The Wishvast Network is an example of an ICT innovation that has been implemented in order to draw out the full potential of the mobile phone through the creation of groups that are of common interest. This innovation also allows members to increase the awareness of their products and services through advertising to group members with similar interests (Jiyane & Fairer-Wessels, 2012). This ICT innovation can have a significant positive influence on the farming activities of the women mussel harvesters in KwaZulu-Natal through the provision of weather information. Gumede, Bob, and Okech (2009) in their study, identify the radio, television, mobile phone and the landline in that order as available ICTs in the region. The study revealed that adults in these communities were of the view that they do not need to know about ICTs as they were believed them to be for the younger generation.

2.4 The Smallholder Farmer

Smallholder farming in Africa is of great importance in providing much-needed jobs and much needed income to the poor, especially in rural communities (World Bank, 2008b). It is the smallholder farmers positive contribution towards food security that cannot be ignored (Aliber, Kirsten, Maharajh, Nhlapo-Hlope, & Nkoane, 2006). Aliber et al. (2006) note that in South Africa, smallholder farmers are affected by land tenure issues and the majority of them are located in areas were the soil is not very suited for agricultural activities and are under communal land. In providing an understanding of the agrarian structure in South Africa, Aliber and Cousins (2013) contend that of the estimated 2 million households that practice smallholder farming, the majority farm for consumption with a small number for income purposes.

Over the years there has been increased calls and focus towards organic farming. This is due to the acknowledgement that this method of farming contributes positively to environmental sustainability through methods such as avoiding the use of synthetic chemical substances as fertilizers or for pest control (Greene & Kremen, 2003). Hellin and Higman (2002) argues that smallholder farmers can through the use of organic farming methods, achieve commercial targets that they cannot do using conventional farming. This alternative farming method is an attractive choice to smallholder farmers as these are people who are characterized as farmers with little financial and farming capacity. The use of

organic farming can help reduce the smallholder farmers cost as it eliminates the use of pesticides that in turn cuts down on the input costs. Similarities can be drawn between organic farming and indigenous African farming methods hence making it a suitable option for smallholder farmers. Before the introduction of synthetic chemicals in agriculture, farmers depended on planting companion crops, rotating crops planted on the same piece of land and the use of natural green manure. A number of smallholder farmers still do practice this type of farming due to financial constraints that inhibit them accessing these synthetic products and inputs. The passage of time and the influence of using synthetic products are having an impact on the indigenous African farming methods as this knowledge is beginning to be lost.

2.4.1 Gender Inequalities in Smallholder Farming

In order to improve food security through smallholder farming, an equal exposure to critical farming information to both male and female smallholder farmers is necessary. The relatively low access of extension services by smallholder farmers to critical farming information remains problematic and even more so in female smallholder farmers (World Bank, 2010). Food and Organization (2011) acknowledges the importance of addressing the gender inequalities that exist amongst smallholder farmers. Resolving existing inequalities in access to production resources including critical information, has the potential to increase yields on female owned farms by 20 to 30 percent. This also has an overall impact on developing nations and can improve agricultural production by between 2.5 percent to 4 percent (Food & Organization, 2011). Manfre et al. (2013) notes that the introduction by the World Bank of the Agricultural Knowledge Information System (AKIS) to help address the problem of access to extension services by smallholder farmers failed to address the gender issue. The recently introduced Agricultural Innovation Systems (AIS) although better suited in terms of it offering customisation unlike the previous ICT based innovation that was more based on best practices and one size fits all has also unfortunately failed to address the gender challenge. It is these oversights related to addressing the gender challenge that Manfre et al. (2013) point to the contradiction that despite the generally agreed upon view that women are key players in agricultural development, there is no equitable application of this recognition (UN News Centre, 2010). Peterman, Behrman, and Quisumbing (2014) warns of potential conflict if attention is not placed on understanding the broader gender relation aspects. The authors also advocate for the mainstreaming of the gender challenge in agricultural research. Manfre and Nordehn (2013) state that both male and female smallholder farmers use the mobile phone similarly. The authors also found that females had a smaller network than males in their use of mobile phones and that the females were highly dependent on their male spouses for farming information.

2.4.2 Indigenous and Institutional Knowledge

Ajibade (2003) expounds that despite the various definitions of indigenous knowledge (Mishra, 1989; Odhiambo, 1990; Warren, 1992) they all have a similar meaning. Indigenous knowledge is local knowledge developed by a particular ethnic group over a long period of time to serve subsistence needs of a particular local environment. Indigenous knowledge involves the use of experiences and skills that are handed down from generation to generation. Robertson, Scarbrough, and Swan (2003) describe institutional knowledge as knowledge that has been created by professionals and is preserved in document form.

Knowledge sharing involves the transfer of existing information from one person to another (Berends, Bij, Debackere, & Weggeman, 2006). An important aspect of knowledge sharing is the sourcing of the information. An existing problem with knowledge sharing has been the ability to identify sources of information and connecting those sources with people who need the information (Gray & Meister, 2004; Huber, 1991). Other earlier authors such as Hargadon and Sutton (1997) also identified the problem of transferring information between those with solutions and those in need of solutions. There is need to create connections between solutions and problems. It is these connections that are usually the birth of innovations as existing solutions are combined to create new solutions to problems. The use of ICTs is an example of ways in which boundaries between problems and solutions can be broken thereby allowing a wealth of information to be made available to people or organisations in a manner that was not ever possible before. The advent of the Internet has also contributed to this interconnectedness and has increased the availability of information that was never possible from all parts of the world. Despite the vast possibilities that ICTs bring in terms of information sharing and storage Appel-Meulenbroek, de Vries, and Weggeman (2014) argue that ICTs are not as effective as face-to-face communication as it cannot convey emotions as is the case with the latter. The authors also suggest that ICTs are more suited for communicating an institutional type of knowledge.

2.4.3 Culture

Quisumbing and Pandolfelli (2010) contend that cultural norms are an important aspect to the success of a smallholder farmer and specifically points at gender bias as the biggest challenge. It is due to cultural differences that the author argues that interventions aimed at resolving challenges female farmers undergo differs greatly between countries. These cultural differences have created the perception in a number of countries that women are not responsible for agricultural decision-making and as a result this biased perception has negatively impacted female smallholder farmer's access to extension services. In countries such as Kenya, Uganda and Ethiopia where this gender bias is strong, this perception has also negatively impacted the number of female extension officers (Quisumbing & Pandolfelli, 2010). This viewpoint on

culture is shared by authors such as Tittonell et al. (2010) who state that culture also impacts farming practices and land use by the smallholder farmer.

For the purposes of this study the concept of culture is based on the views and interpretation of works by Geert Hofstede (Hofstede, 1980a, 2013, 1991). With regards to theories that focus on the role of culture on adoption, the cultural dimensions theory by Hofstede is amongst the most popularly used theories on culture. In an attempt to explain human mental programming at both individual and at a social systems level, Hofstede (1980a) identified values and cultures as key constructs. Parsons (as cited in Hofstede, 1980) defined culture as "transmitted and created content and patterns of values, ideas, and other symbolic-meaningful systems as factors in the shaping of human behaviour and the artefacts produced through behaviour."

Sartorius and Sartorius (2013) also attributes South African historical legacies of colonialism and apartheid, which gave rise to laws such as the Land Act of 1913 that had an influence on the cultural dimensions of the country. These legacies had an impact on the location of communities, the manner in which people perceived various languages and education systems (Crystal, 2012; Sartorius & Sartorius, 2013; Spaull, 2013).

2.4.4 Accessing Markets

Matungul, Lyne, and Ortmann (2001) expounds that the wide geographical spacing of smallholder farmers coupled with poor access to road and communication networks tend to be a significant challenge to smallholder farmers. The authors also note that it is these issues and the low volume of business that are not an attractive choice for private sector transport operators to want to service these areas. The formation of farmer groups or developing partnerships with better established commercial farmers can help overcome the challenge of marketing and physical accessibility to the markets (Matungul et al., 2001). These types of partnerships have the effect of reducing marketing costs and increasing the farmer's crop income. Aliber et al. (2006) identify a number of challenges such as lack of information, policy frameworks and physical challenges that are barriers to smallholder farmers in accessing markets for their produce. There is need for governments to create policy frameworks to encourage these partnerships that will support smallholder farmers in accessing markets. Over the years, the creation of farmer groupings such as cooperatives have become popular in order to overcome high transaction costs (Fischer & Qaim, 2012; Narrod et al., 2009) as has been alluded to by earlier authors. While evidence exists of the inability of smallholder farmers to participate competitively in market, evidence shows that their collective efforts and with institutional support such as extension services they can successfully participate in these activities (Narrod et al., 2009). The use of mobile phones in information transfer can potentially and significantly impact the cost of doing business by reducing the information transfer cost. Fischer and

Qaim (2012) identify the mobile phone as one of the factors that determines joining farmer groups. This is because smallholder farmers who have ownership of a mobile phone, are more easily contactable and due to their advantage in communication, usually are privy to information pertaining to the formation of a farmer group (Fischer & Qaim, 2012).

2.4.5 Information Access and Decision Making

Mittal, Gandhi, and Tripathi (2010) states that smallholder farmers require mainly information that can be classified into three categories; 1. Information on farming methods and what to plant 2. Contextual information e.g. climate data 3. Information related to markets e.g. prices of products and demand. The study also revealed the potential of mobile phones as a technology for the transfer of agricultural information. This is due to the ICT innovation being convenient and its positive contribution towards cost savings (Mittal et al., 2010).

Worth (2012) acknowledges the importance of technology in an effort to support information access and transfer that can significantly contribute to the success of the agrarian reform process. This is a similar position held by Rivera, Alex, Hanson, and Birner (2006) who contend that the agricultural information systems should consist of three components of agricultural research, agricultural extension services and agricultural education services and the farmer should be based at the core of these flows. Earlier authors such as Axinn and Thorat (1972) also agreed to the use of these three pillars in the agricultural development process and emphasised that information flows should not only be in one direction to the farmer. The authors also stressed the importance of incorporating other sources of information and not limiting it to just the three pillars, and suggested incorporating information from aspects such as financial institutions and the markets. This way, decision making can be more informed and farmers can make better decisions to increase production and in supplying markets.

Kiiza and Pederson (2012) contend that opportunities for accessing ICT market based information are greater for smallholder farmers who retain membership of cooperatives and other famer organisations. This is similar for opportunities to access micro finance loans (Kiiza & Pederson, 2012). The authors state that in order to have a positive role in food security, access to ICT based market information should be promoted.

2.4.6 Smallholder Farmer Literacy

Organisation for Economic Co-operation and Development (OECD, 2000) define literacy as the "ability to read and write a short and simple statement with understanding." There is no single measure of adult literacy as it is commonly measured by using the level of formal education attained (Aitchison & Harley, 2004). Pretorius (2002) expounds that there is a difference between reading for communication and for

academic purposes and being able to communicate well does not translate into a good academic performance. It is this school of thought that argues that the use of level of education attained as being simplistic and flawed. In a study by Hough and Home (2001) which involved a sample of 766 grade 12 school leavers who took an English literacy test, 95% of the school leavers had a reading ability of below grade 8 with 3% at grade 8 level and only 2% at a level above grade 8. The use of the English language as the language of conveying academic content has been a subject of much debate and authors like Phillipson (1996) argue that this creates a "elitist" class that become isolated within their own communities. It is for this reasons that the United Nations (2007) declaration on the rights of indigenous peoples (article 16) stated that indigenous people had the right to develop content in their own language. Benson (2004, p. 2) explains that "learning to read is most efficient when students know the first language and can employ psycholinguistic guessing strategies". Kadigi et al. (2013) agrees with this view and identifies this perspective as one of the challenges with ICT innovations that present information in English especially in situations where the literacy levels are low. Maumbe and Okello (2013) expound that literacy is positively associated with adoption of ICT, hence the higher the literacy the greater the likelihood of ICT adoption. The authors suggest that increased government support in basic education can increase literacy levels and hence have a positive effect on ICT adoption. According to the Department of Education (2011) report on KwaZulu-Natal adult education and training, illiteracy levels in iLembe district are being tackled by a number of government projects. This revelation this is encouraging.

2.4.7 Rural Extension

The history of extension services in South Africa can be divided into two tiers: the pre-1994 era of 69 years and the post 1994 era of 21 years to date. The former tier included extension services that were demarcated or organized according to the different races – African, Indian and Coloured. For instance, Indian farming communities were closely intertwined with the sugar industry that started in the then Natal – KZN in 1857 where they cultivated crops on small pieces of rented land on short leases. Their extension service initially promoted production and conservation of resources. Due to a large number of Indian sugar cane farmers (which imposed a physical limitation on giving equal attention to all farmers), extension services concentrated on a small number of larger farmers. It was assumed that the extension message would diffuse among farmers from initial points of contact although the trickle-down effect was disappointingly ineffective. Agricultural extension usually operates on a top-down approach maintaining weak linkages with agricultural research, education, and other farm-support system. It is due to this flaw that Rivera et al. (2006) recommend building stronger ties with agricultural research. South Africa also saw a growth in extension services rendered by cooperatives that function solely to the advantage of their smallholder farmers. Some of the services provided include plant-breeding initiatives, manufacturing of agricultural implements.

In Chennai India when an innovation of high yielding crops was introduced (Samanta, 2010) a question was put to a farmer from the area enquiring how the use of this introduced innovation had impacted his income. The farmer responded by saying "through the use of these rice varieties he had increased his income about five fold. He was grateful to the government Village Extension Worker who had taught him which varieties to grow, how much and which fertilizers to use, how to irrigate, etc…" (Samanta, 2010, p. 34). This response has been evidenced in a number of cases where extension services are extended to smallholder farmers and are able to resolve their problems or attain increases in yields. It is from such accounts that show that the relationship between the extension officer and the farmer is critical.

Genius, Koundouri, Nauges, and Tzouvelekas (2014) contend that extension services and social learning are strong determinants for technology adoption and diffusion. The authors suggest that the two have to be present together as one enhances the other in terms of effectiveness. The involvement of extension officers in the technology adoption process by smallholder farmers, is also supported by other authors (Rogers, 1963). This study shows the influences by the extension officer on the smallholder farmer in terms of technology adoption and use.

Magdalena and Rome (2007) contends that extension services take various models and categorises them into three models as shown in Table 2.

	EXTENSION MODELS/APPROACHES		
Characteristics	Linear	Advisory	Facilitation
Purpose	Production increase through transfer of technology	Holistic approach to farm	Empowerment and ownership
Source of Innovation	Outside innovations	Outside innovations and by farm	Local knowledge and innovations
Promoter's Role	Extending knowledge	Providing advice	Facilitating
Farmer's Role	Passive: others know what is best Adopting recommended technologies	Active: problem solving Asking for advice	Active: problem solving; owns the process Learning by doing Farmer-to-farmer
Assumptions	Research corresponds to farmer's problem	Farmer knows what advisory services he needs	Farmer willing to learn to interact and to take ownership
Supply/Demand	Supply	Demand	Demand
Orientation	Technology	Client	Process

'Target'	Individuals Farmer organisations Projects	Individuals Groups with common problems	Groups and organisations, interaction of stakeholders, networking

Table 2: Comparison of Extension Approaches Magdalena and Rome (2007).

The three models presented (Table 2) were later expanded to four to include the Learning model by Worth (2012) in the Department of Agriculture, Forestry and Fisheries discussion paper of 2012. The author suggests a need for the extension officer to be knowledgeable in all models and that there is no one correct model but rather the choice of model is influenced by the smallholder farmer's need and what best exposes and empowers the smallholder farmer.

As discussed earlier, agricultural extension over the years has changed in roles (Magdalena & Rome, 2007; Rivera et al., 2006) where agricultural research was the centre for innovations, extension services the conduit for innovation transfer and the farmer, the recipient of the innovations. Nowadays, all three pillars are considered as equal and information flows being in all directions between the pillars and to and from the farmer who is based at the centre (Rivera et al., 2006). Despite the changes in extension services Quisumbing and Pandolfelli (2010) states that extension services should retain the traditional model of provision of extension services. This is evident by the still present demand for individual visits by extension officers despite the more recent shift to farmer based organisational support (World Bank, 2010).

2.5 Conclusion

The emergence of ICTs has not just seen huge technological changes but has also significant changes in the manner in which things are done. One of the biggest roles of ICTs has been the ability to remove distance as a barrier to communication. Now more than ever before, people from distant areas are able to be part of a digital community. It is such benefits ICTs bring that they are being now being incorporated in the development process. ICTs have taken such a centre stage in the development process so much so that the use of these technologies are being encouraged in the millennium development goals (MDGs) of the United Nations and now in the newly adopted sustainable development goals (SDGs).

This chapter presented findings of national and international studies regarding ICTs used in development ranging from established to emerging ICTs. The study brought together the fields of food security and ICTs and catalogued the various ICT based initiatives from a global to a national, and finally a provincial level in South Africa. In the aforementioned chapter, gaps in literature were also identified in which this study sought to contribute to. This chapter also provides a background of the smallholder farmer and

extension services and positions the smallholder farmer in terms of the broader discussion of ICTs and their role in farming. In the next chapter, the theoretical frameworks that form the base through which this study is conducted are discussed.

CHAPTER 3

THEORETICAL FRAMEWORK

The theoretical underpinning of the study

"Everything must be taken into account. If the fact will not fit the theory---let the theory go."

(Christie, 1935, p. 109)

3.1 Introduction

In the previous chapter a review of various key literatures that underpinned the study on ICTs and the smallholder farmer was conducted. The literature review also included a review of ICT for development (ICT4D) and ICTs for agriculture (ICT4Ag). The gaps in the literature revealed the need for empirical studies on the role ICTs play in improving food security amongst smallholder farmers in South Africa. Figure 9 illustrates where this chapter is situated within the overall research strategy.

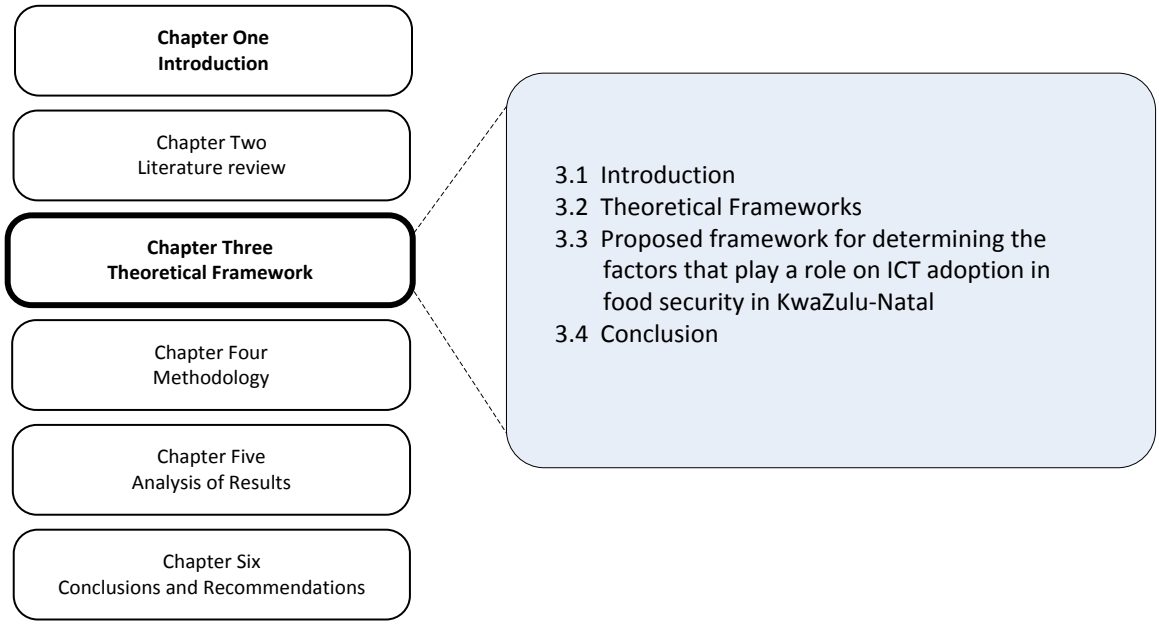


Figure 9: Chapter 3 within the overall research strategy - Phase 2 of the Study

In this chapter, a further review of literature is conducted. The literature review conducted in this chapter relates to the diffusion and adoption of technology theories with the intention of developing a framework. The framework will serve as a lens through which the researcher investigates the role that ICTs play in improving food security in KwaZulu-Natal. The chapter also contains discussions on the theories to be

used in the framework. Justification is also made for the choices of theories that were used to guide the development of the data collection instrument. Furthermore the research objectives, research questions, theoretical framework and the research instruments are aligned to provide a coherent strategy with which the research questions are addressed (Table 4).

3.2 Theoretical Frameworks

Venkatesh, Morris, Davis, and Davis (2003) identify two foci in Information Systems (IS) research; research which focuses on intention or usage of technology by individuals while the other focuses on organizations and the rates of success of implementing IS projects. This classification of research foci is similar to that offered by Coleman (1986) who identified macro and micro levels of a social system. The researcher borrows from these distinctions to classify the various theories used in information systems research (Larsen, Allen, & Eargle, 2014). Venkatesh et al. (2003) developed a conceptual framework (Figure 10) which they used to identify the group of theories that are used to explain information technology acceptance at an individual level with the main dependent variable being intention to use or usage of technology. Venkatesh et al. (2003, pp. 428-432) identified eight theories that use intention to use or usage of technology (Figure 10) as their main dependent variable in adoption and user acceptance research. The authors went a step further and tabulated these theories showing their core constructs (Table 3).

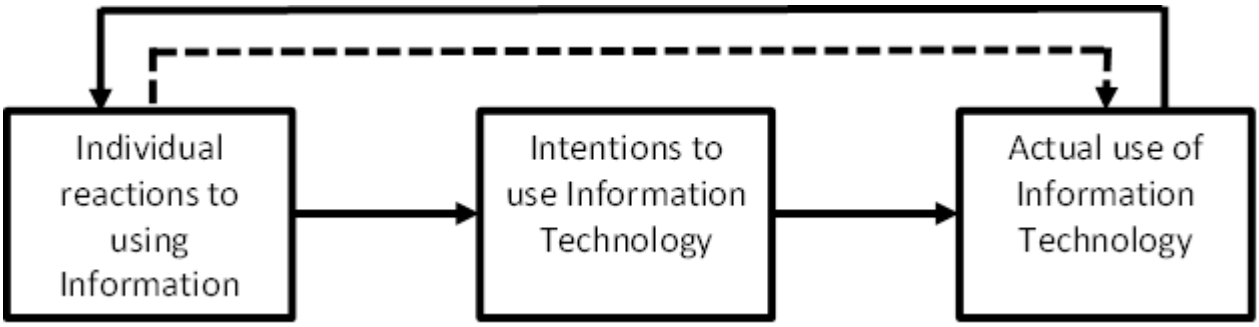


Figure 10: Basic Concept Underlying User Acceptance Models (Venkatesh et al., 2003)

The researcher classified these theories in relation to the level of the social system they address (Coleman, 1986). The Technology Organizational and Environmental Theory (TOE) was deemed to be inappropriate for this study in that it focuses at a macro level (organizational level) when this study focuses primarily on smallholder farmers (micro level). The model of PC utilization (MPCU) was identified to be at a micro level that was the level of focus of the study although this theory was not suitable due to it having a very narrow focus in terms of ICTs (the personal computer). The Unified Theory of Acceptance and Use of

Technology (UTAUT) were also identified as a possible conceptual framework to use as it is usually applied at the micro level of social systems. This theory is constructed using eight previously identified theories of user acceptance. The main reason it was not selected to be used in this study was that UTAUT is mostly used in studies as a predictive conceptual framework (Attuquayefio & Addo, 2014; Hou, 2014; Oh & Yoon, 2014) rather than a descriptive framework. Table 3 shows details of the eight models commonly used in user acceptance research as identified by Venkatesh et al. (2003). Muinde (2009, p. 44-48) provides a summary of the eight most commonly used theories of user acceptance and identifies the constructs of each theory used Table 3.

Models and Theories of Individual Acceptance		
Theory of Reasoned Action (TA)	**Core Constructs**	**Definitions**
Drawn from social psychology, TRA is one of the most fundamental and influential theories of human behaviour. It has been used to predict a wide range of behaviour. Davies *et al.* (1989) applied TRA to individual acceptance of technology and found that the variance explained was largely consistent with studies that had employed TRA in the context of other behaviour.	Attitude toward behaviour	An individual's positive or negative feelings (evaluative effect) about performing the target behaviour (Fishbein and Ajzen 1975, p. 216).
	Subjective norm	The person's perception that most people who are important to him think he should or should not perform the behaviour in question (Fishbein and Ajzen 1975, p. 302).
Technology Acceptance Model (TAM)		
TAM is tailored to IS contexts, and was designed to predict information technology acceptance and usage on the job. Unlike TRA, the final conceptualization of TAM excludes the attitude construct in order to better explain intention parsimoniously. TAM2 extended TAM by including subjective norm as an additional predictor of intention in the case of mandatory settings (Venkatesh and Davis 2000). TAM has been widely applied to a	Perceived Usefulness	The degree to which a person believes that using a particular system would enhance his or her job performance (Davis 1989, p.320).
	Perceived Ease of Use	The degree to which a person believes that using a particular system would be free of effort (Davis 1989, p.320).

diverse set of technologies and users.		
Motivational Model (MM)		
A significant body of research in psychology has supported general motivation theory as an explanation for behaviour. Several studies have examined motivational theory and adapted it to specific contexts. Vallerand (1997) presents an excellent review of the fundamental tenets of this theoretical base. Within the information systems domain, Davis *et al*. (1992) applied motivational theory to understand new technology adoption and use (see also (Venkatesh and Speier 1999)).	Extrinsic Motivation	The perception that the users will want to perform an activity "because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself, such as improved job performance, pay, or promotions" (Davis, Bagozzi et al. 1992, p.1112).
	Intrinsic Motivation	The perception that users will want to perform an activity "for no apparent reinforcement other than the process of performing the activity per se" (Davis, Bagozzi et al. 1992, p.1112).
Theory of Planned Behaviour (TPB)		
TPB extended TRA by adding the construct of perceived behavioural control.	Attitude toward behaviour	
Models and Theories of Individual Acceptance		
Theory of Reasoned Action (TA)	**Core Constructs**	**Definitions**
	Subjective norm	Adapted from TRA
	Perceived	The perceived ease or difficulty of performing the

	Behavioural control	behaviour (Ajzen 1991, p. 188). In the context of IS research, "perceptions of internal and external constraints on behaviour" (Taylor and Todd 1995, p. 149).
Combined TAM and TPB (C-TAM-TPB)		
This model combines the predictors of TPB with perceived usefulness from TAM to provide a hybrid model (Taylor and Todd 1995)	Attitude toward behaviour	Adapted from TRA/TPB.
	Subjective norm	Adapted from TRA/TPB.
	Perceived behavioural control	Adapted from TRA/TPB.
	Perceived usefulness	Adapted from TAM.
Model of PC Utilization (MPCU)		
Derived largely from Triandis' (1977) theory of human behaviour, this model presents a competing perspective to that proposed by TRA and TPB. Thompson, Higgins, & Howell (1991) adapted and refined Triandis' model for IS contexts and used the model to predict PC utilization. However, the nature of model makes it particularly suited to predict individual acceptance and use of a range of information technologies. Thompson, *et al.* (1991) sought to predict behaviour rather than	Job-fit	"The extent to which an individual believes that using [a technology] can enhance the performance of his or her job" (Thompson, Higgins et al. 1991).
	Complexity	Based on Rogers and Shoemaker (1971), "the degree to which an innovation is perceived as relatively difficult to understand and use" (Thompson, Higgins et al. 1991, p. 128)
	Long-term	Outcomes that have a pay-off in the future

intention; however, in keeping with the theory's roots, the Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh, *et al.* (2003) has examined the effect of these determinants on intention to facilitate fair comparison of the different models.	consequences	(Thompson, Higgins et al. 1991, p. 129)
	Affect towards use	Based on Triandis, affect toward use is "feelings of joy, elation, or pleasure, or depression, disgust, displeasure, or hate associated by an individual with a particular act" (Thompson, Higgins et al. 1991, p. 127)
	Social factors	Derived from Triandis, social factors are 'the individual's internalization of the reference group's subjective culture, and specific interpersonal agreements that the individual has made with others, in specific social situations" (Thompson, Higgins et al. 1991, p. 126)
Models and Theories of Individual Acceptance		
Theory of Reasoned Action (TA)	**Core Constructs**	**Definitions**
	Facilitating conditions	Objective factors in the environment that observers agree make an act easy to accomplish. For example, returning items purchased online is facilitated when no fee is charged to return the item. In an IS context, "provision of support for users of PCs may be one type

		of facilitating condition that can influence system utilization" (Thompson, Higgins et al. 1991, p. 129)
Diffusion of Innovation Theory (DOI)		
Grounded in sociology, DOI (Rogers 2003) has been used since the 1960s to study a variety of innovations, ranging from agricultural tools to organisational innovation (Tornatzky and Klein 1982). Within information systems, Moore and Benbasat (1991) adapted the characteristics of innovations presented in Rogers and refined a set of constructs that could be used to study individual technology acceptance. Moore and Benbasat (1996) found support for the predictive validity of these characteristics (see also (Agarwal and Prasad 1997; Agarwal and Prasad 1998; Karahanna, Straub et al. 1999; Plouffe, Hulland et al. 2001).	Relative advantage	"the degree to which an innovation is perceived as being better than its precursor" (Moore and Benbasat 1991, p. 195).
	Ease of use	"The degree to which an innovation is perceived as being difficult to use" (Moore and Benbasat 1991, p. 195).
	Image	"The degree to which use of an innovation is perceived to enhance one's image or status in one's social system" (Moore and Benbasat 1991, p. 195)
	Visibility	The degree to which one can see others using the system in the organization (adapted from Moore and Benbasat (1991).
	Compatibility	"The degree to which an innovation is perceived as being consistent with the existing values, needs, and past experiences of potential adopters" (Moore and Benbasat 1991, p.195).
	Results demonstrability	"The tangibility of the results of using the innovation, including their observability and communicability" (Moore and Benbasat 1991, p. 203).
	Voluntariness of	"The degree to which use of the innovation is

	use	perceived as being voluntary or free will" (Moore and Benbasat 1991, p. 195).
Social Cognitive Theory (SCT)		
One of the most powerful theories of human behaviour is social cognitive theory (see (Bandura 1986)). Compeau and Higgins (1995) applied and extended SCT to the context of computer utilization (see also Compeau, Higgins, & Huff (1999)). Compeau and Higgins (1995) model studied computer use but the nature of the model and the underlying theory allow it to be extended to acceptance and use of information technology in general. The original model of Compeau and Higgins (1995) used usage as a dependent variable but in keeping with the spirit of predicting individual acceptance, Venkatesh et al. (2003) in UTUAT model examine the predictive validity of the model in the context of intention and usage to allow a fair comparison of the models.	Outcome expectations-Performance	"The performance – related consequences of the behaviour. Specifically, performance expectations deal with job-related outcomes (Compeau and Higgins 1995)."
	Outcome expectations – Personal	"The personal consequences of the behaviour. Specifically, personal expectations deal with the individual esteem and sense of accomplishment (Compeau and Higgins 1995)."
	Self-efficacy	"Judgement of one's ability to use a technology (e.g., computer) to accomplish a particular job or task."
	Affect	"An individual's liking for a particular behaviour (e.g., computer use)."
	Anxiety	"Evoking anxious or emotional reactions when it comes to performing a behaviour (e.g., using a computer)."
Models and Theories of Individual Acceptance		
Theory of Reasoned Action (TA)	**Core Constructs**	**Definitions**
The Unified Theory of Acceptance and Use of Technology (UTAUT)		

The Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh, et al. (2003) advances individual technology acceptance research by unifying the many theoretical perspectives common commonly used in the study of IT in organisations. Out of the seven constructs that appeared to be significant direct determinants of intention or usage in one or more of the individual models, they theorized that four constructs played significant role as direct determinants of user acceptance and usage behaviour – performance expectancy, effort expectancy, social influence and facilitating conditions. Attitude toward using technology, self-efficacy and anxiety were theorized not to be direct determinants of intention. He incorporates four moderators (gender, age, experience, voluntariness of use) to account for dynamic influences including organisational context, user experience and demographic characteristics. He examines the effect of these determinants on intention to facilitate fair comparison of the different models (Venkatesh, Morris et al. 2003).	Performance expectancy	The degree to which an individual believes that using the system will help him or her to attain gains in job performance (Venkatesh, Morris et al. 2003, p.447). The five constructs from the different models that pertain to performance expectancy are perceived usefulness (TAM/TAM2 and C_TAM_TPB), extrinsic motivation (MM), job-fit (MPCU), relative advantage (DOI) and outcome expectations (SCT).
The Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh, *et al*. (2003) advances individual technology acceptance research by unifying the many theoretical perspectives common commonly used in the study of IT in organisations. Out of the seven constructs that appeared to be significant direct determinants of intention or usage in one or	Effort expectancy	"the degree of ease associated with the use of the system" (Venkatesh, Morris et al. 2003, p.450). The concept of effort expectancy is captured in three constructs from the existing models: perceived ease of use (TAM/TAM2), complexity (MPCU) and ease of use (DOI).

more of the individual models, they theorized that four constructs played significant role as direct determinants of user acceptance and usage behaviour – *performance expectancy, effort expectancy, social influence* and *facilitating conditions. Attitude toward using technology, self-efficacy* and *anxiety* were theorized *not* to be direct determinants of intention. He incorporates four moderators (gender, age, experience, voluntariness of use) to account for dynamic influences including organisational context, user experience and demographic characteristics. He examines the effect of these determinants on intention to facilitate fair comparison of the different models (Venkatesh, Morris et al. 2003).	Social influence	The degree to which an individual perceives that important others believe he or she should use the new system (Venkatesh, Morris et al. 2003, p.451). Social influence as a direct determinant of behavioural intention is represented as subjective norm in TRA, TAM2, TPB/DTPB and C-TAM-TPB, social factors in MPCU and image in DOI. Each of these constructs contains the explicit or implicit notion that the individual's behaviour is influenced by the way in which they believe others will view them as a result of having used the technology (Venkatesh, Morris et al. 2003).
	Facilitating conditions	The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system" (Venkatesh, Morris et al. 2003, p.453). This definition captures concepts embedded by three different constructs: perceived behavioural control (TPB/DTPB, C-TAM-TPB), facilitating conditions (MPCU) and compatibility (DOI). Each of the constructs is set to include aspects of the technological and/or organisational environment that are designed to remove barriers to use (Venkatesh, Morris et al. 2003).
Models and Theories of Individual Acceptance		

Theory of Reasoned Action (TA)	**Core Constructs**	**Definitions**
	Attitude toward using technology (indirect determinant)	An individual's overall affective reaction to using a system" (Venkatesh, Morris et al. 2003, p.455). "Four constructs from the existing models align closely with the definition: attitude toward behaviour (TRA, TPB/DTPB, C-TAM-TPB), intrinsic motivation (MM), affect toward use (MPCU) and affect (SCT). All the four constructs tap into an individual's liking, enjoyment, joy and pleasure associated with technology use (Venkatesh, Morris et al. 2003).
	Self-efficacy (indirect determinant)	An individual's overall affective reaction to using a system" (Venkatesh, Morris et al. 2003, p.455). "Four constructs from the existing models align closely with the definition: attitude toward behaviour (TRA, TPB/DTPB, C-TAM-TPB), intrinsic motivation (MM), affect toward use (MPCU) and affect (SCT). All the four constructs tap into an individual's liking, enjoyment, joy and pleasure associated with technology use (Venkatesh, Morris et al. 2003).
	Anxiety	Self-efficacy is the judgement of one's ability to use a technology (e.g., computer) to accomplish a particular job or task while anxiety is evoking anxious or emotional reactions when it comes to performing a
	Behavioural intention to use the system	

		behaviour (e.g., using a computer) (Venkatesh, Morris et al. 2003). Though the two are significant direct intentions in SCT, UTUAT does not include them as direct determinants for previous research Venkatesh & Davis (2000) have shown self-efficacy and anxiety to be conceptually and empirically distinct from effort expectancy (perceived ease of use). UTAUT treats the two as indirect determinants of intention fully mediated by perceived ease of use (Venkatesh, Morris et al. 2003).

Table 3: Theories of Technology Acceptance (Adopted fromVenkatesh et al., 2003, pp. 428-432)

It is suggested in a study of diffusion of the internet, that internal models alone fail to provide an adequate understanding of the diffusion process and that consideration should be made to external models as well (Rai, Ravichandran, & Samaddar, 1998). It therefore follows that this study was informed by three models; the Diffusion of Innovation, Technology Acceptance Model and Hofstede's Cultural Dimensions theories. In the subsequent sections these three theories are discussed in more detail and justification of their choice is provided.

3.2.1 The Diffusion of Innovation Theory (DOI)

Rogers (2003, p. 5) defines diffusion as "the process in which an innovation is communicated through certain channels over time among the members of a social system". The author interchangeably uses technology and innovation and offers a definition of innovation as being "an idea, practice, or project that is perceived as new by an individual or other unit of adoption" (Rogers, 2003, p. 12). Rogers makes an interesting observation in his definition of technology as consisting of hardware and software and describes the hardware aspect to be a tool and the software is the information aspect of the tool. The author notes that due to the low observability of software when viewed as a technological innovation, its adoption rate is low compared to hardware.

Rogers' diffusion of innovation theory is widely used in IS research with over 4000 publications on this topic of diffusion research using this DOI theory (Rogers, 2010, p. XV). The diffusion of innovation theory is made up of four key components; innovation, communications channels, time and a social system.

Constructs of DOI

Innovation

As defined earlier an innovation is "an idea, practice, or project that is perceived as new by an individual or other unit of adoption" (Rogers, 2003, p. 12). The innovation release date is not relevant to the adopter of that innovation for as long as they perceive that innovation to be new to them then they will still consider it an innovation. A number of initiatives including ICT based initiatives are prone to technological lock in. This situation arises when technology communities are driven by similar guidelines which tend to not be receptive to initiatives that they are not familiar with (Perkins, 2003). The high adoption levels the current technology enjoys also propagate the concept of technological lock in. A number of developed countries are faced with this situation of technological lock in. In developing parts of the world like Africa, there is a lack of investment in technological infrastructure. This situation has a positive side as it creates a fertile opportunity to adopt new current technologies without having to face the huge financial burden of switching from existing technological infrastructure. The process of adopting the most current innovation without going through the

intermediary innovations is referred to as leapfrogging and James (2014) attributes a substantial number of innovations to this concept. Rogers (2003, p. 232) identifies five attributes of innovation that impact on the uncertainty reduction process. These five attributes are:

- Relative advantage: "the degree to which an innovation is perceived as being better than the idea it supersedes" (Rogers, 2003, p. 229).
- Compatibility: "the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters" (Rogers, 2003, p. 15)
- Complexity: "the degree to which an innovation is perceived as relatively difficult to understand and use" (Rogers, 2003, p. 15).
- Trialability: "the degree to which an innovation may be experimented with on a limited basis" (Rogers, 2003, p. 16).
- Observability: "the degree to which the results of an innovation are visible to others" (Rogers, 2003, p. 16).

Rogers explains that for the innovation diffusion process to be successful all the five attributes; relative advantage, compatibility, complexity (the innovation should show simplicity), trialability, and observability need to be present.

Communication Channels

Rogers (2003, p. 5) defines a communication channel as "a process in which participants create and share information with one another in order to reach a mutual understanding". A channel is a media type though which a message is transmitted to the designated recipient. Rogers identifies diffusion to be a type of communication and further identified mass media e.g. TV and radio and interpersonal communication e.g. communication between two or more individuals, as communication channels.

Communication channels are critical in social networks as they aid the innovation diffusion process of new technologies. Communication channels can also influence a farmer's technology adoption decisions based on how he communicates with other stakeholders in the agricultural sector (Mashavave et al., 2013, p. 11).

Time

Rogers (2003) identifies the time element in the innovation diffusion process to be an important factor. The adopter classification and the rate of adoption both use the time element. The rate of adoption and the innovation-decision process all make use of the time element.

Social System

Rogers (2003, p. 23) states a social system as being "a set of interrelated units engaged in joint problem solving to accomplish a common goal". Due to the fact that innovation diffusion takes place within a social system, the nature of that social system impacts on individual's innovativeness.

In addition to the five attributes identified earlier (Relative advantage, Compatibility, Complexity, Trialability and Observability), innovation-decision type and change agents also contribute in analysing adoption rates of an innovation (Rogers, 2003). The author contends that an individual undergoes five stages that are part of the innovation-diffusion process after which that individual makes the decision of whether to adopt an innovation or reject it. The steps in the innovation-diffusion process include; knowledge, persuasion, decision, implementation and confirmation. Rogers (2003) categorised the individuals in a social system using the time dimension in reference to their adoption of innovations. The author identifies innovation adopters and classifies them into innovators, early adopters, early majority, late majority and laggards.

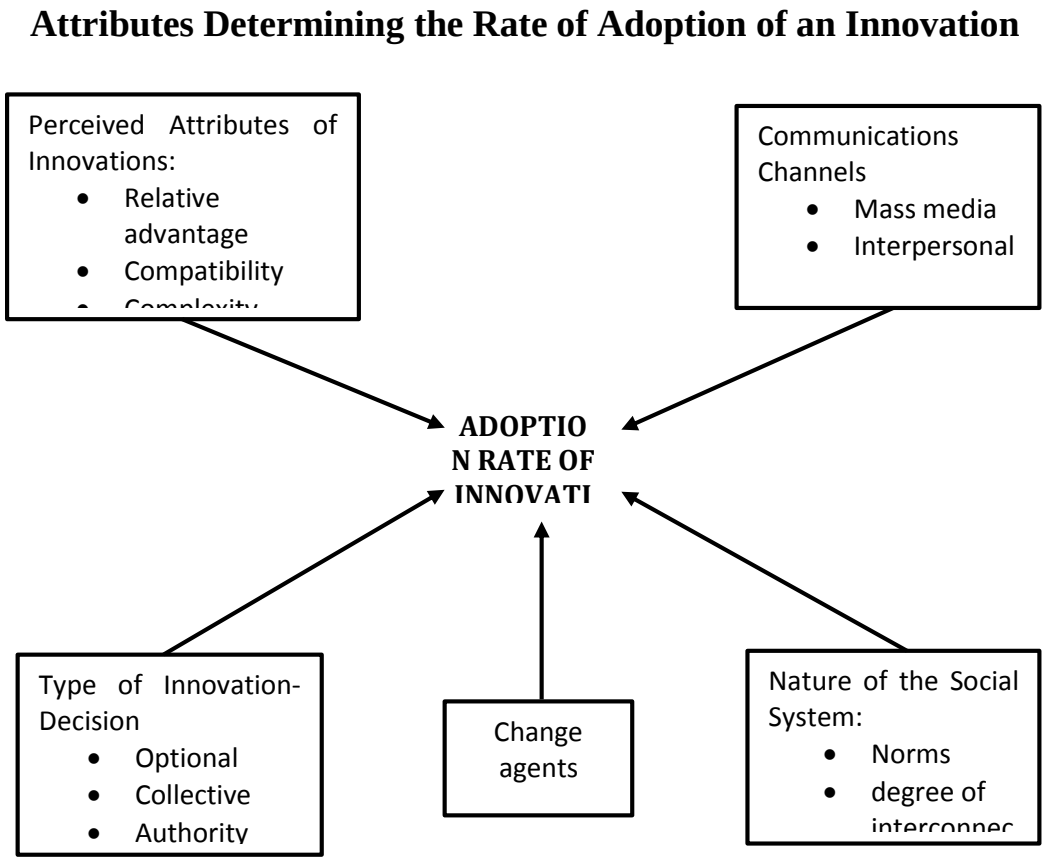


Figure 11: Constructs of the DOI model that determine the rate of adoption of innovation (Rogers, 2003)

Justification for the use of Theoretical Models

An interesting observation is that there are many theories that are used in innovation adoption research (Table 3) these theories include the Technology Acceptance Model (TAM), the Theory of Reasoned Action (TRA), the Unified Theory of Acceptance and Use of Technology (UTAUT), and the Theory of Planned Behaviour (TBP) most of which use similar constructs. This study made use of Roger's Diffusion of Innovation (DOI) theory because this theoretical framework has frequently been reviewed and takes into account changing societies. Some of the changes include the various cultural differences that exist in them (Rogers, 1995, 2003, 2010). In addition to the previously mentioned benefit, the DOI theory is very well established and addresses a significantly higher number of constructs in comparison to most other technology diffusion models (K. Bagchi & Udo, 2007; Venkatesh et al., 2003). It is due to this accommodation of a variety of constructs that it provides a more comprehensive understanding of diffusion of technology. The theoretical model also provides an added advantage in that it is widely used in IS research (Kapoor, Dwivedi, & Williams, 2014). Sharif, Troshani, and Davidson (2014) puts forward the theory's simplicity as an advantage of using Roger's diffusion of innovation theory.

3.2.2 Technology Acceptance Model (TAM)

The Technology Acceptance Model is extensively made use of in order to assist in providing explanations to technology usage and as a result has been used in a number of empirical studies (Davis, 1989; Hu, Chau Y., Liu Sheng R, & Yan Tam, 1999). Davis (1989) expounds that attitude regarding a technology affects the use of the technology. The model puts forward constructs that determine whether an individual will use a technology when presented with it. The model identifies two main constructs that influence an individual's decision to use a technology. These constructs being perceived usefulness and perceived ease of use (Davis, 1989). These two constructs will form part of the cognitive responses of this study (Figure 14).

Constructs of TAM

Perceived Usefulness (PU)

Davis (1989) defines perceived usefulness (PU) as an individual's "subjective probability that using a specific application system will increase his or her job performance".

Perceived Ease-of-use (PEOU)

Davis (1989) defines perceived ease-of-use (PEOU) as the "degree to which the prospective user expects the target system to be free of effort".

Additional constructs identified by Davis (1989, p. 985) are Attitude (A) and Behavioural Intention (BI) and these are said to influence acceptance behaviour indirectly, it is for this reason that these additional constructs will not be used in this study, but rather the two core constructs will be focused on. The author postulates that attitude towards use of an innovation governs the behavioural intention. The author further explains that an individual's reaction is governed by both the individual's perceived usefulness of that innovation and its perceived ease of use in performing tasks.

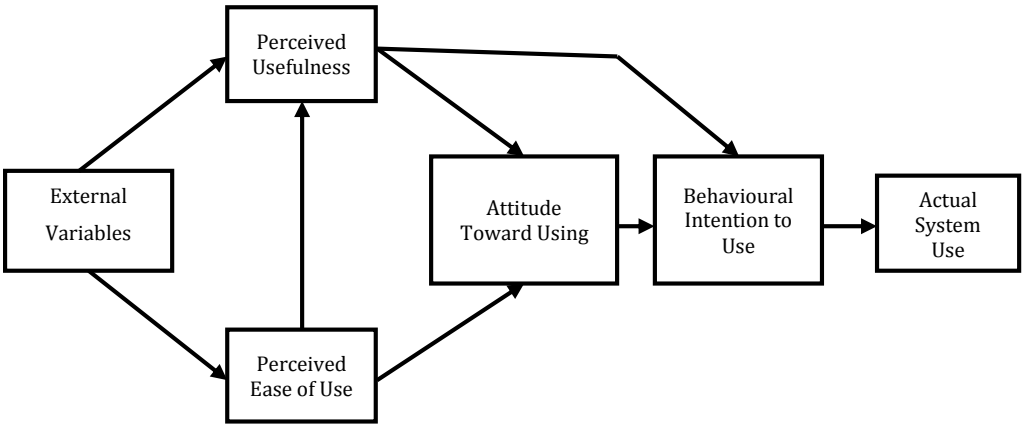


Figure 12: Technology Acceptance Model (Davis, 1989)

Justification of for use in this study

TAM is also one of the widely employed theories in IS research and was selected as a complementary theory of technology acceptance to DOI. TAM is a modification of the theory of reasoned action and has imbedded in it aspects of behavioural intentions, although now, specifically towards information systems. TAM was included in this study to provide interventions that can improve ICT adoption and diffusion amongst smallholder farmers in KwaZulu-Natal, and also due to its capability to explain an individual's behaviour regarding a wide range of technologies which form the broad spectrum of technologies that fall under ICTs (Davis, 1989). TAM is at a micro level (individual level) and is based on the argument that individuals use technology for personal achievements i.e. improving your personal effectiveness, increases work output by the individual and enhancing the decision making process.

3.2.3 Hofstede's Cultural Dimensions Model

Hofstede (1980b) states that ''the collective mental programming of the people in an environment'' is refered to as culture. The author goes further to say "culture refers to the

collective mental programming that these people have in common; the programming that is different from other groups." Hofstede's cultural dimensions is used extensively in studies to determine the influence of culture on values (Hofstede, 1980b). Hofstede's research on IBM employees from over 70 countries gave rise to his definition of culture being a conditioning of behaviours of a group to be similar with one another but can be differentiated from other groups (Hofstede, 2001).

Constructs of Hofstede's Cultural Dimensions Model

Hofstede's cultural model identifies five dimensions (Figure 13). The original model consisted of four dimensions but the model was later extended by Hofstede and Bond (1988) who conducted extended research with the aid of Chinese social scientists. This further work on culture resulted in the addition of a fifth dimension which was called Confucian dynamism and later renamed to long vs. short term orientation (Hofstede, 1991).

Power Distance

This refers to the extent to which a society gives credence to the fact that there is an unequal distribution in power within an organization; that is, the distribution of power between people in authority and their subordinates and also between various organizations (Hofstede, 1980b, 2013). This dimension relates to varying solutions that apply to the problem of inequality and varying levels of power in societies among individuals and groups. Power distance is further categorized in two; large power distance being a larger difference between various individuals, groups or organizations whereas small power distance is a situation where the power distance between various individuals, groups or organizations is perceived by society to be small. The dimension is tested in this study to determined the relationship between the smallholder farmer and the agricultural extension officer. This in turn has an impact on the ICT innovation diffusion process showing that Hofstede's cultural dimensions theory is complementary to Roger's diffusion of innovation theory.

Uncertainty Avoidance

Hofstede (2013, p. 8) states that uncertainty avoidance refers to the extent to which a society feels threatened by unclear and inexplicit situations. Organizations and communities attempt to avoid uncertainty through the creation of formal rules, using experts and by not being tolerant to differing opinions. Societies with low uncertainty avoidance are more tolerant with vague situations, and can be seen in a study by Archie, Dilling, Milford, and Pampel (2014) where land managers were used to making decisions with a level of uncertainty and was considered the norm, while societies with strong uncertainty avoidance are more aggressive due to intolerance to divergent views. Huat, Aubry, and Dore (2014) show this variable in the their study where the majority of farmers involved in the study sought reassurance in that any

new innovation which they were not familiar with, did not increase the degree of strain the task it performs is perceived to have.

Individualism vs. Collectivism

The individualism vs. collectivism dimension refers to the extent to which individuals are integrated into a society or organization. Individualism refers to a situation where individuals only care for themselves and close family, and this creates a weakly structured society in terms of people's welfare. Collectivism on the other hand, refers to a situation with a strongly unified society by interweaving the responsibility of each other's welfare onto everyone. This situation creates loyalty, strong bonds and social groups through this interdependence.

Masculinity vs. Femininity

The masculinity vs. femininity dimension focuses on gender and the characteristics that are generally attributed to either masculinity or femininity. Masculinity is characterised by the dominance of certain characteristics such as assertiveness, competitiveness, perseverance, and the drive to acquire material wealth, thus, masculine cultures attach great importance on materialism. Femininity on the other hand, is dominated by characteristics such as compassion and quality of life (Hofstede, 2013). Societies that have strong competitiveness and a heavy push towards innovation adoption, can be considered to have a strong masculine culture whereas feminine cultures are inclined to be more modest and promote cooperation in society (Hofstede, 2013).

Long vs. Short Term Orientation

The long vs. short-term orientation dimension is an extension to Hofstede's original model and was originally referred to as "Confucian dynamism". This dimension refers to individuals and societies focus using the time factor as the main determinant (now or future oriented) of how effort should be applied to tasks and the importance an individual applies towards tradition.

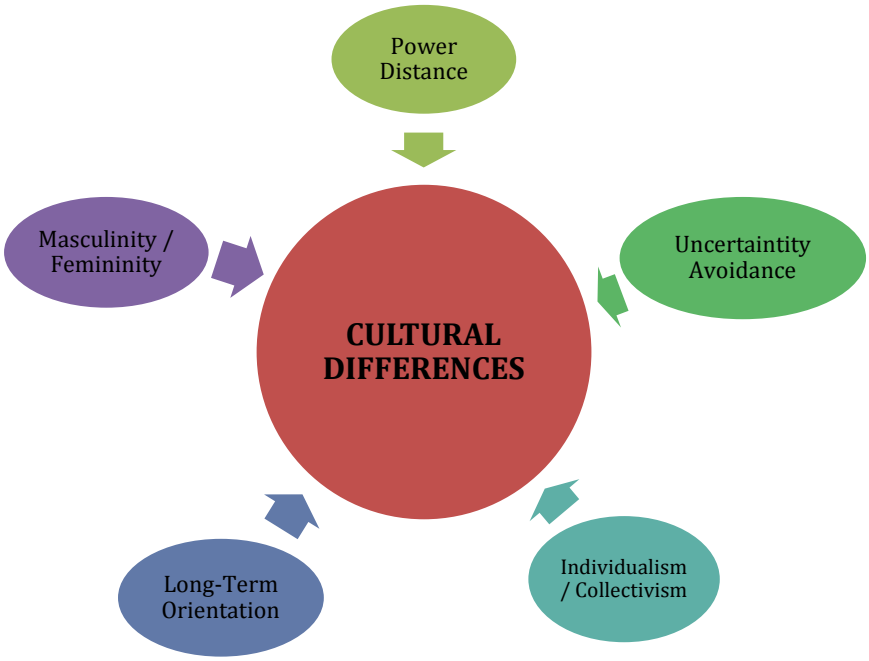


Figure 13: Hofstede's Cultural Dimensions

Justification of use in this study

A criticism of diffusion models such as the DOI and TAM is that they do not take into account external influences such as organizational or environmental factors (Lee & Cheung, 2004). Bagchi (2001) identifies the lack of consideration of external influences on the diffusion of technology as a weakness of the DOI model, and it is the need to incorporate individual, organizational and environmental factors in order to adequately understand ICT diffusion amongst smallholder farmers that motivated the inclusion of Hofstede's cultural dimensions. Studies have shown the need to understand other factors such as the social-cultural and organizational factors together with technological factors (Bakkabulindi, Nkata, & Amin, 2008; Damanpour & Schneider, 2009) in order to understand innovation diffusion research more holistically. The inclusion of Hofstede's cultural dimensions theory provided an added perspective in understanding the influence culture has on the ICT adoption by smallholder farmers. The inclusion of Hofstede's cultural dimensions theory as part of this study counters the arguments by critics that were raised with regards to the DOI and TAM models.

3.3 Proposed framework for determining the role of ICT adoption in Food Security in KwaZulu-Natal Province

This study investigated the role ICTs play in improving food security in the agriculture sector in KwaZulu-Natal province. In order to achieve this task, there was a need to develop a theoretical framework that would be used as the lens through which diffusion and adoption of ICTs can be understood. The developed model was informed by the theories of Diffusion of Innovation, Technology Acceptance Model and Hofstede's cultural dimensions.

Constructs from DOI and TAM were used to investigate technological, institutional and social factors (sections 3.2.1 and 3.2.2) while constructs from Hofstede's cultural dimensions (section 3.2.3) were used to investigate cultural factors associated with adoption of ICTs amongst smallholder farmers. It is the complementary nature these models provide to each other that serves as justification for their use as has already been alluded to in the previous sections.

The model was aligned with the three research objectives of the study. Five research questions were then developed in order to achieve the objectives of the study. The research questions are embodied in the developed model (Figure 14) and were used to guide questionnaire development. The data collected was then used to answer the main research question "How does the adoption and diffusion of ICTs amongst smallholder farmer's influence food security in KwaZulu-Natal?"

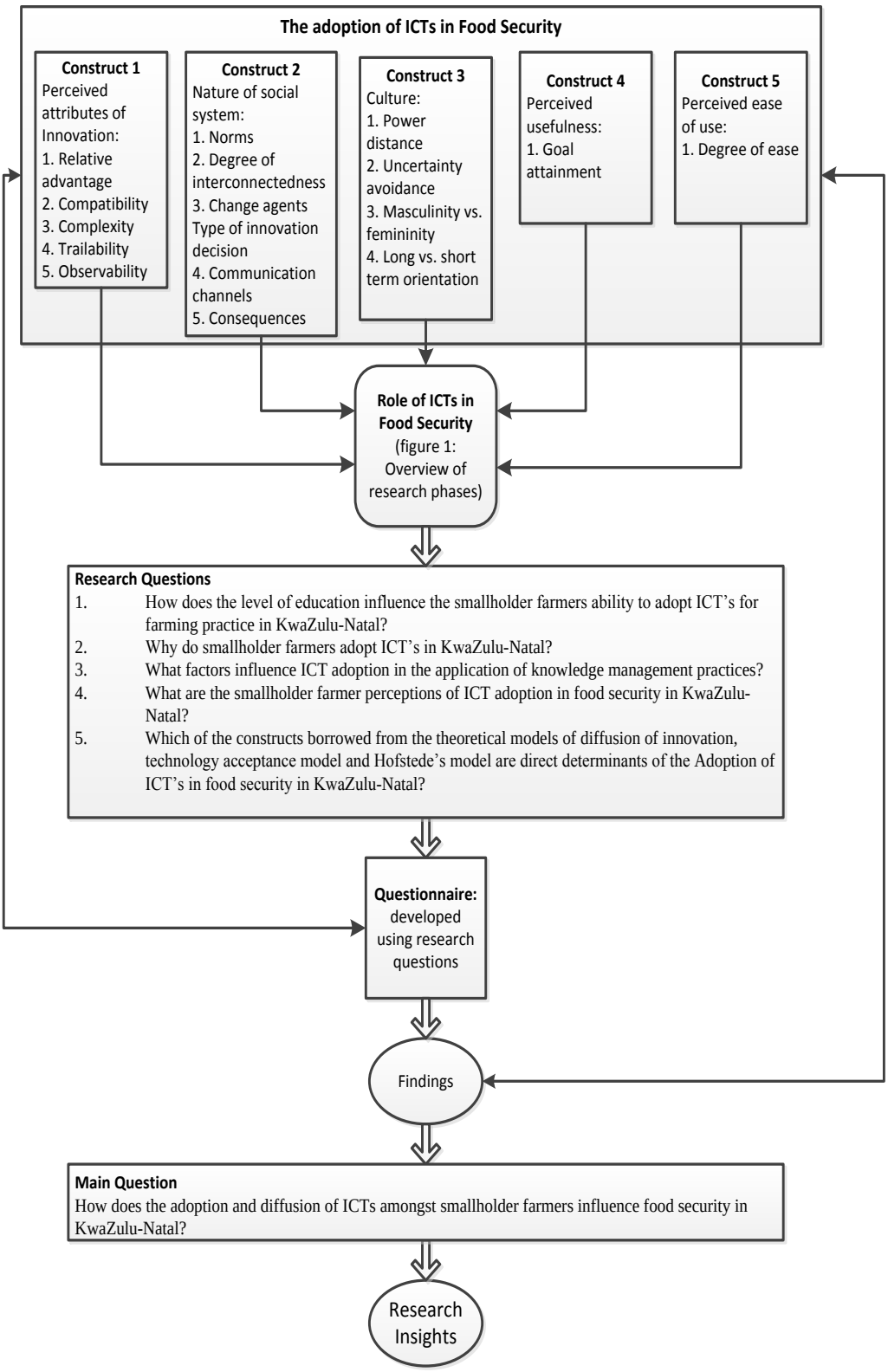


Figure 14: Proposed framework for determining the role of ICT adoption in Food Security in KwaZulu-Natal Province

Based on the proposed framework for determining the factors factors that play a role on ICT adoption in food security in KwaZulu-Natal, the researcher designed Table 4 to show the links between the research questions, the theoretical framework and the elements of the two questionnaires that relate to the constructs identified.

Research Questions	**Theoretical Framework Construct**	**Questions in smallholder farmer questionnaire**	**Questions in extension officer questionnaire**
Research Question 1		**Section 1, 2, 3 & 5 of the questionnaire**	**Section 1, 2 & 3 of the questionnaire**
How does the level of education influence the smallholder farmers ability to adopt ICTs for farming practice in KwaZulu-Natal?	Nature of social system	4, 5, 6, 10, 11, 12, 22, 31	6, 9, 10
	Perceived usefulness	16	
	Perceived ease of use	15	14
Research Question 2		**Section 2 & 3 of the questionnaire**	**Section 2 & 3 of the questionnaire**
Why do smallholder farmers adopt ICTs in KwaZulu-Natal?	Nature of social system	6	
	Perceived attributes of innovation	22, 26, 27, 28	19, 23, 24, 25
	Perceived usefulness	16	
	Perceived ease of use	15	
Research Question 3		**Section 1 & 2**	**Section 1 & 2**

		of the questionnaire	**of the questionnaire**
What factors influence ICT adoption in the application of knowledge management practices?	Nature of social system	1, 4, 5, 6	
Research Question 4		**Section 3, 6 & HFIAS part of the questionnaire**	**Section 3 & 6 of the questionnaire**
What are the smallholder farmer perceptions of ICT adoption in food security in KwaZulu-Natal?	Perceived usefulness	24, 31, 35	28, 35
	Perceived attributes of innovation	26, 28	
	Nature of social system	1, 4, 23, 25	
		Food insecurity section (7) Q1-Q9	
Research Question 5		**Section 2, 3 & HFIAS part of the questionnaire**	**Section 2 & 3 of the questionnaire**
Which of the constructs borrowed from the theoretical models of diffusion of innovation, technology acceptance model and Hofstede's model are direct determinants of the	Perceived attributes of innovation	11, 14.1, 26.1, 26.2, 26.3, 26.4, 27, 28, 29.1	
	Nature of social system	9, 10, 12, 19, 20, 21.1, 21.2, 22, 24,	
	Culture	13.1, 13.2, 13.3, 13.4, 13.5, 25.1, 25.2	

adoption of ICTs in food security in KwaZulu-Natal?	Perceived usefulness	16	
	Perceived ease of use	15	
		Food insecurity section (7) Q1-Q9	

Table 4: Link between research objectives, research questions, the proposed theoretical framework and the questionnaires

3.4 Conclusion

In this chapter the researcher identifies various theories related to technology adoption and diffusion. The chapter then further identifies and describes the three theories that were used in this study to investigate the adoption and diffusion of ICTs amongst smallholder farmers and the role ICTs play in food security in KwaZulu-Natal. Even though the Diffusion of Innovation theory and Technology Acceptance Model provide understanding of technology acceptance from distinct perspectives, researchers have increasingly suggested using the two theories together to provide a greater understanding of technological changes and improve specificity (Agarwal & Prasad, 1997; Chong, 2004; Legris, Ingham, & Collerette, 2003). This school of thought is supported by authors (Chen, Gillenson, & Sherrell, 2002; Wu & Wang, 2005) who believe combining these models increases explanatory power and produces a stronger model.

The Diffusion of Innovation theory formed part of the three theoretical frameworks used in this study; this theory was included because it helped the researcher to understand how the spread of ideas and technologies in a social system takes place. Social networks amongst potential adopters are emphasized by Rogers (1995). Studies have shown that TAM is prominently used to explain an individual's intention to use technology (Amin & Li, 2014; Strong, Ganpat, Harder, Irby, & Lindner, 2014; Tsai, Hong, Yeh, & Wu, 2014). These studies make use of the two main determinants of perceived ease of use and perceived usefulness that have been noted by Bagozzi (2007) as being one of the strengths of TAM. Venkatesh and Bala (2008) make use of these two main determinants of TAM to develop interventions that can encourage ICT adoption at an individual level. This study makes use of TAM using these two main determinants as one of the three models to investigate smallholder farmer adoption and diffusion of ICTs and their preferences and the role of ICT adoption on food security in KwaZulu-Natal. Based on the statistics of the province, it is clear that ICT adoption and diffusion is increasing (StatsSA, 2012) and this can be in part, attributed to the encouraging

signs from Internet Service Providers (ISPs) to provide affordable prices (Dzansi & Amedzo, 2014). This study goes further to empirically attempt to understand the influence of culture in the adoption of ICTs amongst smallholder farmers. In a study by Tong, Tak, and Wong (2013) it was revealed that knowledge sharing and job satisfaction is significantly impacted upon by organizational culture. In a study by Moghaddam (2010) the author expounded the importance of culture in ICT adoption and makes use of Hofstede's cultural values to understand attitudes towards technology adoption. Some similar studies have also attempted to explain Hofstede's cultural values influence on technology acceptance (Beaudry & Pinsonneault, 2010; Veltri & Elgarah, 2009; Venkatesh & Zhang, 2010). It is for this reason that the cultural perspective is also taken into account in this study using Hofstede's cultural dimensions theory.

It is based upon these theories, that a theoretical framework was developed by the researcher as the lens through which to view the study. An alignment of the study's objectives, research questions, theoretical constructs (from the theories used) and which elements in the research instrument represented the construct is then provided. In the following chapter a detailed account is discussed of how data was gathered.

CHAPTER 4

STUDY DESIGN & METHODOLOGY

An interdisciplinary approach to research into ICT and Food Security

"Then 'laws' handed down from God are no longer handed down from God. They're actually handed down to us by ourselves, through the methodology we adopt."

Steven Goodman (as cited in Nuzzo, 2014, p. 150)

4.1 Introduction

In the previous chapter, the researcher discussed various theoretical frameworks of interest to this study and the reasoning behind their selection and then outlined in detail the theoretical framework used in this study.

In this chapter the researcher describes the research area and the sample collected, an outline of the research paradigm adopted, instruments for data collection, an account of the data preparation, data collection and processing and the methods used to answer the research questions put forward in chapter one. Figure 15 illustrates where this chapter is situated within the overall research strategy.

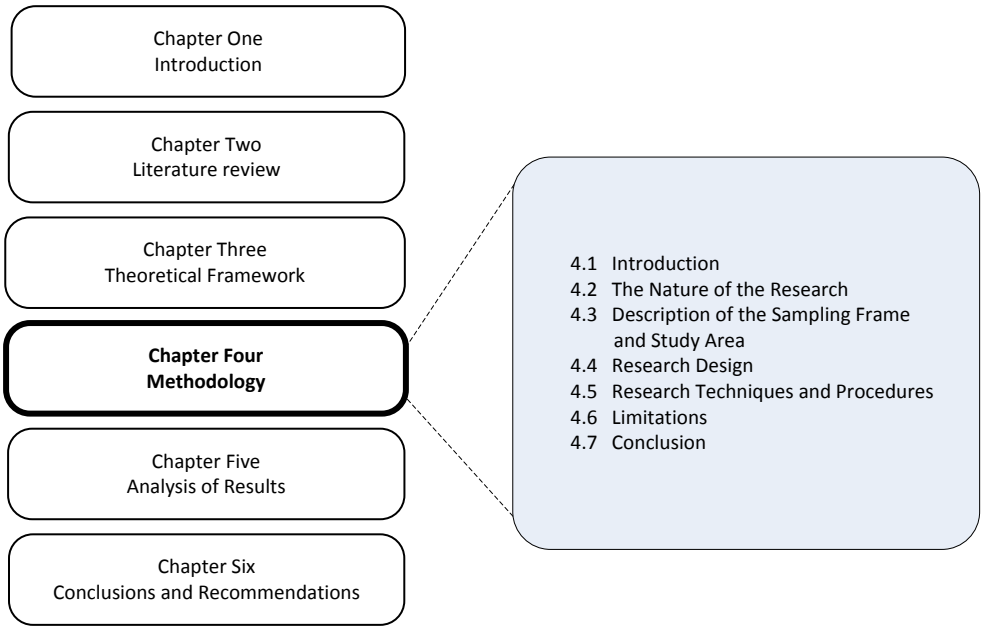


Figure 15: Chapter 4 within the overall research strategy - Phase 3 of the Study

The aim of this study was to investigate the role of ICTs on food security with a focus on the smallholder farmer. The preliminary literature review undertaken during the conceptual stage revealed other relevant players such as the extension officers and non-governmental organizations. This was followed by the development of a research proposal including two preliminary research questionnaires which were presented to the college higher degrees committee for defence on 08/11/12 and because the University of KwaZulu-Natal demands that all research be conducted in an ethical manner, the researcher sought ethical clearance which was applied for to the college ethical clearance committee and obtained on 22/05/13 (a copy of the ethical clearance letter is provided in Appendix G). To accompany the ethical clearance letter a researcher is required to show evidence that they have sought permission from the individuals, group, community or organization under study. The researcher therefore sought a gatekeeper's letter from the Department of Agriculture and Environmental Affairs that is responsible for extension officers and smallholder farmer cooperatives seeking permission from them to participate in the study (the gatekeeper's letter is provided as Appendix F). Upon finalisation of the survey instruments and all administrative requirements, the data collection was conducted. The data collected was then analysed with the studies theoretical underpinnings being taken into consideration.

4.2 The Nature of the Research

The research investigates the role of Information and Communications Technology in improving food security. The research makes use of a quantitative approach; this is achieved through the use of structured questionnaires (smallholder farmers, extension officers and the HFIAS survey). The analytical procedures were conducted through the use of SPSS 23, which established the empirical basis of the results. The qualitative aspects relate to the constructivist/interpretive approach to conducting the analysis of the knowledge, attitudes and skills of the farmers and extension officers regarding ICTs.

The study made use of three questionnaires that targeted two different groups of respondents. The first group were the smallholder farmers who were the primary respondent group. The second respondent group was that of extension officers to whom a similar questionnaire to that of smallholder farmers was posed. The purpose was to be able to triangulate responses from the two groups. The third questionnaire was an ancillary questionnaire that was posed to the farmers (HFIAS survey). The purpose of the HFIAS survey was to establish the farmer household food security status, which was then used in establishing correlations with the role ICTs have on food security.

The main survey on farmer perceptions of the role of Information and Communications Technology on food security in KwaZulu-Natal, and the ancillary survey measuring the

farmer household food security level, involved 529 respondents. The researcher then surveyed 47 agricultural extension officers. This follow-up survey was used to triangulate the farmers' responses.

Due to the large number of respondents involved in this study and a limited timeframe including the cost factor, the study adopted a quantitative approach which allowed for survey data to be collected (Groves et al., 2013). The nature of the study was also influenced by the aim of the study, which seeks to contribute to the limited literature on empirical studies focusing on ICT diffusion and adoption in agriculture by smallholder farmers. It is also for this reason that a quantitative approach for data collection was used. Sekaran and Bougie (2010) supports the use of the survey technique to achieve explanatory and descriptive objectives.

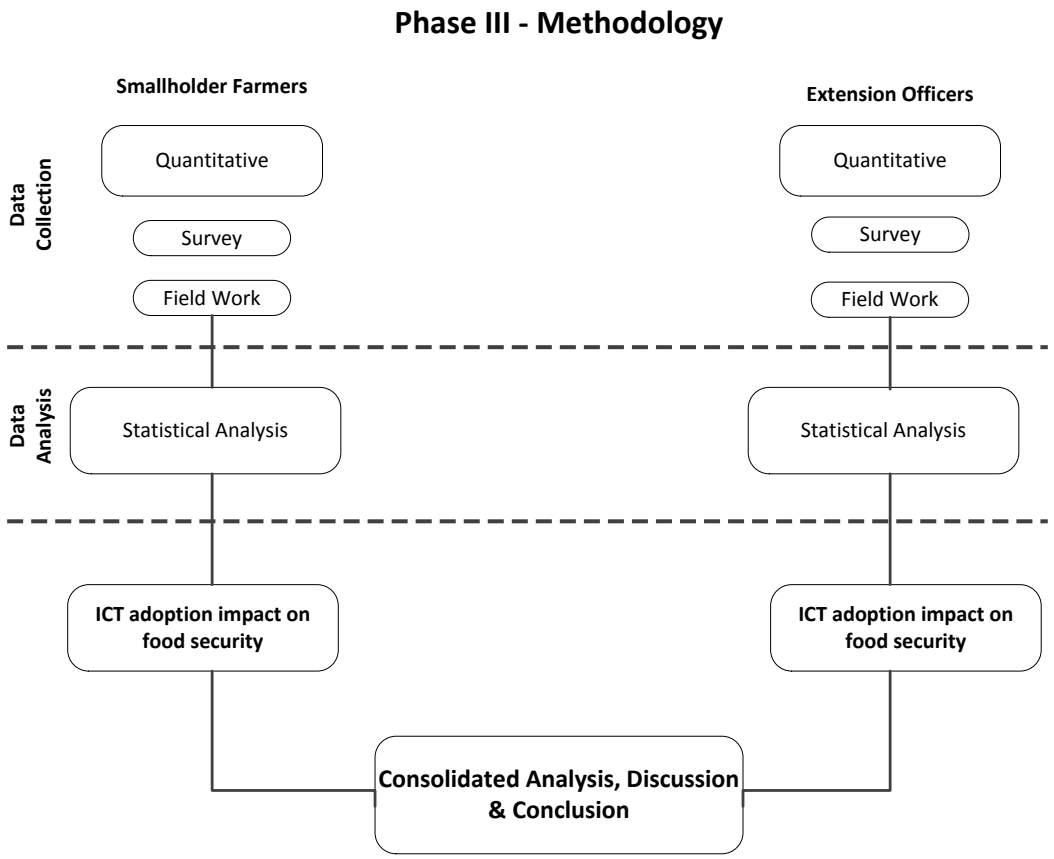


Figure 16: Phase III – Methodology phase - The Role of Information and Communications Technology on Food Security in KwaZulu-Natal

4.3 Description of the Sampling Frame and Study Area

Cousins (2010) argues that the term "smallholder farmer" is inherently problematic in that it does not recognise the differences within the homogenous group of households engaged in agricultural production on a relatively small scale. For the purposes of this study the

researcher borrowed one of the authors' definitions of who a smallholder farmer is. Smallholder farmers are a type of farmer who produces food for personal consumption and this meets their home requirements (Cousins, 2010) . In a report issued to the AsgiSA High Level Task Team in the Presidency (Cousins, 2009) a historical account of the smallholder hardships is articulated and suggests ways which can be implemented to increase household production and the activities of smallholders. Information provided in a timely manner is of crucial importance to smallholder farmers in South Africa and some authors (Ajani, 2014; Mashavave et al., 2013) have identified the ability to send and receive information timeously as a factor which gives smallholders a relative advantage. It is at this point that ICTs can be instrumental in resolving the problem of timely communication (Ballantyne, 2009).

Figure 17: Smallholder farmers (researcher conducting fieldwork)

Figure 18: Extension officers (A workshop with researcher - fieldwork)

Figure 19: Smallholder farmer using mobile phone

Figure 20: Extension officers using digital pens to capture farmer data

The sub-problems of this study were identified in consultation with the agricultural experts from the department of agriculture in Cedara, academics in the School of Agriculture/food security centre at the University of KwaZulu-Natal and smallholder farmers from a pilot study. The consultations revealed a possible influence by agricultural extension officers on the farmers' perceptions of ICTs on food security, hence the researcher deemed it fit to have two groups of participants in this study as part of the sampling frame (extension officers and smallholder farmers).

4.3.1 Geographical Location, Socio-Economic/Socio-Institutional Characteristics

iLembe district municipality is one of ten district municipalities in KwaZulu-Natal province. The district municipality is situated on the northern region of eThekwini Municipality along the east coast. iLembe district extends 25 kilometres from the eThekwini metropolitan boundary. The district municipality consists of four local municipalities Ndwedwe, Mandeni, KwaDukuza and KwaMapumulo local municipalities. The district also consists of urban areas such as the Dolphin coast, Mandeni, Nkwazi and KwaDukuza. The district covers an area of 3269 square kilometres, as listed in Table 5.

Municipalities within the District	Area (km²) in 2009
iLembe District Municipality	3,269.26
KwaDukuza Local Municipality	670.43
Mandeni Local Municipality	545.48
Maphumulo Local Municipality	895.91
Ndwedwe Local Municipality	1,157.44

Table 5: Area statistics of iLembe district

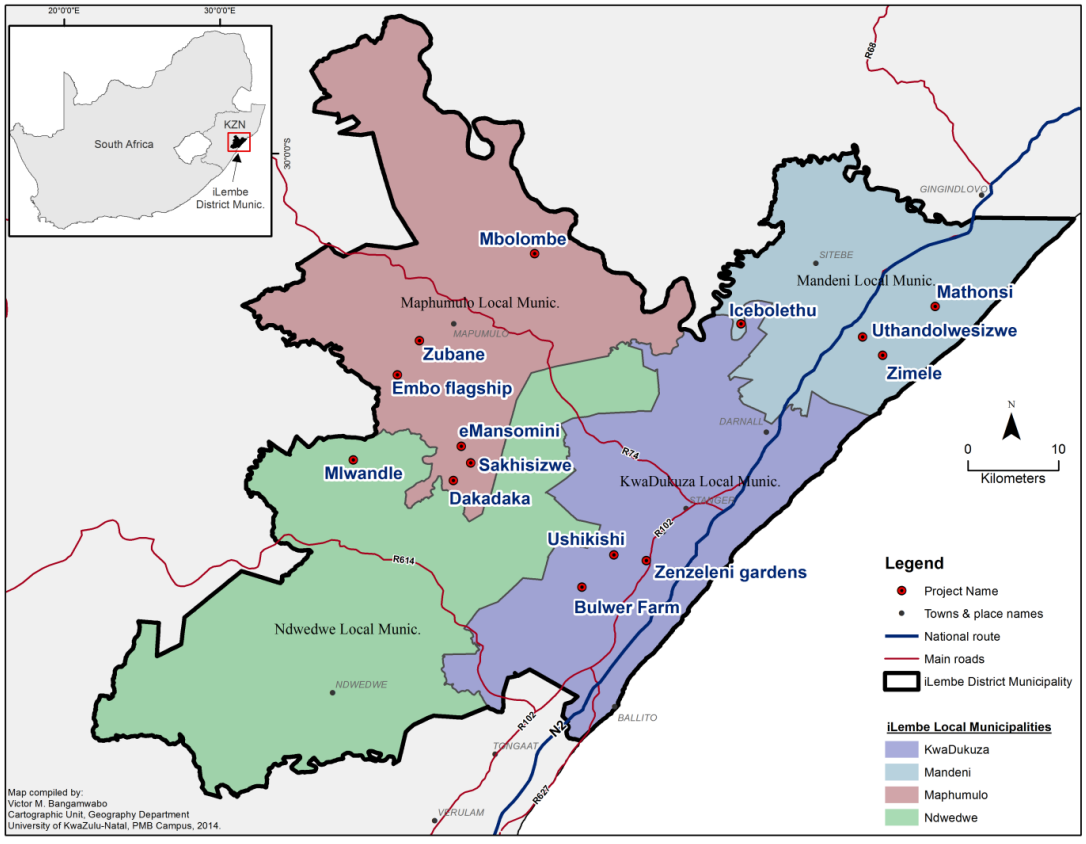


Figure 21: Area map of iLembe district municipality showing research sites in each local municipality (University of KwaZulu-Natal Cartographic Unit, Pietermaritzburg - 10 June 2014

Figure 21 shows the 14 sites the researcher conducted the study in iLembe district municipality. The sites are spread across all the four local municipalities and are accessible from a national route (N2) and main roads. 31 percent of arable land mostly consists of private commercial farms and is predominantly involved in the production of sugar cane. Smallholder farming is mainly concentrated in Mandeni and the southern areas of Ndwedwe Municipality (Figure 22). Informal dwellings surround the more urbanised areas in the district. Figure 22 provides a geospatial view of the distribution of farming activities between commercial farmers and smallholder farmers. Based on this data it shows that commercial farming is the predominant farming undertaken in this province.

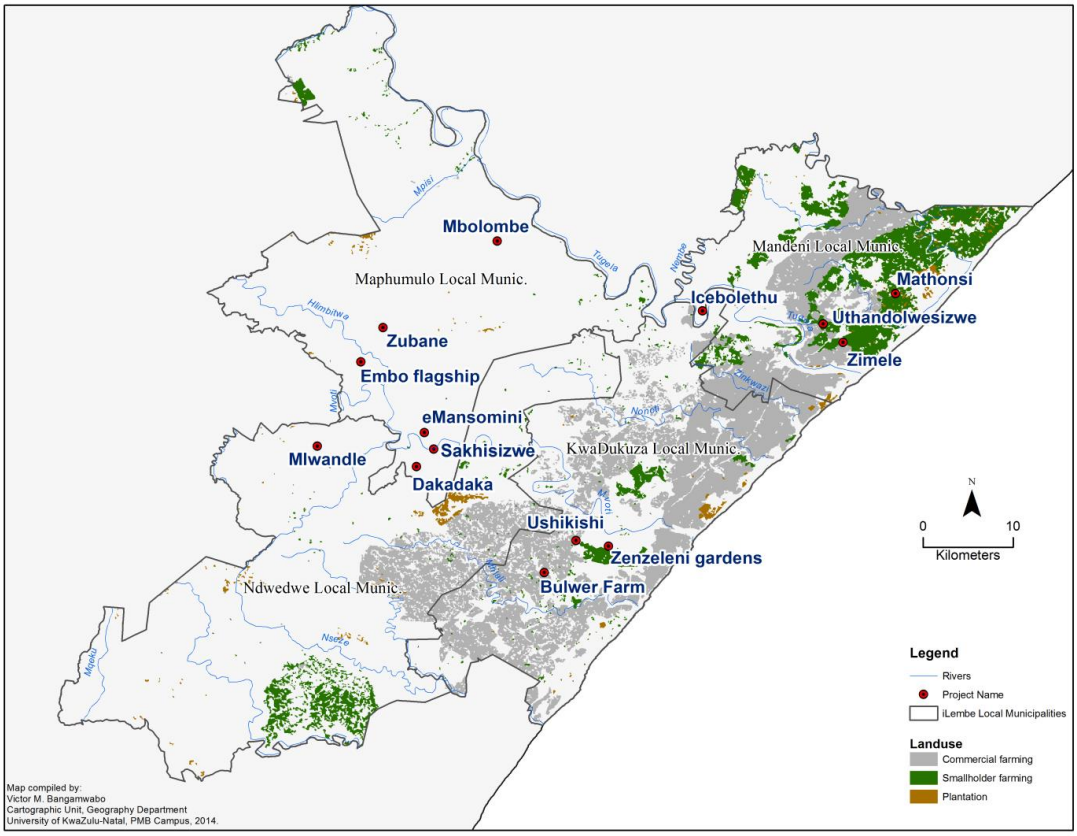


Figure 22: GIS map of iLembe Municipality showing research sites and smallholder/Commercial farming activity (University of KwaZulu-Natal Cartographic Unit, Pietermaritzburg - 10 June 2014)

iLembe district has 9 varying soil types. The most dominant soil type in the district are dystric regosols which are usually formed as a result of natural erosion and is not very suitable for agriculture as it is sandy, usually contains aluminium toxicity, manganese and generally are considered to have a low ph reading (Figure 23). In order to prepare the soil in areas where soil types are generally classified as regosols, a substantial capital investment is required in

terms of chemical applications such as fertilisers. It is for this reason that commercial farmers who have the financial capacity as compared to the smallholder farmers generally occupy the area. Leptic phaeozems and luvisols are more readily fertile soils and hence suitable for smallholder farmers who have limited resources to prepare the land for agricultural activities. It is partly for this reason that most smallholder activity in the municipality is concentrated in the Mandeni local municipality area (Figure 22).

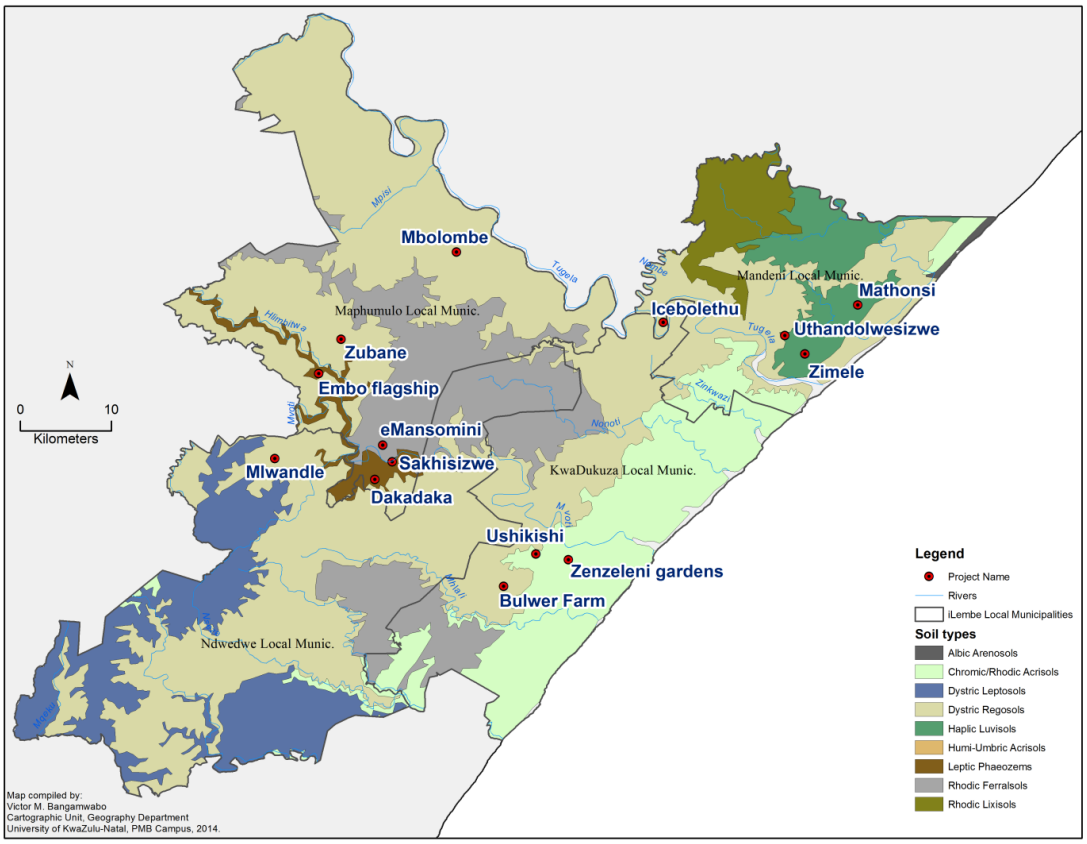


Figure 23: GIS map of iLembe district municipality showing research sites, soil types and rivers (University of KwaZulu-Natal Cartographic Unit, Pietermaritzburg - 10 June 2014)

According to the municipal report compiled by Statistics South Africa for KwaZulu-Natal (StatsSA, 2012), the total population for iLembe district municipality based on the 2011 census stood at 606 809 with a growth rate of 0.8 percent since 2001. The municipality has more females than males, and the majority of the population falls within the age range of 15-64 for both genders (174 987 for males and 196 983 for females). Unemployment in the iLembe district stands at 30.6% with 40417 traditional dwellings (StatsSA, 2012). The district has an average household income of R61,587.00 with 0.9% of the households being led by children under the age of 18 and 45.8% of households being led by women. In this district municipality, 51 150 residents have had no schooling and from a total of 281 216 residents who have had some form of schooling ranging from some primary education to post matriculation (grade 12) education, 53 104 have had some primary education, 15 790 have

completed their primary education, 103 432 have had some secondary education, 89 033 have completed their standard 10/Grade 12 education and 19 857 have a post matriculation (grade 12) education.

According to the municipal census (StatsSA, 2012), the following are the ICT adoption and diffusion statistics for iLembe district municipality:

DC29: iLembe Municipality (ICT adoption and diffusion stats)										
Radio		**Television**		**Computer**		**Landline/ telephone**		**Cell-phone**		**Internet**
2001	**2011**	**2001**	**2011**	**2001**	**2011**	**2001**	**2011**	**2001**	**2011**	**2011**
82 088	**97 493**	**45 573**	**91 535**	**4 061**	**16 657**	**18 980**	**15 092**	**24 669**	**132 189**	**43 524**

Table 6: iLembe Municipality ICT statistics

Based on the adoption and diffusion statistics shown representing iLembe municipality, there has been a notable increase in the adoption of ICTs ranging from radios, televisions, personal computers, cell-phones (mobile phones) and the Internet. In line with the international trend regarding landline/telephone penetration, the statistics of iLembe municipality show a decline in the landline/telephone penetration over the years leading up to 2011.

4.3.2 Vulnerability Classification

The department of cooperative governance (DCoG) developed a mechanism of municipal spatial classification. This classification profiles municipalities according to their economic and social profile. The profile also assesses the challenges a municipality faces such as backlogs in service delivery. The four DCoG classifications on municipalities are as follows:

Class 1: Most vulnerable

Class 2: Second most vulnerable

Class 3: Second highest performing

Class 4: Highest performing

In iLembe district its four local municipalities are classified as follow:

Local Municipality	Classification

KwaDukuza	Highest performing
Mandeni	Second most vulnerable
Maphumulo	Most vulnerable
Ndwedwe	Most vulnerable

Table 7: Vulnerability status of iLembe district

Based on Table 7, iLembe district consists of three out of the four classifications developed by DCoG with two of its municipalities having the lowest classification of "most vulnerable". iLembe district municipality therefore consists of a fairly even representation from almost all municipal classifications available making it an attractive choice to conduct a fairly representative study.

4.4 Research Design

The task of drawing legitimate conclusions from this study was dependant on a properly formulated research design. This research design provided a guide of how to go about obtaining the empirical results that were used to solve the research problem posed (Yin, 1989). The "Research onion" by Saunders, Lewis, and Thornhill (2009) guided the research design of this study. The various layers of the research onion are identified in Figure 24 until the data collection and analysis stage. The research design was developed after careful consideration of each layer of the onion and the most appropriate option selected. The research onion provided a well-guided framework for the creation of a research design that would meet the objectives of the study. The subsequent sections provide a detailed discussion of the researchers' choices in research design with reference to the research onion used.

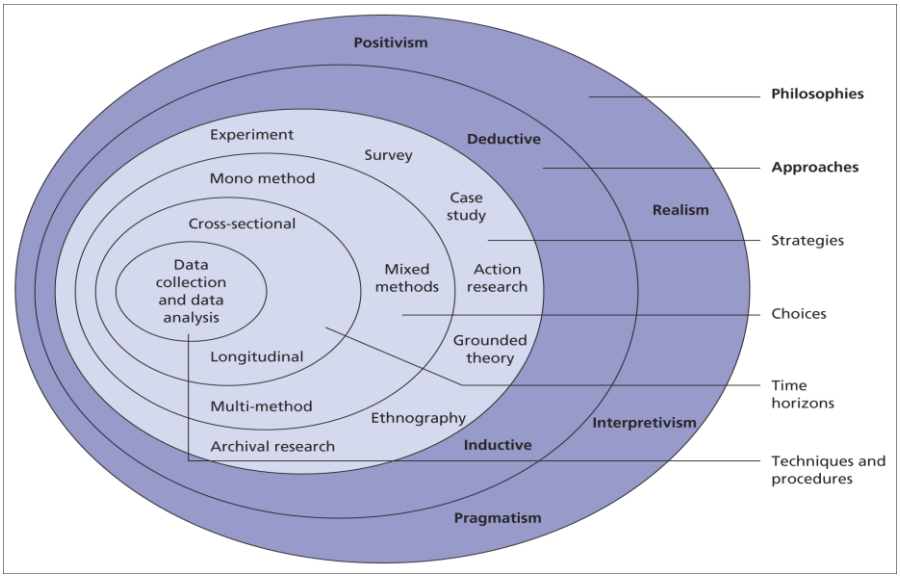


Figure 24: The "research onions" (Saunders et al., 2009)

4.4.1 Research Philosophy

The Oxford English dictionary has been identified to offer one of the most concise definitions of the positivistic philosophy. In it, Comte (1998, p. xiv) defines this philosophical approach as a view:

> *"which recognises only positive facts and observable phenomena, with the objective relations of these and the laws that determine them, abandoning all enquiry into causes or ultimate origins, as belonging to the theological and metaphysical stages of thought, held to be now superseded."*

Schiffman and Kanuk (1997) state that the principle of the positivist philosophy is that of observation and the subsequent use of statistical methods on the observed data. Another principle that underpins this philosophy is the assumption that the researcher is independent of the study. In this study the researcher attempted to be objective and used scientific methods that involved identifying causes and testing hypotheses. Hypotheses were developed based on five constructs that were used as a lens through which the study was conducted. These constructs; perceived attributes of innovation, nature of the social system, culture, perceived usefulness and perceived ease of use are derived from the three theoretical frameworks used in this study; Diffusion of Innovation, Hofstede's Cultural Dimensions and Technology Acceptance Model. An inductive approach was followed and tested on the data collected; this provided insights on the theoretical constructs being tested and allowed conclusions to be drawn:

Hypothesis 1

H_0: The perceived attributes of innovation do not influence ICT diffusion amongst smallholder farmers in iLembe district municipality.

H_1: The perceived attributes of innovation influence ICT diffusion amongst smallholder farmers in iLembe district municipality.

Hypothesis 2

H_0: The nature of the social system that smallholder farmers exist in does not influence ICT diffusion in iLembe district municipality.

H_1: The nature of the social system that smallholder farmers exist in does influence ICT diffusion in iLembe district municipality.

Hypothesis 3

H_0: The perceived usefulness of ICTs to smallholder farmers in iLembe district municipality in their farming activities does not influence ICT diffusion.

H_1: The perceived usefulness of ICTs to smallholder farmers in iLembe district municipality in their farming activities does influence ICT diffusion.

Hypothesis 4

H_0: The perceived ease of using ICTs by smallholder farmers in iLembe district municipality in their farming activities has no influence on ICT diffusion.

H_1: The perceived ease of using ICTs by smallholder farmers in iLembe district municipality in their farming activities does influence ICT diffusion.

Hypothesis 5

H_0: The perceived ease of using ICTs by smallholder farmers in iLembe district municipality has no influence on ICTs perceived usefulness.

H_1: The perceived ease of using ICTs by smallholder farmers in iLembe district municipality has a positive influence on ICTs perceived usefulness.

Hypothesis 6

H_0: Culture does not influence on ICT diffusion amongst smallholder farmers in iLembe district municipality.

H_1: Culture does influence ICT diffusion amongst smallholder farmers in iLembe district municipality.

4.4.2 Research Approach

The main purpose of this study was to identify if ICTs, including "new ICTs" particularly GIS, knowledge management systems (KMS) and early warning systems (EWS), play a role in improving food security, and how they can be utilised in KwaZulu-Natal to improve food security. Because of the need to obtain generalizable results and therefore, the need for objectivity in the research, hypotheses were tested with the aim of testing the theories put forward. The study used a quantitative research design and techniques to better understand the phenomenon under investigation. Crowther and Lancaster (2012) posit that as a general rule the positivist philosophy adopts a deductive approach in terms of the research design. Based on this general rule and Saunders et al. (2009) research onion, this study followed a deductive approach, as a positivist philosophy was the philosophy of choice. This meant using observation and statistical methods to arrive at the empirical results. The deductive approach allowed for the use of the survey technique to collect data and making use of questionnaires as the data collection instruments. The choice to use a quantitative design was made due to its association with the deductive research approach that makes use of hypothesis testing and surveys. The deductive approach also emphasises scientific measures of quantities, intensity or frequencies.

4.4.3 Research Strategy

The data collected and used in this study was from three questionnaires. The three questionnaires focused on the two respondent groups identified in section 4.3 of this chapter. Two of the questionnaires focused on the smallholder farmer (farmer questionnaire and HFIAS questionnaire) and the third focused on the extension officer. All three questionnaires were quantitative in nature and were designed in that manner because of the need to obtain generalizable, reliable and statistically valid results. Another factor which influenced the research strategy was the number of respondents which formed the study sampling frame (statistical requirement of sample size of 517 farmers and a survey of all extension officers as they numbered less than 100 respondents as recommended by Gay and Lorrie (2006). Data triangulation was then applied to the three sets of data. Denzin (1970, 1978) identified the method of data triangulation and acknowledged his critics by explaining that various accounts produced when data is gathered from different sources do not validate a phenomenon but rather provide a better understanding of the phenomenon under study. Triangulation is usually

associated with the qualitative research approach although in this case the data triangulation provides the richness in data from the various sources it is gathered from (smallholder farmers and extension officer). Triangulation provided an interpretive approach and thus a richer understanding of the phenomenon under study (Denzin, 1989).

4.4.4 Time Horizon

Food security is dynamic by nature and a number of factors are involved in attaining a food secure society. Climate change and population changes compound the dynamic nature of attaining a food secure society (Poppy et al., 2014). Jarosz (2014) expounds on the dynamic nature of food security by identifying political economics, geographies, national and local levels of measure and the ever-changing nature of these factors that cause food security to be "fluid". The researcher employed a cross-sectional approach to the data collection for this study due to the timeframes on which the study was based and the dynamic nature of food security.

4.5 Research Techniques and Procedures

The Kolmogorov-Smirnov test was used to assess whether the data within each of the questions was normally distributed within the dataset with the predictions of a Gaussian distribution. The Cronbach's Alpha test was applied to questions with the same scales to determined internal consistency; this test is commonly used as a test for reliability and hence determines the quality of the data. The Cronbach's Alpha test has a bearing on the integrity of the research methodology that was used, specifically the data collection instrument. The Cronbach's alpha test was applied to both the farmer and the extension officer questionnaires and calculated for all the questions that were of the same scales in each section. The results with regards to the reliability of the instruments were also increased by the use of the five point Likert-scales in the surveys. The integrity was determined by using consistency and reliability, results were considered to be good for all questions tested whose value obtained as a result of this Cronbach's Alpha test was 0.7 or higher. The following table shows the results obtained from this study's survey instruments.

QUESTIONS	SIMILARITY OF SCALE	CRONBACH'S ALPHA
12, 14, 18, 29, 31, 35 and 37	Very Small Extent to Very Large Extent	0.764
11, 13, 25-28	Strongly Disagree to Strongly Agree	0.730

21 and 24	Never to More Than Once Per Day	0.749
HFIAS section 1-9	Occurrence (Yes or No)	0.879
HFIAS section 1a-9a	Frequency (Rarely to Often)	0.938

Table 8: Results of Cronbach's alpha reliability analysis – Farmer questionnaire

QUESTIONS	SIMILARITY OF SCALE	CRONBACH'S ALPHA
10, 12, 22, 23, 24 and 25	Strongly Disagree to Strongly Agree	0.711
11, 29, 33	Yes or No	0.715
13, 26, 28 and 32	Very Small Extent to Very Large Extent	0.744
14 and 34	Extremely Hard to Extremely Easy	0.705
15 and 35	Extremely Useless to Extremely Useful	0.773
18 and 21	Never to More Than Once Per Day to Never	0.815

Table 9: Results of Cronbach's alpha reliability analysis – Extension officer questionnaire

4.5.1 Ethical Considerations

In order to adhere to ethical practice and standards set by the University of KwaZulu-Natal the institute through which the researcher was conducting this study, permission was sought from the Department of Agriculture (gatekeeper letter) and the ethical clearance was applied for and granted by the ethical clearance committee of the University before conducting the research. In ensuring that the 1st group of respondents (smallholder farmers) fully comprehended the research they took part in, the questionnaire developed for them including the household food insecurity access scale (HFIAS) questionnaire were both translated into isiZulu which is the local language of the study area (KwaZulu-Natal province) and amaZulu research assistants (research assistants from the same ethnic group) were used after being trained on filling in the questionnaire and how to assist smallholder farmers who are not able

to read nor write isiZulu. All the data collection instruments were accompanied by a covering letter informing the respondent groups of the confidentiality of their responses and that their responses will be kept safely and anonymous. The respondents were also reminded that the research was purely voluntary and they were allowed to withdraw from the research at any time (Appendix A and B – farmer questionnaire).

4.5.2 Sampling Technique and Sample Size

In order to determine a sampling technique and sample size, the researcher sought to understand the study population and area. Due to the nature of smallholder farmers (vulnerable in terms of capacity to engage in agricultural activities and hence dynamic in existence) the most feasible method to go about identifying smallholder farmers in iLembe district was through the use of structures that provided support to smallholder farmers. The department of agriculture district office encourages smallholder farmers in the district to form farmer cooperatives (registered groupings with the department) and it is through these cooperatives that support services such as agricultural support through extension officers, water provision through borehole drilling, fencing to protect crops from animal damage and assistance to prepare the soil for planting are provided. A database of registered farmers is maintained by the department of agriculture district office in iLembe in conjunction with Enterprise iLembe, which is the Economic Development Agency for the iLembe district municipality and has the responsibility of promoting trade and investments in the district. It is this database that was the source of information on smallholder farmers in the district that had a total of 1008 smallholder farmers in the cooperatives. As previously mentioned, due to the vulnerability of the smallholder farmer, obtaining the exact number of smallholder farmers in the iLembe district municipality was challenging. Smallholder farmers used in this study were smallholder farmers who held registration with cooperatives and are stored on the department of Agriculture database in the district. Extension officer information was obtained from the provincial head office based in the Cedara area, in Pietermaritzburg the provincial capital of KwaZulu-Natal province. The extension officer information was also confirmed at the district office in iLembe where the extension officers are based. This confirmation proved helpful as it revealed that of the 160 agricultural extension officers based in iLembe district as identified from the Department of Agriculture head office in Cedara, 68 were permanent extension officers and the remaining 92 were working as contracted extension officers designated to assist the more experienced permanent staff compliment. The decision to survey only the permanent members of staff was arrived at by the researcher due to the fact that only the permanent extension officers were issued with a full complement of ICTs; a digital pen, a laptop and a smart phone (Blackberry).

In a recent study by Carter, Dubois, and Tremblay (2014) where the authors critically reviewed and synthesised published literature on food security, some of the recommendations the authors made were the use of cluster random sampling as an appropriate sampling method in situations where the survey was undertaken in person. The authors also recommended the use of standardised food security measures that then allow the comparability of results across different studies. Similar studies have also made use of such sampling techniques (Ghattas, Sassine, Seyfert, Nord, & Sahyoun, 2014; Sahyoun et al., 2014). This study used a composite sampling method which included multi stage clustering, some simple random sampling and to a small extent some convenience sampling (limitations on movement within the clusters). The study also employed the Household Food Insecurity Access Scale (HFIAS) to measure food insecurity. The target population were smallholder farmers in iLembe district municipality and extension officers. The district municipality consisted of four local municipalities that formed the clusters (1st level). An excel list of registered smallholder farmers was created from the database of smallholder farmers information kept by Enterprise iLembe. These farmers are registered under farmer cooperatives which were separated according to the clusters (local municipalities) they belonged to (2nd level). The list of registered farmers totalled 1008 in the cooperatives. Therefore, the farmer survey was designed as a two-phase cluster sample (a representative selection of farmers), not a simple random sample. Thereafter, a sample size of 246 was calculated and multiplied by the design effect of 2 to correct for the difference in design and a contingency of 5% was added, this brought the total sample size for the smallholder farmers to 517. The choice of making use of a clustering technique was influenced by the difficulty to obtain the entire list of smallholder farmers in iLembe district as they are informal in operation, it was also arrived at due to the limited financial resources and time constraints associated with this study. The sample population in this research also included agricultural extension officers as stated earlier. As previously stated the sample size for the extension officers was 68. Gay and Lorrie (2006) provided guidance on the sample sizes who recommended for populations of 100 people or less a survey of the entire population is required. The guidance provided by the authors informed this study in the collection of data from the agricultural extension officers. Out of the 68 extension officers identified to be surveyed, 41 took part in the study. Twenty seven (27) extension officers did not take part in the survey due to temporary absence; employee leave and working outside the district at the time of data collection of this study.

4.5.3 Pilot Study

In this study the researcher conducted a pilot survey to control for the concerns raised by McNabb (2013). The researcher developed two survey instruments for smallholder farmers and extension officers with insights from three key informants; consultations with IT experts including the researcher's supervisor, experts from the School of Agriculture/Food Security

Centre at the University of KwaZulu-Natal and experts from the government Department of Agriculture head office in Cedara (strategic support services which is the unit that is involved with training of extension officers and the food security unit in the government department of agriculture). The questionnaire was then administered to IT and agriculture experts for content validation that helped determine adequate coverage of the research problems and clarifications. The experts also helped identify ambiguities and provided suggestions of focus areas and concepts. Secondly, the questionnaire was put to scrutiny by a statistician from the School of Mathematics and Statistics at the University of KwaZulu-Natal who tested the instrument for issues of reliability and to check if all the anticipated responses could be appropriately and adequately analysed. The smallholder questionnaire was then converted into the local language of the research area (IsiZulu) by a language practitioner. This was to ensure the smallholder farmer fully understood the study and would give more accurate responses to the questions. A preliminary survey of the area and data from statistics South Africa revealed that majority of the population in that area were illiterate (StatsSA, 2012).

The resulting two questionnaires that were developed were then administered to 4 extension officers and 8 smallholder farmers. This revealed any area of the instruments that required further explanation more so with regards the converted questionnaire into isiZulu, repetitions and similarities that resulted in the researcher deleting unnecessary items. This pilot survey also provided the researcher with an opportunity to estimate an accurate time the respondents will take to complete the surveys. The resulting pilot survey was successful as respondents clearly understood the questions put to them and the survey also took into account various possible responses which allowed the respondents to accurately provide a response which they felt represented their views and helped determine the number of scale points to use in the Likert-scale questions (Munshi, 2014).

4.5.4 Methods of Data Collection

This study made use of primary data sources which were collected through three questionnaires, specifically for the purpose of addressing the research problems indicated in this study (Zikmund, Babin, Carr, & Griffin, 2012). The fieldwork which involved data collection from the two respondent groups (extension officers and smallholder farmers) commenced in August 2013 and took 3 months to complete. The process consisted of a team that included the researcher, four extension officers who identified the project sites throughout the district and six isiZulu speaking research assistants who were contracted by the researcher. Over the course of 3 months 529 farmers and 47 extension officers were surveyed.

4.5.5 Research Questions

The section offers an explanation of the statistical methods that were employed in order to answer the research questions. The section also shows (Table 10) the link between the research questions, data collection techniques and the data expected outcomes.

Hypothesis Testing

The use of simple random sampling within the clusters and the categorical nature of the data allowed the researcher to formulate hypotheses for each sub-research question (1-5). The researcher made use of the Chi-square goodness of fit test. The choice of test used was informed by the reasoning that if the responses were in favour of a particular category, for instance in favour of the "large extent" category rather than the "small extent" category, then the researcher could determine if certain factors that influence the usage of ICTs are effectively being practiced based on the distribution of the responses within the question categories. The Kolmogorov Smirnov test was also applied to test the following hypothesis:

H_0: the tested variables come from a Normal distribution

H_1: the tested variables do not come from a Normal distribution

This test revealed the non-parametric nature of the data and in order to test for significant differences between the demographic variables the researcher used the Mann Whitney U test and the Kruskal Wallis test.

Logistic Regression

In order to answer research question 4, the researcher used logistic regression to the binary response variable and several categorical variables that are the explanatory variables in this study. The binary response variable is question 32 of the farmer's questionnaire i.e. Do you use ICTs in your knowledge management practices? The explanatory variables were age, formal education, experience in farming activities and gender.

Research Questions	Research Method	Expected Data Outcome
Sub-Research Question 1		

How does the level of education influence the smallholder farmers ability to adopt ICTs for farming practice in KwaZulu-Natal?	- Structured questionnaire use by researcher & research assistants in the selected study area. - Document analysis: 1. Government documentation – annual reports, policies, strategic plans, reviews. 2. Libraries & databases – journal articles, books, reports, thesis, webpages, conference proceedings.	- Insights from farmers and extension officers on the role of demographic variables on ICT adoption. - Documentary evidence from existing documents.
Sub-Research Question 2		
Why do smallholder farmers adopt ICTs in KwaZulu-Natal?	- Structured questionnaire use by researcher & research assistants in the selected study area. - Document analysis: 1. Government documentation – annual reports, policies, strategic plans, reviews. 2. Libraries & databases – journal articles, books, reports, thesis, webpages, conference proceedings.	- Insights from farmers and extension officers on the factors that motivate ICT adoption in KwaZulu-Natal. - Documentary evidence from existing documents.
Sub-Research Question 3		
What factors influence ICT adoption in the application of knowledge management practices?	- Structured questionnaire use by researcher & research assistants in the selected study area. - Document analysis: 1. Government documentation – annual reports, policies,	- Insights from farmers and extension officers of influences ICT adoption in the application of knowledge management practices. - Documentary evidence from existing documents.

	strategic plans, reviews. 2. Libraries & databases – journal articles, books, reports, thesis, webpages, conference proceedings.	
Sub-Research Question 4		
What are the smallholder farmer perceptions of ICT adoption in food security in KwaZulu-Natal?	- Structured questionnaire use by researcher & research assistants in the selected study area. - Document analysis: 1. Government documentation – annual reports, policies, strategic plans, reviews. 2. Libraries & databases – journal articles, books, reports, thesis, webpages, conference proceedings.	- Insights from farmers and extension officers on perceptions of ICTs role in food security - Documentary evidence from existing documents.
Sub-Research Question 5		
Which of the constructs borrowed from the theoretical models of diffusion of innovation, technology acceptance model and Hofstede's model are direct determinants of the adoption of ICT's in food security in KwaZulu-Natal?	- Structured questionnaire use by researcher & research assistants in the selected study area. - Document analysis: 1. Government documentation – annual reports, policies, strategic plans, reviews. 2. Libraries & databases – journal articles, books, reports, thesis, webpages, conference proceedings.	- Validation of proposed framework. - Documentary evidence from existing documents.

Table 10: Link between research questions, data collection techniques and data expected outcomes

4.5.6 Research Instrument

Three questionnaires were used in this study:

The Farmer Questionnaire and Extension Officer Questionnaire

For the purpose of this study a five point Likert-scale was used and the precision error was controlled for by the high number of items included in the instrument (Murphy & Likert, 1938).

The smallholder and extension officer questionnaires consisted of six generic sections (see Table 11) with very similar items in each of them from two different perspectives (smallholder farmer and extension officer).

Part	**Name**	**No. of Items smallholder farmer questionnaire**	**No. of Items extension officer questionnaire**
Section 1:	Your Personal Information	4	4
Section 2:	General farmer Information	13	12
Section 3:	Information & Communication Technology (ICT)	36	31
Section 4:	Geographic Information Systems (GIS)	12	12
Section 5:	Knowledge Management Systems (KMS)	31	30
Section 6:	Early Warning Systems (EWS)	5	5

Table 11: Structure of smallholder farmer and extension officer questionnaires

Household Food Insecurity Access Scale (HFIAS Questionnaire)

The third questionnaire that was put to the smallholder farmer respondent group was the HFIAS questionnaire. The purpose of this questionnaire was to determine the food insecurity level of the smallholder farmer. This data was then correlated with various ICT variables to ascertain relationships between food insecurity and ICT adoption decision, willingness, extent of use and the various elements related to the diffusion of innovation theory of perceived

attributes of innovation; trialability, observability and compatibility. The HFIAS questionnaire consists of nine questions related to occurrence of a phenomenon. Each occurrence question had a follow up question measuring the frequency of that occurrence. An example of a HFIAS questionnaire question is as follows:

Q1. In the past four weeks, did you worry that your household would not have enough food?

0 = No (skip to Q2)

1 = Yes

Q1.a. How often did this happen?

1 = Rarely (once or twice in the past four weeks)

2 = Sometimes (three to ten times in the past four weeks)

3 = Often (more than ten times in the past four weeks)

4.5.7 Data Analysis

The data collected using the three research questionnaires in this study was analysed using the Statistical Package for Social Science version 21 (SPSS 23). The data analysis procedures included:

Coding of the data – number values were assigned to each variable.

Descriptive statistics – these were generated to describe the main features of the data.

Bar graphs – were generated and used in answering aspects of sub-research questions 1 and 2.

Cross tabulation analysis – was used in answering aspects of sub-research questions 1 and 2.

Logistic regression – was used to answer sub-research question 3 it was used to assess the significance in relationship between the binary response variable and several categorical variables that are the explanatory variables in this study.

Correlation analysis - was then performed on various variables of interest to determine the strength and the direction the relationship between the variables. This analysis measured both positive and a negative correlation. The non-parametric nature of the data made the use of Spearman's correlation coefficient (no requirement of normality) a more appropriate test compared to Pearson's correlation. The Spearman's correlation was therefore used to measure the correlation between food insecurity and various ICT variables and this test revealed a

negative correlation; an increase in the value of one variable shows a decrease in the value of another. This test helped answer research question 4.

Structural Equation Modelling – was performed to validate the proposed framework for determining the role of ICT adoption in Food Security in KwaZulu-Natal Province. This test helped answer research question 5.

The Kolmogorov Smirnov test – was performed to test the null hypothesis for normality of distribution of the data.

Mann Whitney U test and the Kruskal Wallis test – was performed due to the non-parametric nature of the data and in order to test for significant differences between the demographic variables.

Independent sample t-test and ANOVA – was used for the parametric data identified, the researcher accepted H_0 and a conclusion was made that these variables come from a Normal distribution.

4.6 Limitations

Because the study was dealing with farmers and extension officers, the researcher felt the respondents could give complementary information on the role that information and communication technology can play in improving food security in KwaZulu-Natal based on their perspectives. It was the researcher's view that based on the cultural dimensions theory (Hofstede, 2013) a percieved power distance might lead the smallholder farmers to provide biased responses by trying to be as positive as possible and not being candid in their responses. This created awareness in the researcher to look out for such bias. A potential limitation was the researcher and research assistants had to interact with the respondents in the data collection process. To control for response bias, the researcher conducted training for the research assistants to be mindful of leading respondents to giving a particular response when assisting the farmers who could not read nor write isiZulu but rather should always phrase the questions and explanations in a manner which is neutral and solicits their opinion on a subject matter (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Even though the questionnaires to these respondents were accompanied by an Informed Consent document that introduced the researcher and outlined the research, the researcher opened all gatherings at farm sites with an introduction in isiZulu of the researcher as a student, and not a government official. This was done in order to create a free open environment and avoid any bias in their responses to the questionnaires. The introduction also included a detailed explanation of the study being conducted Furthermore, the researcher explained during the introduction, that participation was voluntary and if they really felt uncomfortable with a question, they had the

option to not respond. However, respondents were encouraged to be as honest as possible. This approach was especially necessary and extremely helpful in alleviating tension when dealing with the ancillary questionnaire (HFIAS questionnaire) as issues of household food insecurity were considered very personal. Upon adoption of this approach, the researcher was very surprised at the level of honesty and openness that was shown by both the smallholder farmers and extension officers. Lastly, the researcher acknowledged a language limitation, as a few of the technical English terms had no isiZulu equivalent. To control for this error, a more detailed explanation was provided in place of the term and the use of research assistants to further explain these terms was implemented.

4.7 Conclusions

This chapter is best read in association with Figure 14 (Proposed framework for determining the factors that play a role on ICT adoption in food security in KwaZulu-Natal) on page 66 of the previous chapter, which deals with the Theoretical Framework. This chapter provided a detailed account of the researcher's activities during the study, which begun by foregrounding the nature of the study and a description of the area of study. The researcher then went on to discuss the research design with the aid of the research onion by Saunders et al. (2009). The next chapter covers the data analysis and a discussion of the results produced.

CHAPTER 5

ADOPTION OF ICTs IN FOOD SECURITY AMONGST SMALLHOLDER FARMERS IN KWAZULU-NATAL

Analysing the role of ICTs in improving food security amongst smallholder farmers in KwaZulu-Natal

"It is necessary, first of all, to find a correct logical starting point, one which can lead us to a natural and sound interpretation of the empirical facts."

(Schirmacher, 2002, p. 115)

5.1 Introduction

Chapter four discussed the fieldwork that was undertaken by the researcher. In that chapter, the characteristics of the respondents are discussed including the steps that were taken to address the research objectives. In this chapter, the researcher presents the results of the data analysis that was conducted. The data was gathered by means of surveys and the chapter also presents an interpretation and discussion of the results within the context of the literature and in a quantitative manner in the form of tables, graphs and charts.

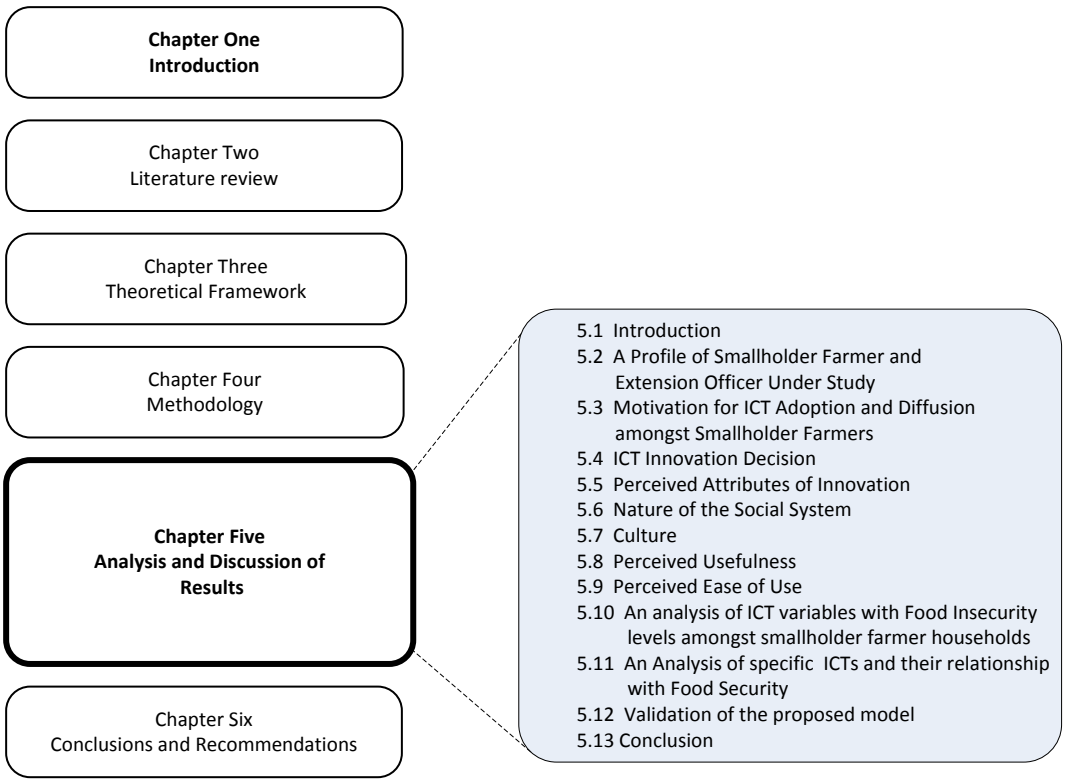


Figure 25: Chapter 5 within the overall research strategy - Phase 4 of the Study

Section 5.2 provides findings and discussions in order to answer research question 1:

- How does the level of education influence the smallholder farmers ability to adopt ICTs for farming practice in KwaZulu-Natal?

The surveyed population of smallholder farmers and extension officers are profiled in section 5.2. This section begins by testing the hypotheses that were formulated followed by demographic profiles and general farmer information. This section also profiled the smallholder farmer in relation to their food security status and provided an overview on the food security status of smallholder farmers in iLembe district municipality. Section 5.3 provides findings and discussions in order to answer research question 2:

- Why do smallholder farmers adopt ICTs in KwaZulu-Natal?

Section 5.4 discusses the ICT innovation decision. Sections 5.5 to 5.9 focus on the theoretical constructs that were used in this study. Section 5.10 Focuses on ICT variables that play a role on food insecurity while section 5.11 provides findings and discussions in order to answer research question 3 and 4:

- What factors influence ICT adoption in the application of knowledge management practices?
- What are the smallholder farmer perceptions of ICT adoption in food security in KwaZulu-Natal?

The proposed framework used to understand ICT adoption in food security amongst smallholder farmers was evaluated in section 5.12. This section provides findings and discussions in order to answer research question 5:

- Which of the constructs borrowed from the theoretical models of diffusion of innovation, technology acceptance model and Hofstede's model are direct determinants of the adoption of ICT's in food security in KwaZulu-Natal?

Each section of this chapter addresses aspects of ICT adoption amongst smallholder farmers and its role in food security as was structured in the questionnaire, an illustration of this relationship is shown in Table 12.

Sections of Chapter	**Questions**
5.2 A Profile of Smallholder Farmer and Extension Officer Under Study	Farmer Questionnaire: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13

	Extension Officer Questionnaire: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
5.3 What motivates ICT diffusion amongst Smallholder Farmers	Farmer Questionnaire: 22, 23, 25
5.4 ICT Innovation Decision	Farmer Questionnaire: 17
5.5 Perceived Attributes of Innovation	Farmer Questionnaire: 11, 14, 15, 26, 27, 28
5.6 Nature of the Social System	Farmer Questionnaire: 9, 10, 12, 22, 19, 20, 21, 24
5.7 Culture	Farmer Questionnaire: 13
5.8 Perceived Usefulness	Farmer Questionnaire: 16
5.9 Perceived Ease of Use	Farmer Questionnaire: 15
5.10 An analysis of ICT variables with Food Insecurity levels amongst Smallholder Farmer Households	Farmer Questionnaire: 22, 25, 26, 27, 28, 29, 37 Farmer Questionnaire Part B (Food Insecurity Measure): 1, 2, 3, 4, 5, 6, 7, 8, 9
5.11 Specific ICTs and their role in Food Security	Farmer Questionnaire: 29, 30, 31, 32, 33, 34, 35, 36, 37, 38
5.12 Validation of the Proposed Framework	Farmer Questionnaire: 9, 10, 11, 12, 13, 14, 15, 16, 19, 20, 21, 22, 24, 26, 27, 28

Table 12: Overview of question analysis

5.2 A Profile of the Smallholder Farmer and Extension Officer under Study

5.2.1 Hypothesis Testing

Hypotheses were formulated and tested as part of the study to provide a better insight of the study. Normality tests were conducted on the data to determine the appropriate statistical analysis to be performed. The detailed accounts of these results follow in the subsequent sections.

KOLMOGOROV SMIRNOV TEST

The following hypotheses were tested:

H_0: the tested variables come from a Normal distribution

H_1: the tested variables do not come from a Normal distribution

	Kolmogorov-Smirnov Z	Asymp. Sig. (2-tailed)
Gender of Respondent	9.268	.000
Respondent Grew up in	12.252	.000
Ethnic Group	11.855	.000
Age Range	4.540	.000
Experience in Farming Activities	4.753	.000
Formal Education	10.631	.000
Farm Size	12.152	.000
Travel to big towns/cities	4.629	.000
Farmer Visits to Extension Officer Offices	5.217	.000
Receive reading materials from extension officers	6.015	.000
Effectiveness of Information Provided in English	4.828	.000
Extent of farmer dependence on extension officers for farming information	8.602	.000
I am closely involved with the day-to-day running of my farm with the extension officer	6.453	.000
I am on first name basis with the extension officer	9.824	.000
Extension officers help remove unease in situations in which there are no clear guidelines	8.444	.000
Farming innovations lead by females are usually not adopted by farmers	6.499	.000
The extension officer encourages planning only on a seasonal basis	7.351	.000
Extent of ICT use on the farm	7.796	.000
Ease of use of ICTs in farming activities	6.405	.000
Usefulness of ICTs in relation to farming activities	6.331	.000
Begin using ICTs	3.412	.000
Extent of ICT use for information sharing with fellow farmers	7.482	.000
Face to Face		
Local Radio	4.074	.000
Agric. Extension Officer		
Gatherings	7.162	.000
Phone	8.047	.000

Phone	8.289	.000
Extent of ICT use for information sharing with fellow farmers	4.698	.000
Extent of ICT use for information sharing with extension officers	5.330	.000
Innovation	6.811	.000
To solve problems	7.696	.000
Desire for new technology	5.374	.000
Institutional pressure	3.141	.000
Cellphone	8.342	.000
Smartphone	2.940	.000
Local Radio	3.581	.000
Agric. Extension Officer	4.089	.000
Gatherings	3.923	.000
Telephone	5.428	.000
Websites	2.851	.000
Newspapers	2.740	.000
Email	3.286	.000
Posters	2.354	.000
Use of Mobile phones (sms & voice calls)	10.183	.000
Use of Desktop Computer	10.198	.000
Use of Laptop or Tablet Computer	10.151	.000
Use of Smart Phone (internet services)	8.264	.000
Use of Satellite Data	10.788	.000
Use of Fixed line internet	10.563	.000
Television	4.290	.000
Landline	7.955	.000
Radio	8.850	.000
Willingness to adopt new communication media to access information	6.810	.000
Willingness to adopt new communication media to share information	7.808	.000
ICTs are compatible with the business needs of the farm	7.334	.000
ICTs are compatible with the information needs of farming	7.115	.000
ICTs are compatible with the cultural norms of farming	6.941	.000
ICTs are compatible with the existing infrastructure at the farms	6.727	.000
Trialability of ICTs	7.990	.000
Observability of ICTs	6.484	.000
Extent of GIS use	6.502	.000
Determining suitable areas for growth of crops	7.369	.000
Determining easiest access routes to markets	6.398	.000

Extent of indigenous knowledge use	8.056	.000
Extent of institutional knowledge use	8.808	.000
Extent indigenous knowledge influencing choice to use ICTs	7.743	.000
Extent institutional knowledge influencing choice to use ICTs	8.091	.000
Extent of involvement in knowledge management practices	7.209	.000
Use of ICTs in Knowledge Management Practices	9.722	.000
Notebooks	8.554	.000
Traditional stories	9.088	.000
Food processing	4.899	.000
Food storage	7.070	.000
Food marketing	5.807	.000
Do not use in any area	5.009	.000
Use farm produce traceability systems	5.904	.000
RFID tags	1.703	.006
Do not use any	9.449	.000
Extent of use of early warning systems	6.849	.000
Websites	1.485	.024
Phones	7.047	.000
Radio	10.056	.000
Two way radios	7.696	.000
Did you worry that your household would not have enough food?	12.380	.000
How often did this happen?	7.828	.000
Were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	12.414	.000
How often did this happen?	7.433	.000
Did you or any household member have to eat a limited variety of foods due to a lack of resources?	12.224	.000
How often did this happen?	7.530	.000
Did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	12.362	.000
How often did this happen?	7.639	.000
Did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	12.313	.000
How often did this happen?	7.945	.000
Did you or any household member have to eat fewer meals in a day because there was not enough food?	12.315	.000
How often did this happen?	7.690	.000
Was there ever no food to eat of any kind in your household because of a lack of resources to get food?	11.047	.000
How often did this happen?	6.956	.000

Did you or any household member go to sleep at night hungry because there was not enough food?	10.669	.000
How often did this happen?	6.682	.000
Did you or any household member go a whole day and night without eating anything because there was not enough food?	9.645	.000
How often did this happen?	5.796	.000

Table 13: Summary of Kolmogorov Smirnov test for significance - Farmer questionnaire

Using significance levels of 5%, the researcher rejected H_0 for questions which had a p-values of less than 0.05 this also allowed the researcher to conclude that the variables which were tested did not come from a Normal distribution. This meant that based on these results, the researcher was required to use non-parametric statistics. Some of the tests applied on the data include Kruskal Wallis test, chi-square tes and the Mann-Whitney U test. These tests were applied were the situation deemed necessary. The researcher made use of nonparametric techniques due to the fact that all of the questions had p-values of less than 0.05, On some of the variables, the Kolmogorov Smirnov test could not be applied since there was a variance of zero due to one response dominating the data on that variable and hence the test statistic could be calculated.

The Chi-square goodness of fit test was used to test the hypotheses that were formulated. The reasoning behind the choice of use of this test was that if the responses are tending towards a certain category, for instance towards the "large extent" category rather than the "small extent" category, this helped the researcher to determine if certain factors that influence the usage of ICTs are effectively being practiced based on the distribution of the responses within the question categories.

5.2.2 The Smallholder Farmer

The first part of the sampling frame consisted of smallholder farmers from the iLembe district municipality of KwaZulu-Natal. This section presents an overview of the demographic characteristics of the smallholder farmers. Factors such as gender, age, the level of education of the smallholder farmers, their frequency of visits to the extension officers will be presented.

5.2.3 Reliability Analysis

In order to determine the reliability of the data the Cronbach's alpha test was used. A value of 0.7 or higher is acceptable. The Cronbach's alpha was calculated for all the questions probing the same issues in each section.

QUESTIONS	SIMILARITY OF SCALE	CRONBACH'S ALPHA
12, 14, 18, 29, 31, 35 and 37	Very Small Extent to Very Large Extent	0.764
11, 13, 25-28	Strongly Disagree to Strongly Agree	0.730
21 and 24	More Than Once Per Day to Never	0.749
New section 1-9	Occurrence (Yes or No)	0.879
New section 1a-9a	Frequency (Rarely to Often)	0.938

Table 14: Results of Cronbach's alpha reliability analysis – Farmer questionnaire

Based on the use of the Cronbach's alpha test previously discussed and the results shown in Table 14, questions, 11, 12, 13, 14, 18, 21, 24 - 29, 31, 35, 37 and the entire section on which assessed the food insecurity in the smallholder farmer households showed alpha values above 0.7, this meant that the reliability is good.

5.2.4 Testing For Significant Differences

Based on the results of the Kolmogorov Smirnov test earlier (Section 5.1.1), the researcher has had to use Non-parametric statistics. To test for significant differences between the demographic variables the researcher makes use of the Mann Whitney U and Kruskal Wallis tests.

MANN WHITNEY U TEST

H_0: there is no difference between males and females in their perceptions with respect to ICTs

H_1: there is a difference between males and females in their perceptions with respect to ICTs

	Mann-Whitney U	Z	Asymp. Sig. (2-tailed)
Extent of ICT use on the farm	32373.000	-.380	.704
Ease of use of ICTs in farming activities	29157.000	-2.385	.017
Usefulness of ICTs in relation to farming activities	31120.500	-1.098	.272

Begin using ICTs	26484.500	-1.668	.095
Extent of ICT use for information sharing with fellow farmers	21420.500	-2.566	.010
Face to Face	16129.000	.000	1.000
Local Radio	405.000	-.933	.351
Agric. Extension Officer	462.500	.000	1.000
Gatherings	4049.500	-1.418	.156
Phone	6670.000	-.794	.427
Newspapers	2.000	.000	1.000
email	36.000	.000	1.000
Posters	4.500	.000	1.000
Face to Face	15960.000	.000	1.000
Local Radio	50.000	.000	1.000
Agric. Extension Officer	272.000	.000	1.000
Gatherings	3807.000	.000	1.000
Do Not Share	28.000	.000	1.000
Phone	7393.500	-.762	.446
Email	32.500	.000	1.000
Posters	1.500	.000	1.000
Extent of ICT use for information sharing with fellow farmers	31811.500	-.103	.918
Extent of ICT use for information sharing with extension officers	29108.500	-1.030	.303
Innovation	2670.500	-1.484	.138
Fear of being left behind	634.500	.000	1.000
To solve problems	5372.000	-.314	.754
Desire for new technology	1298.500	-.953	.341
Institutional pressure	70.000	-.415	.678
Cellphone	26256.500	-1.368	.171
Smartphone	14588.000	-4.319	.000
Local Radio	25223.500	-.703	.482
Agric. Extension Officer	25308.000	-1.022	.307
Gatherings	22727.000	-.919	.358
Telephone	24456.500	-.887	.375
Websites	15782.500	-2.952	.003
Newspapers	23837.500	-.476	.634
Email	14411.500	-.128	.899
Posters	21181.000	-.310	.757
Use of Mobile phones (sms & voice calls)	27209.500	-3.794	.000
Use of Desktop Computer	31120.500	-.205	.837
Use of Laptop or Tablet Computer	31122.000	-.009	.993

Use of Smart Phone (internet services)	27261.500	-3.029	.002
Use of Satellite Data	29720.500	-1.063	.288
Use of Fixed line internet	28216.500	-.773	.440
Television	24050.500	-4.189	.000
Landline	25107.000	-1.095	.273
Radio	26968.500	-2.894	.004
Willingness to adopt new communication media to access information	29862.500	-1.578	.114
Willingness to adopt new communication media to share information	28306.000	-1.785	.074
ICTs are compatible with the business needs of the farm	30496.500	-1.498	.134
ICTs are compatible with the information needs of farming	28796.000	-1.910	.056
ICTs are compatible with the cultural norms of farming	28886.000	-1.813	.070
ICTs are compatible with the existing infrastructure at the farms	29509.500	-.552	.581
Trialability of ICTs	32179.500	-.231	.817
Observability of ICTs	26307.500	-3.717	.000

Table 15: Summary of significance (Mann Whitney U) between age group and ICTs

KRUSKAL WALLIS TEST

H_0: there is no difference between age group in their perceptions with respect to ICTs

H_1: there is a difference between age group in their perceptions with respect to ICTs

Test Statistics[a,b]

	Chi-Square	df	Asymp. Sig.
Extent of ICT use on the farm	9.799	4	.044
Ease of use of ICTs in farming activities	20.132	4	.000
Usefulness of ICTs in relation to farming activities	18.278	4	.001
Begin using ICTs	6.254	4	.181
Extent of ICT use for information sharing with fellow farmers	1.031	4	.905
Face to Face	.000	4	1.000
Local Radio	1.417	4	.841
Agric. Extension Officer	.000	4	1.000

Gatherings	12.537	4	.014
Phone	2.449	4	.654
Newspapers	.000	2	1.000
email	.000	4	1.000
Posters	.000	3	1.000
Face to Face	.000	4	1.000
Local Radio	.000	4	1.000
Agric. Extension Officer	.000	4	1.000
Gatherings	.000	4	1.000
Do Not Share	.000	4	1.000
Phone	12.316	4	.015
Email	.000	4	1.000
Posters	.000	2	1.000
Extent of ICT use for information sharing with fellow farmers	31.291	4	.000
Extent of ICT use for information sharing with extension officers	38.426	4	.000
Innovation	9.093	4	.059
Fear of being left behind	.000	4	1.000
To solve problems	3.854	4	.426
Desire for new technology	1.861	4	.761
Institutional pressure	1.429	4	.839
Cellphone	7.055	4	.133
Smartphone	.097	4	.999
Local Radio	1.086	4	.896
Agric. Extension Officer	4.153	4	.386
Gatherings	5.478	4	.242
Telephone	5.377	4	.251
Websites	5.328	4	.255
Newspapers	3.218	4	.522
Email	8.915	4	.063
Posters	8.381	4	.079
Use of Mobile phones (sms & voice calls)	3.825	4	.430
Use of Desktop Computer	12.677	4	.013
Use of Laptop or Tablet Computer	25.970	4	.000
Use of Smart Phone (internet services)	16.327	4	.003
Use of Satellite Data	8.424	4	.077
Use of Fixed line internet	4.286	4	.369
Television	9.863	4	.043
Landline	1.323	4	.857
Radio	3.037	4	.552

Willingness to adopt new communication media to access information	9.329	4	.053
Willingness to adopt new communication media to share information	1.569	4	.814
ICTs are compatible with the business needs of the farm	7.080	4	.132
ICTs are compatible with the information needs of farming	1.088	4	.896
ICTs are compatible with the cultural norms of farming	6.247	4	.181
ICTs are compatible with the existing infrastructure at the farms	8.962	4	.062
Trialability of ICTs	10.620	4	.031
Observability of ICTs	1.448	4	.836

a. Kruskal Wallis Test

b. Grouping Variable: Age Range

Table 16: Summary of Significance (Kruskal Wallis) between age group and ICTs

At the 5% significance level the researcher rejected H_0 (questions whose p-values are less than 0.05- whose values are in red in Table 15 and Table 16) and concluded that for these questions there is a difference in the smallholder farmer perceptions with respect to ICTs based on gender and age group.

5.2.5 Gender Representation of Smallholder Farmers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	328	61.5	62.0	62.0
	Male	201	37.7	38.0	100.0
	Total	529	99.2	100.0	
Missing	System	4	.8		
Total		533	100.0		

Table 17: Gender Representation of Smallholder Farmers

The results shown in Table 17 are consistent with the census 2011 municipal report for KwaZulu-Natal (StatsSA, 2012, p. 15). Traditionally, the trend has been for men to migrate out of rural areas in search of work, although with the increase in the number of women accessing education, this trend is also evident amongst rural women (Collinson, 2010). This trend can be explained by the growing liberalization of markets that have led to the growth in "non-agricultural income diversification" thus men in their prime of life capable of engaging in the labour intensive smallholder agriculture move away from agriculture to more

financially rewarding activities e.g. mining (Bryceson & Jønsson, 2010). Other literature (Tacoli & Mabala, 2010) puts forward that migration from rural areas to urban areas is not restricted to a particular gender and suggests that it is encouraged more in females by the land insecurity that women smallholder farmers are subjected to due to culture and customs (females do not inherit land); hence the movement to urban areas and other forms of employment.

A cross tabulation was carried out (Table 18) in order to ascertain the dependence between the variables for gender and question 21.1, 'To what extent do you depend on the extension officer responsible for your ward for farming information?'

			Extent of farmer dependence on extension officers for farming information					Total
			Very small extent	Small extent	Never	Large extent	Very large extent	
Gender of Respondent	Female	Count	27	75	26	182	18	328
		% of Total	5.1%	14.2%	4.9%	34.4%	3.4%	62.0%
	Male	Count	23	31	7	132	8	201
		% of Total	4.3%	5.9%	1.3%	25.0%	1.5%	38.0%
Total		Count	50	106	33	314	26	529
		% of Total	9.5%	20.0%	6.2%	59.4%	4.9%	100.0%

Table 18: Gender of farmers * Extent of farmer dependence on extension officers for farming information

The results from Table 18 reveal that the general trend is that both males and females, but females more so, depend on the extension officer for farming information. The chi square statistic was 11.505 with a p-value= .021 meaning that there is a relationship that shows males and females depend on the extension officers for information.

5.2.6 Area where Farmer Grew Up

Figure 26 reveals that majority of the sample (94.8%) grew up in rural areas. Smallholder farmers are predominantly indigenous members of the social system and it can be assumed that they have a better understanding of the environment as compared to non-indigenous members of that social system. The data analysis also revealed that almost all smallholder farmers are black South African (99.8%).

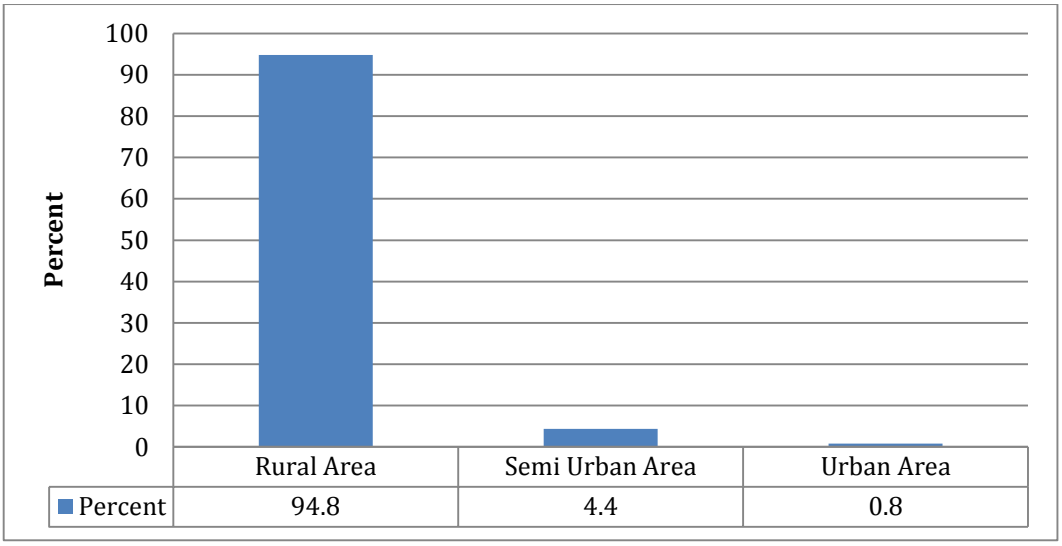


Figure 26: An Analysis of where the Smallholder Farmers Grew Up

5.2.7 Age Range of Smallholder Farmers

The smallholder farmers' age distribution is presented in Figure 27 below.

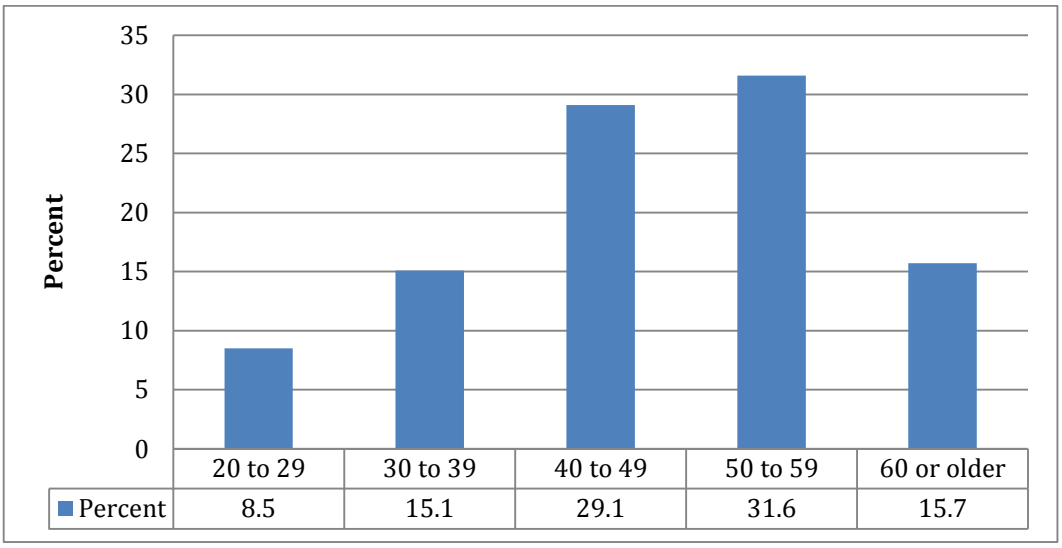


Figure 27: Age Range of Smallholder Farmers

The modal age group of smallholder farmers is 50-59 years (31.6%). An interesting observation is that a significant number of farmers (15.7%) are 60 years or older. This 60 years or older age group is the third highest range higher than the 20 to 29 and the 30 to 39 age groups. According to StatsSA (2012, p. 11) it should be noted that the 20 to 29 age group is the highest in the district followed by the 30 to 39 age group with more females than males. These results are in line with a similar study also conducted in the northern rural areas of KwaZulu-Natal province (Kunene & Fossey, 2010), which revealed that majority of smallholder farmers were within the age group of 40 to 59 and the lowest age group being below 30 years. The results of this study show that there were fewer young people available at

the time of the study, recalling from chapter 4 the study design and methodology chapter in section 4.4.4 which discussed methods of data collection, it states that the data collection process was over a duration of three months covering several sites (14 sites) spread throughout the iLembe district municipality (Figure 21 in chapter 4) and not a once off activity. This suggest that young people in their prime working age of 20 to 29 are not heavily engaged in farming and Dinkelman (2011) attributes this low involvement of young people in agriculture to be due to urban migration in search of better rewarding economic activities. This stance is supported by other authors (Bryceson & Jønsson, 2010). White (2012) expounds that current education practices especially at secondary school level tends to place farming as more of an occupation than a career and this contributes to the "deskilling" of youths and their ill preparedness to engage in agricultural activities. A cross tabulation was carried out (Table 19) to ascertain the dependence between the variables age and formal education, question 6 "Do you have formal education?"

			Formal Education				Total
			Yes (Certificate)	Yes (Degree)	Yes (Higher than Degree)	No	
Age Range	20 to 29	Count	14	5	2	24	45
		% of Total	2.7%	1.0%	0.4%	4.6%	8.6%
	30 to 39	Count	41	0	1	38	80
		% of Total	7.8%	0.0%	0.2%	7.3%	15.3%
	40 to 49	Count	31	5	1	115	152
		% of Total	5.9%	1.0%	0.2%	21.9%	29.0%
	50 to 59	Count	17	6	0	142	165
		% of Total	3.2%	1.1%	0.0%	27.1%	31.5%
	60 or older	Count	6	2	0	74	82
		% of Total	1.1%	0.4%	0.0%	14.1%	15.6%
Total		Count	109	18	4	393	524
		% of Total	20.8%	3.4%	0.8%	75.0%	100.0%

Table 19: Age Range of Smallholder Farmers * Formal Education of Farmers

The cross tabulation shown in Table 19 reveals that both old and young smallholder farmers had a certificate (20.8%) with a larger percentage of the older farmers i.e. above 30 years holding more certificates than the younger farmers i.e. 20-29 years. It should also be noted that the majority of the farmers at 75% were uneducated. The chi square statistic was 90.878 with a p-value=.000 meaning that age and education are related i.e. older farmers are less educated than younger farmers.

5.2.8 Years of Experience in Farming of Smallholder Farmers

The results of the analysis of this study (Figure 28) show that almost three quarters of farmers have over 4 years of experience in farming activities. Kabunga, Dubois, and Qaim (2012) after an analysis of 10 studies investigating reasons for low adoption of precision agriculture technologies, identified years of agriculture experience as one of the influencing factors. Bryan (2014) supports this viewpoint that focuses on the level of experience of a farmer and argues that the more experienced the farmer the greater the chances of adoption of an innovation.

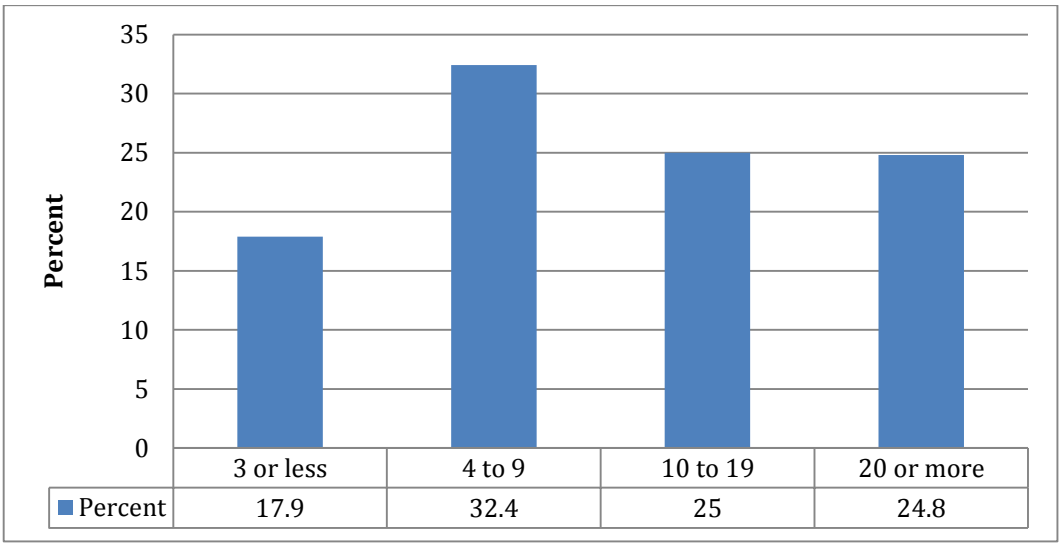


Figure 28: Years of Experience in farming of Smallholder Farmers

			Age Range	Experience in Farming Activities	Formal Education	Extent of farmer dependence on extension officers for farming information
Spearman's rho	Age Range	Correlation Coefficient	1.000	.443**	.325**	-.177**
		Sig. (2-tailed)	.	.000	.000	.000
	Experience in Farming	Correlation Coefficient	.443**	1.000	.116**	-.073

	Activities	Sig. (2-tailed)	.000	.	.008	.096
	Formal Education	Correlation Coefficient	.325**	.116**	1.000	-.174**
		Sig. (2-tailed)	.000	.008	.	.000
	Extent of farmer dependence on extension officers for farming information	Correlation Coefficient	-.177**	-.073	-.174**	1.000
		Sig. (2-tailed)	.000	.096	.000	.
**. Correlation is significant at the 0.01 level (2-tailed).						

Table 20: Summary of correlation between age and experience of Smallholder Farmers

Table 20 reveals that there is a weak, linear inverse but significant relationship between education and dependency on the extension officer i.e. as the education of the farmer increases his/her dependency on the extension officer starts to decrease and vice versa. It also must be stated that this is a weak negative relationship. The significant positive relationship between age and experience of the farmers is a weak to medium strength relationship. Hence as the age of the farmer increases so does the experience of the farmer in his/her activities and vice versa.

5.2.9 Education level of Smallholder Farmers

The study revealed that 75% of the smallholder farmers had no formal education while 20.8% of the sample had certificates and 3.4% of the sample had degrees. Collier and Dercon (2013) expounds the importance of knowledge and the key role education plays in the adoption of an innovation. The smallholder farmer is better placed to adopt or diffuse an innovation when they are educated (Boithi, Muchiri, Birech, & Mulu-Mutuku, 2014; Doss, 2006). The education provides the smallholder farmer with good management, numeracy skills and easier understanding of scientific processes and procedures (Collier & Dercon, 2013). A study by Anoop, Ajjan, and Ashok (2015) support this viewpoint by showing that the farmers who adopted ICTs had spent more years in school than the farmers who did not adopt ICTs. The results (Figure 29) reveal that for the adoption of a technological innovation to take place amongst smallholder farmers reliance will have to be placed on extension services in the provision of knowledge and education, as evidenced by Collier and Dercon (2013). As much as farmer education is considered important in adoption of technology in farming, other studies (Ainembabazi & Mugisha, 2014) have found that education is not critical.

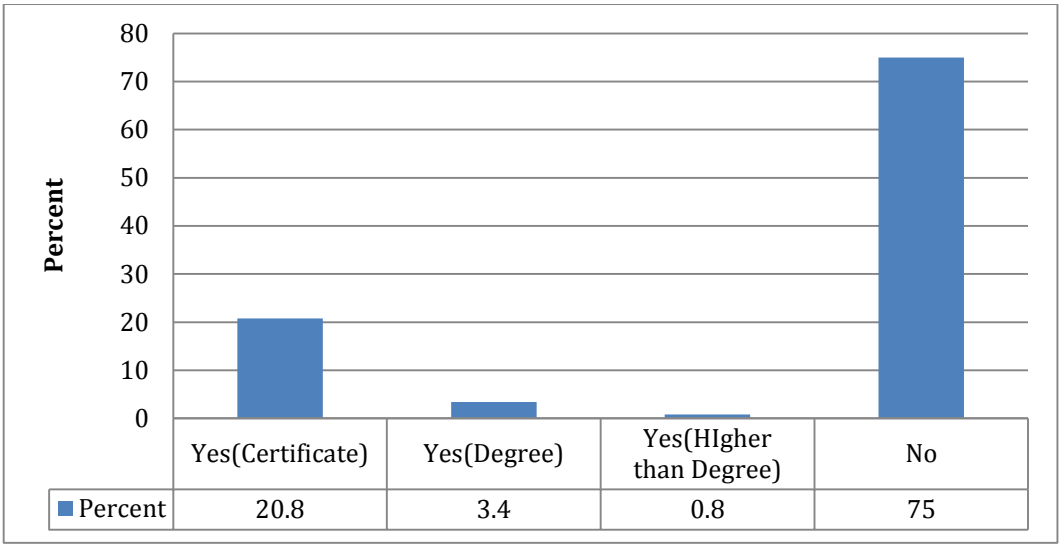


Figure 29: Education level of Smallholder Farmers

5.2.10 Frequency of Travel to Big Towns/Cities of Smallholder Farmers

Figure 30 indicates how often the respondents visited towns or cities. Ryan and Gross (1943) discovered that farmers who are early adopters (Rogers, (1961) of an innovation are those who frequently visited big cities, and referred to them as cosmopolite.

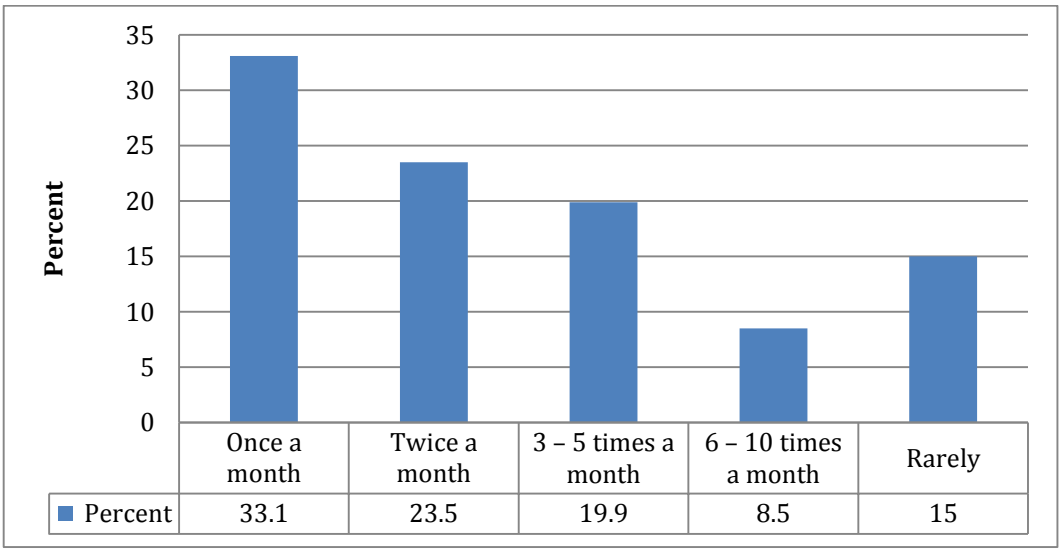


Figure 30: Frequency of travel to big towns/cities of Smallholder Farmers

5.2.11 How frequently do Smallholder Farmers visit Extension Officers

In the Diffusion of Innovation theory, change agents are determinants of the rate of diffusion of a technology in a social system. Rogers (1963) defines change agents as "professional persons who attempt to influence adoption decisions in a direction they feel is desirable." In this study, the extension officer is considered to be a change agent. Figure 31 shows that the majority of smallholder farmers visit extension officers approximately once a month (37.6%). This result can be interpreted from a number of perspectives i.e. smallholder farmer independence, lack of knowledge of extension services, or lack of financial capacity to travel

amongst others (Baiyegunhi & Fraser, 2014). It is therefore, important to understand this result in conjunction with other analysis e.g. smallholder farmer household food insecurity status (Figure 32) to help understand the farmers' financial capacity and if smallholder farmers are dependent on extension officers for farming information (Figure 42).

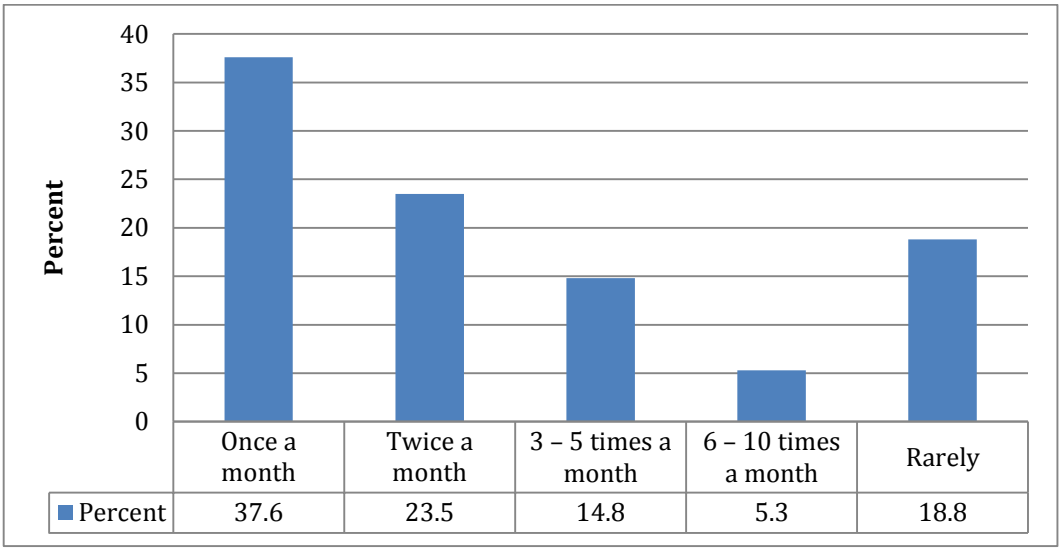


Figure 31: How frequent Smallholder Farmers visit Extension Officers – Farmer responses

5.2.12 Overview of Food Security Status of Smallholder Farmers in iLembe District Municipality Using the Household Food Insecurity Access Scale (HFIAS).

Hendriks and Msaki (2014) contend that food insecurity is a reality in rural areas of South Africa, but according to Labadarios et al. (2011) food insecurity has reduced by at least 50 percent from 1999 to 2008 in both rural and urban areas of South Africa. However, the authors noted that the population of people who are at risk of experiencing food insecurity has remained the same, which raises a need to target this population. In order to be able to measure the role ICTs play in food security in KwaZulu-Natal province, the researcher firstly sought to benchmark the smallholder farmer's food security status. The researcher made use of the Household Food Insecurity Access Scale (Coates, Swindale, & Bilinsky, 2007). The Cronbach alpha reliability test produced values over 0.7 indicating good data consistency. This consistency allowed the researcher to apply techniques such as Chi-square and correlation tests to ascertain the independence of the variables of food insecurity and ICTs and to understand how strongly these pairs of variables are related to each other.

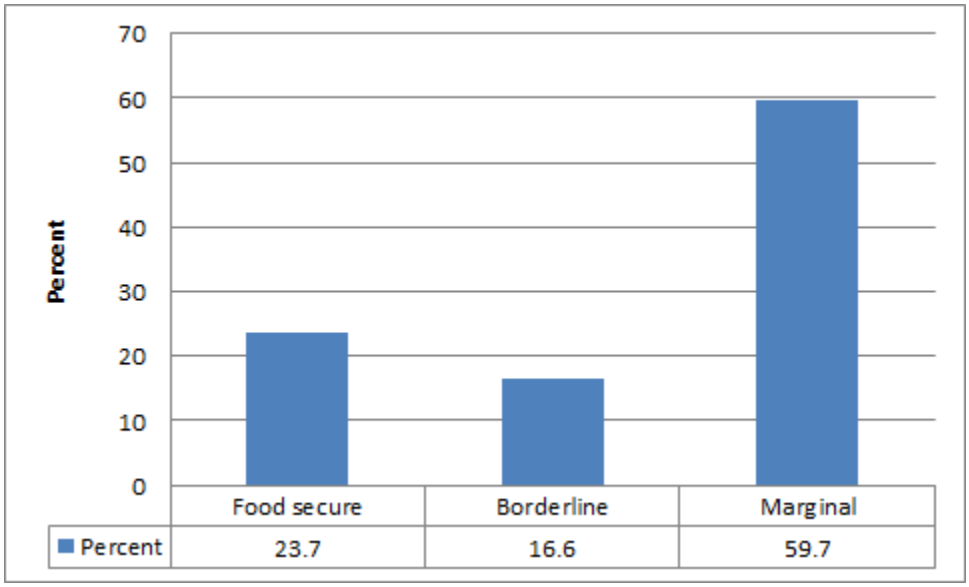


Figure 32: Smallholder Farmers Household Food Insecurity overview in iLembe District

HFIAS Value	Food Insecurity Phase	Warning Stage
0%-25.0%	Food Secure	Normal
25.1% - 30.0%	Borderline	Tolerable
30.1% - 40.0%	Marginal	Watch
40.1% - 50.0%	Moderate	Alert
50.1-60.0%	Chronic	Alarm
60.1%-70.0%	Severe	At High Risk
70.1-100%	Immediate Assistance Required	Crisis Declaration

Table 21: Food Insecurity Classification Guide

The study reveals that (Figure 32) approximately 60 percent of smallholder farmers in iLembe district are marginally food insecure. There were only nine missing responses that translated into 1.7% of the sample. A further analysis of the food security status of the smallholder farmers in iLembe district is conducted in section 5.1.13 using cross tabulations.

5.2.13 Marginally Food Secure Smallholder Farmer Households

The analysis provided in Figure 32 indicates that majority of the sample of smallholder farmer households in iLembe district are marginally food insecure (30 to 40 percent food insecurity existed amongst smallholder farmer households). Based on the classification guide used in this study (Table 21) a more detailed analysis was conducted on the smallholder

farmers' household food insecurity status. The analysis was by way of cross tabulations using various diffusion and ICT variables that formed part of the farmer questionnaire.

			Food Insecurity Status							Total
			Food secure	Borderline	Marginal	Moderate	Chronic	Severe	Immediate assistance required	
Travel to big towns/cities	Once a month	Count	8	13	41	18	15	13	61	169
		% of Total	1.6%	2.6%	8.1%	3.5%	3.0%	2.6%	12.0%	33.3%
	Twice a month	Count	16	13	38	21	9	6	18	121
		% of Total	3.1%	2.6%	7.5%	4.1%	1.8%	1.2%	3.5%	23.8%
	3 – 5 times a month	Count	24	15	22	21	7	2	6	97
		% of Total	4.7%	3.0%	4.3%	4.1%	1.4%	0.4%	1.2%	19.1%
	6 – 10 times a month	Count	2	13	20	3	4	0	3	45
		% of Total	0.4%	2.6%	3.9%	0.6%	0.8%	0.0%	0.6%	8.9%
	Rarely	Count	0	14	19	7	4	7	25	76
		% of Total	0.0%	2.8%	3.7%	1.4%	0.8%	1.4%	4.9%	15.0%
Total		Count	50	68	140	70	39	28	113	508
		% of Total	9.8%	13.4%	27.6%	13.8%	7.7%	5.5%	22.2%	100.0 %

Table 22: Frequency of Travel to big cities and Food Insecurity status

In an analysis that tested if exposure to urban societies influenced smallholder farmers food security status, a cross tabulation of the question 8, 'By estimation, how often do you travel to big towns/cities' and 'smallholder farmer household food insecurity status' was conducted. The results revealed that smallholder farmers who were classified as having a marginal food security status, borderline and food secure status travelled to big towns/cities more than once a month. It was also observed that smallholder farmers who were classified as "immediate assistance required" mostly went to big towns or cities once a month. These results imply that smallholder farmer's exposure to urban societies has a role on their food security status. The monthly travel to big towns/cities by those classified as "immediate assistance required" could be attributed to travelling merely to receive government grants which is usually a major source of income for the rural poor (Musemwa, Zhou, & Aghdasi, 2013). It is also noted that farmers classified as "immediate assistance required" were the largest group of smallholder farmers who rarely went to big towns/cities (Table 22).

			Food Insecurity Status							Total
			Food secure	Borderline	Marginal	Moderate	Chronic	Severe	Immediate assistance required	
Farmer Visits to Extension Officer Offices	Once a month	Count	9	32	54	24	11	15	45	190
		% of Total	1.8%	6.3%	10.7%	4.7%	2.2%	3.0%	8.9%	37.5%
	Twice a month	Count	11	18	47	12	9	4	19	120
		% of Total	2.2%	3.6%	9.3%	2.4%	1.8%	0.8%	3.7%	23.7%
	3 – 5 times a month	Count	16	5	11	17	4	3	17	73
		% of Total	3.2%	1.0%	2.2%	3.4%	0.8%	0.6%	3.4%	14.4%
	6 – 10 times a month	Count	2	1	8	4	5	1	7	28
		% of Total	0.4%	0.2%	1.6%	0.8%	1.0%	0.2%	1.4%	5.5%
	Rarely	Count	12	12	20	12	9	5	26	96
		% of Total	2.4%	2.4%	3.9%	2.4%	1.8%	1.0%	5.1%	18.9%
Total		Count	50	68	140	69	38	28	114	507
		% of Total	9.9%	13.4%	27.6%	13.6%	7.5%	5.5%	22.5%	100.0%

Table 23: Frequency of visits to extension officers and Food Insecurity Status

When testing the relationship between the question 9, 'By estimation, how often do you visit the agricultural extension officer responsible for your ward' and 'smallholder farmer household food insecurity status,' the cross tabulation revealed that smallholder farmers who are classified as having a marginal food security status, borderline and food secure status visited agricultural extension officers responsible for their ward more than once a month. It was also observed that smallholder farmers who are classified as "immediate assistance required" formed the largest group of smallholder farmers who rarely visited the agricultural extension officer (Table 23). These results imply that smallholder farmer visits to agricultural extension officers has an effect on their food security status.

Use of ICTs and Smallholder farmer households Food Insecurity Status

For the purposes of this study ICTs are defined to include the Internet, wireless networks, cell phones, radio, television and other communication media. When testing the relationship between the use of various ICTs and household food insecurity status, the cross tabulation revealed that the majority of smallholder farmers from all food security classifications (Food

secure, Borderline, Marginal, Moderate, Chronic, Severe, Immediate assistance required) use mobile phones more than once a day (Table 24). An analysis of the responses from the "more than once a day" option for each food insecurity classification against the total responses in each classification revealed that the highest number of users of mobile phones were smallholder farmers classified as Food secure (96%), Borderline (96%) and Marginal (88%) following that order. A point to note is that smallholder farmers classified as "Immediate assistance required" formed the largest group of farmers that did not use mobile phones. The results show that there are fewer farmers who frequently use mobile phones in the classifications of Immediate assistance required (57%), Severe (55%) and Chronic (42%) following this order. Although the frequency of use of mobile phones reduces as we move from the food secure farmers to the food insecure farmers this result is encouraging with regards to mobile phone use and provides an incentive for the development of mobile phone based innovations. Aker (2011) expounds that mobile phones can significantly reduce the cost of information access and can aid agricultural extension service provision to the rural farmer that can in turn play a positive in food security. This school of thought is supported by authors such as Davis, Tall, and Guntuku (2014) who argue that the mobile phone aids the delivery of extension services to smallholder farmers by speeding up the query response time and allowing individual farmers to seek specific assistance making the information delivery always relevant to the smallholder farmer. Mwombe, Mugivane, Adolwa, and Nderitu (2014) found that ICT use had a positive impact on banana growth by smallholder farmers, the authors identified mobile phones as one of the ICT tools farmers identified to be most useful. The results revealed in Table 25, shows that the majority of smallholder farmers from all food security classifications (Food secure, Borderline, Marginal, Moderate, Chronic, Severe, Immediate assistance required) use the television more than once a day. A further analysis of the responses from the "more than once a day" option for each food insecurity classification against the total responses in each classification reveals that the highest number of users of the television are smallholder farmers classified as Marginal (56%), Borderline (54%) and Food secure (28%) following that order. Smallholder farmers classified as "Immediate assistance required" form the largest group of farmers that did not use televisions. The classifications of Chronic (11%), Immediate assistance required (8%) and Severe (0%) following this order had the least farmers who frequently use televisions. It is also observed that the television is the least utilized ICT (the total responses from once a day to more than once a day; 428 smallholder farmers use mobile phones, 223 use television, 395 use radios). These results are in line with the results obtained in the study by Mwombe et al. (2014) which showed that the television is the least used by smallholder farmers. Smallholder farmers classified to have marginal food insecurity in their households represented the majority of farmers who use the radio more than once a day (Table 26). The "more than once a day"

option also represented the majority of smallholder farmer responses from all food security classifications. A further analysis of the responses from this option of each food insecurity classification against the total responses in each classification reveals that the highest number of users of the radio are smallholder farmers classified as Borderline (82%), Marginal (80%) and Food secure (72%) following that order. Smallholder farmers classified as "Immediate assistance required" form the largest group of farmers that did not use radios. The classifications of Immediate assistance required (59%), Severe (56%) and Chronic (48%) following this order had the least farmers who use the radio more than once a day. May and Tall (2013) identified the radio as an effective channel for information dissemination in extension services to smallholder farmers. The authors identified the broadcast nature of radio (simplex communication – one direction) as being problematic in that it does not address uncertainties in the delivered information. This limitation can be problematic with regards to transmitting scientific information as it can be subject to misinterpretation leading to maladaptation e.g. misinterpretation of weather information. Despite the popularity of the radio amongst smallholder farmers, misinterpretation can lead to a loss of trust in scientific information (May & Tall, 2013).

			Food Insecurity Status							Total
			Food secure	Borderline	Marginal	Moderate	Chronic	Severe	Immediate assistance required	
Use of Mobile phones (sms & voice calls)	More than once per day	Count	48	64	121	55	21	11	64	384
		% of Total	9.6%	12.8%	24.2%	11.0%	4.2%	2.2%	12.8%	76.6%
	Once a day	Count	1	2	4	8	10	5	14	44
		% of Total	0.2%	0.4%	0.8%	1.6%	2.0%	1.0%	2.8%	8.8%
	2-3 times per week	Count	0	0	7	3	7	4	10	31
		% of Total	0.0%	0.0%	1.4%	0.6%	1.4%	0.8%	2.0%	6.2%
	Seldom	Count	1	0	5	2	0	2	13	23
		% of Total	0.2%	0.0%	1.0%	0.4%	0.0%	0.4%	2.6%	4.6%
	Never	Count	0	1	1	1	0	4	11	19
		% of Total	0.0%	0.2%	0.2%	0.2%	0.0%	0.8%	2.2%	4.2%
Total		Count	50	67	138	70	38	26	112	501

	% of Total	10.0%	13.4%	27.5%	14.0%	7.6%	5.2%	22.4%	100.0%
% of farmers who use mobile phones more than once a day from total count		96%	96%	88%	78%	55%	42%	57%	

Table 24: Use of mobile phones (SMS & voice calls) and Food Insecurity Status

			Food insecurity Status							Total
			Food secure	Borderline	Marginal	Moderate	Chronic	Severe	Immediate assistance required	
Television	More than once per day	Count	14	36	78	8	4	0	9	149
		% of Total	2.8%	7.3%	15.8%	1.6%	0.8%	0.0%	1.8%	30.2%
	Once a day	Count	12	5	18	8	10	7	14	74
		% of Total	2.4%	1.0%	3.6%	1.6%	2.0%	1.4%	2.8%	15.0%
	2-3 times per week	Count	3	2	9	10	4	3	15	46
		% of Total	0.6%	0.4%	1.8%	2.0%	0.8%	0.6%	3.0%	9.3%
	Seldom	Count	10	13	10	16	9	5	11	74
		% of Total	2.0%	2.6%	2.0%	3.2%	1.8%	1.0%	2.2%	15.0%
	Never	Count	10	11	25	25	9	12	59	151
		% of Total	2.0%	2.2%	5.1%	5.1%	1.8%	2.4%	11.9%	30.6%
Total		Count	49	67	140	67	36	27	108	494
		% of Total	9.9%	13.6%	28.3%	13.6%	7.3%	5.5%	21.9%	100.0%
% of farmers who use television more than once a day from total count			28%	54%	56%	11%	11%	0%	8%	

Table 25: Use of television and Food Insecurity Status

			Food Insecurity Status							Total
			Food secure	Borderline	Marginal	Moderate	Chronic	Severe	Immediate assistance required	
Radio	More	Count	36	55	110	34	18	15	64	332

	than once per day	% of Total	7.3%	11.1%	22.2%	6.9%	3.6%	3.0%	12.9%	67.1%
	Once a day	Count	3	8	12	15	7	3	15	63
		% of Total	0.6%	1.6%	2.4%	3.0%	1.4%	0.6%	3.0%	12.7%
	2-3 times per week	Count	4	0	6	14	6	3	7	40
		% of Total	0.8%	0.0%	1.2%	2.8%	1.2%	0.6%	1.4%	8.1%
	Seldom	Count	4	2	4	2	3	2	12	29
		% of Total	0.8%	0.4%	0.8%	0.4%	0.6%	0.4%	2.4%	5.9%
	Never	Count	3	2	5	3	3	4	11	31
		% of Total	0.6%	0.4%	1.0%	0.6%	0.6%	0.8%	2.2%	6.3%
Total		Count	50	67	137	68	37	27	109	495
		% of Total	10.1%	13.5%	27.7%	13.7%	7.5%	5.5%	22.0%	100.0%
% of farmers who use radio more than once a day from total count			72%	82%	80%	50%	48%	56%	59%	

Table 26: Use of radio and Food Insecurity Status

Extent of ICT Use on farm and Smallholder farmer Household Food Insecurity Status

			Food Insecurity Status							Total
			Food secure	Borderline	Marginal	Moderate	Chronic	Severe	Immediate assistance required	
Extent of ICT use on the farm	Very small extent	Count	3	4	4	4	2	1	16	34
		% of Total	0.6%	0.8%	0.8%	0.8%	0.4%	0.2%	3.1%	6.7%
	Small extent	Count	8	12	30	25	19	14	25	133
		% of Total	1.6%	2.4%	5.9%	4.9%	3.7%	2.8%	4.9%	26.1%
	Never	Count	2	0	9	4	2	2	24	43
		% of Total	0.4%	0.0%	1.8%	0.8%	0.4%	0.4%	4.7%	8.4%
	Large extent	Count	35	51	91	30	14	6	45	272
		% of Total	6.9%	10.0%	17.9%	5.9%	2.8%	1.2%	8.8%	53.4%
	Very	Count	2	1	6	7	2	5	4	27

	large extent	% of Total	0.4%	0.2%	1.2%	1.4%	0.4%	1.0%	0.8%	5.3%
Total		Count	50	68	140	70	39	28	114	509
		% of Total	9.8%	13.4%	27.5%	13.8%	7.7%	5.5%	22.4%	100.0%
% of farmers who use ICTs to a large extent from total count			70%	75%	65%	43%	20%	21%	39%	

Table 27: Extent of ICT Use on farms and Food Insecurity Status

A cross tabulation analysis of (Table 27) the relationship between the extent of ICT use on the farm and household food insecurity status reveals that the majority of smallholder farmers from all food security classifications use ICTs to a large extent. A further analysis of the data from the option "large extent" which has the highest responses against the total count in each classification was conducted. The results reveal that the classifications Borderline (75%), Food secure (70%) and Marginal (65%) represents the largest number of farmers who use ICTs to a large extent on their farms. The analysis also reveals that the classifications Immediate assistance required (39%%), Severe (21%) and Chronic (20%) following this order, had the least number of farmers who use ICTs on their farms to a large extent.

Culture and Smallholder farmer households Food Insecurity Status

Based on Hofstede's cultural dimensions a set of similar statements were put to the smallholder farmers and extension officers aimed at understanding the role of culture on the smallholder farmer food insecurity status. The study (Table 28) revealed that the majority of the smallholder farmers (42.9%) agree that extension officers are involved in the day to day running of their farms. A further analysis of this majority response shows that slightly more than half of Borderline farmers (54%) and Marginal farmers (54%) agree to this statement. Less than half of the farmers classified as Chronic (42%), Severe (36%) and Immediate assistance required (34%) agree to this statement. A point to note is that smallholder farmers classified as Food secure (24%) were the least in agreement with this statement. A possible reason for this is that farmers who are food secure to a large extent show self-reliance and can be considered to be innovators and are well ahead of their colleagues who need more support. The data suggests that there is a small power distance between the smallholder farmers and the extension officers; the smallholder famer feels the extension officer is closely involved in supporting farmer decision-making with regards to agricultural matters on their farms. A number of authors (Doss & Morris, 2000; Quisumbing & Pandolfelli, 2010) are of the viewpoint that gender can play a role on the power distance relationship. The authors contend

that women farmers tend to have less contact with extension officers as compared to their male counterparts. The significant number of smallholder farmers who disagree (32.9%) with this statement could be as a result of this gender bias keeping in mind that the sample of farmers in this study consists of more females (62%) than males (38%). It is also observed that a large majority of smallholder farmers from all the food insecurity classifications concur (70.4%) that they are on first name basis with the extension officers responsible for their area (Table 29). A further analysis of this majority response shows that more than half of the farmers from all the classifications agree with this statement with farmers classified as Severe (86%), Borderline (82%) and Marginal (81%) having the highest response to this statement. Farmers classified as Immediate assistance required were the highest in number in terms of disagreeing to this statement. The study also reveals that (Table 30) the majority of farmers agree (62.4%) that extension officers help remove unease in situations where there are no clear guidelines. A further analysis of this majority response shows that more than half of the farmers in all the classifications agree with this statement except for farmers classified as Food secure (44%). The majority of the smallholder farmers (Table 31) are of the opinion (47.1%) that farming innovations lead by females are usually not adopted by farmers. This response can be attributed to the gender bias that exists amongst farmers due to cultural norms (Quisumbing & Pandolfelli, 2010; Warburton, Blake, Coupe, Pasteur, & Phillips, 2012). A further analysis shows that over half of farmers classified as Borderline (63%), Marginal (59%) and Moderate (53%) agree with this statement. A point to note is that Food secure (28%) farmers agree in the least to this statement. Furthermore, the study (Table 32) shows that smallholder farmers agree (51.1%) with the assertion that extension officers encourage planning only on a seasonal basis. The analysis shows that over half of farmers classified as Borderline (66%), Marginal (66%) and Chronic (53%) agree with this statement. The analysis also revealed that farmers classified as Food secure (26%) were in the least agreement to this statement.

			Food Insecurity Status							Total
			Food secure	Borderline	Marginal	Moderate	Chronic	Severe	Immediate assistance required	
I am closely involved with the day-to-day running of	Strongly Disagree	Count	0	2	9	7	4	2	19	43
		% of Total	0.0%	0.4%	1.8%	1.4%	0.8%	0.4%	3.7%	8.5%
	Disagree	Count	26	21	45	22	11	12	30	167
		% of Total	5.1%	4.1%	8.9%	4.3%	2.2%	2.4%	5.9%	32.9%
	Uncertain	Count	6	6	6	11	3	2	10	44

my farm with the extension officer		% of Total	1.2%	1.2%	1.2%	2.2%	0.6%	0.4%	2.0%	8.7%
	Agree	Count	12	37	76	28	16	10	39	218
		% of Total	2.4%	7.3%	15.0%	5.5%	3.1%	2.0%	7.7%	42.9%
	Strongly Agree	Count	6	2	4	2	4	2	16	36
		% of Total	1.2%	0.4%	0.8%	0.4%	0.8%	0.4%	3.1%	7.1%
Total		Count	50	68	140	70	38	28	114	508
		% of Total	9.8%	13.4%	27.6%	13.8%	7.5%	5.5%	22.4%	100.0%
% of farmers who agree with statement per classification from total count			24%	54%	54%	40%	42%	36%	34%	

Table 28: Power distance and Food Insecurity Status

			Food Insecurity Status							Total
			Food secure	Borderline	Marginal	Moderate	Chronic	Severe	Immediate assistance required	
I am on first name basis with the extension officer	Strongly Disagree	Count	0	1	5	1	1	0	15	23
		% of Total	0.0%	0.2%	1.0%	0.2%	0.2%	0.0%	3.0%	4.5%
	Disagree	Count	13	3	11	13	8	3	20	71
		% of Total	2.6%	0.6%	2.2%	2.6%	1.6%	0.6%	4.0%	14.0%
	Uncertain	Count	4	5	6	6	3	0	2	26
		% of Total	0.8%	1.0%	1.2%	1.2%	0.6%	0.0%	0.4%	5.1%
	Agree	Count	28	56	112	46	23	24	67	356
		% of Total	5.5%	11.1%	22.1%	9.1%	4.5%	4.7%	13.2%	70.4%
	Strongly Agree	Count	5	3	5	4	3	1	9	30
		% of Total	1.0%	0.6%	1.0%	0.8%	0.6%	0.2%	1.8%	5.9%
Total		Count	50	68	139	70	38	28	113	506
		% of Total	9.9%	13.4%	27.5%	13.8%	7.5%	5.5%	22.3%	100.0%
% of farmers who agree with statement per classification from total count			56%	82%	81%	66%	61%	86%	59%	

Table 29: Individualism vs. Collectivism (looseness of relationship) and Food Insecurity Status

			Food Insecurity Status							Total
			Food secure	Borderline	Marginal	Moderate	Chronic	Severe	Immediate assistance required	
Extension officers help remove unease in situations in which there are no clear guidelines	Strongly Disagree	Count	0	1	4	1	1	2	8	17
		% of Total	0.0%	0.2%	0.8%	0.2%	0.2%	0.4%	1.6%	3.3%
	Disagree	Count	1	2	7	3	2	1	11	27
		% of Total	0.2%	0.4%	1.4%	0.6%	0.4%	0.2%	2.2%	5.3%
	Uncertain	Count	13	4	10	8	3	2	9	49
		% of Total	2.6%	0.8%	2.0%	1.6%	0.6%	0.4%	1.8%	9.6%
	Agree	Count	22	47	100	39	24	21	64	317
		% of Total	4.3%	9.3%	19.7%	7.7%	4.7%	4.1%	12.6%	62.4%
	Strongly Agree	Count	14	14	19	19	8	2	22	98
		% of Total	2.8%	2.8%	3.7%	3.7%	1.6%	0.4%	4.3%	19.3%
Total		Count	50	68	140	70	38	28	114	508
		% of Total	9.8%	13.4%	27.6%	13.8%	7.5%	5.5%	22.4%	100.0%
% of farmers who agree with statement per classification from total count			44%	69%	71%	56%	63%	75%	56%	

Table 30: Uncertainty Avoidance and Food Insecurity Status

			Food Insecurity Status							Total
			Food secure	Borderline	Marginal	Moderate	Chronic	Severe	Immediate assistance required	
Farming innovations lead by females are usually not adopted by farmers	Strongly Disagree	Count	0	3	6	1	2	2	9	23
		% of Total	0.0%	0.6%	1.2%	0.2%	0.4%	0.4%	1.8%	4.5%
	Disagree	Count	9	11	20	11	5	5	15	76
		% of Total	1.8%	2.2%	3.9%	2.2%	1.0%	1.0%	3.0%	15.0%
	Uncertain	Count	16	9	15	15	13	6	43	117
		% of Total	3.2%	1.8%	3.0%	3.0%	2.6%	1.2%	8.5%	23.1%
	Agree	Count	14	43	83	37	16	11	35	239

		% of Total	2.8%	8.5%	16.4%	7.3%	3.2%	2.2%	6.9%	47.1%
	Strongly Agree	Count	11	2	16	6	2	4	11	52
		% of Total	2.2%	0.4%	3.2%	1.2%	0.4%	0.8%	2.2%	10.3%
Total		Count	50	68	140	70	38	28	113	507
		% of Total	9.9%	13.4%	27.6%	13.8%	7.5%	5.5%	22.3%	100.0%
% of farmers who agree with statement per classification from total count			28%	63%	59%	53%	42%	39%	31%	

Table 31: Gender and Food Insecurity Status

			Food Insecurity Status							Total
			Food secure	Borderline	Marginal	Moderate	Chronic	Severe	Immediate assistance required	
The extension officer encourages planning only on a seasonal basis	Strongly Disagree	Count	0	1	3	3	0	3	10	20
		% of Total	0.0%	0.2%	0.6%	0.6%	0.0%	0.6%	2.0%	3.9%
	Disagree	Count	2	2	6	0	2	0	8	20
		% of Total	0.4%	0.4%	1.2%	0.0%	0.4%	0.0%	1.6%	3.9%
	Uncertain	Count	4	1	9	5	0	1	7	27
		% of Total	0.8%	0.2%	1.8%	1.0%	0.0%	0.2%	1.4%	5.3%
	Agree	Count	13	44	92	32	20	11	47	259
		% of Total	2.6%	8.7%	18.1%	6.3%	3.9%	2.2%	9.3%	51.1%
	Strongly Agree	Count	31	19	30	30	16	13	42	181
		% of Total	6.1%	3.7%	5.9%	5.9%	3.2%	2.6%	8.3%	35.7%
Total		Count	50	67	140	70	38	28	114	507
		% of Total	9.9%	13.2%	27.6%	13.8%	7.5%	5.5%	22.5%	100.0%
% of farmers who agree with statement per classification from total count			26%	66%	66%	46%	53%	39%	41%	

Table 32: Long-term vs. Short-term orientation and Food Insecurity Status

5.2.14 The Extension Officer

The second part of the sampling frame consisted of extension officers from the iLembe district municipality of KwaZulu-Natal. This section presents the overview of demographic

characteristics of the extension officers. Factors similar to that of the smallholder farmer presented in the previous section such as gender, area where respondent grew, ethnic group and age will also be presented. Reliability Analysis

The Cronbach's alpha test was also applied to the extension officer questionnaire and calculated for all the questions that were probing the same issues in each section. The alpha values (Table 9) from the survey indicate a good internal consistency

QUESTIONS	SIMILARITY OF SCALE	CRONBACH'S ALPHA
10, 12, 22, 23, 24 and 25	Strongly Disagree to Strongly Agree	0.711
11, 29, 33	Yes or No	0.715
13, 26, 28 and 32	Very Small Extent to Very Large Extent	0.744
14 and 34	Extremely Hard to Extremely Easy	0.705
15 and 35	Extremely Useless to Extremely Useful	0.773
18 and 21	More Than Once Per Day to Never	0.815

Table 33: Results of Cronbach's alpha reliability analysis– Extension officer questionnaire

5.2.15 Gender Distribution and Type of Farms Serviced by Extension Officer

The study shows that there were more female extension officers (70.7%) than males extension officers (29.3%) that participated in the study. The analysis revealed (Figure 33) that extension officers mostly service commercial farms (95.2%) and only 4.8% of the extension officers service smallholdings (small scale). This uneven distribution of extension services can be a stumbling block in the diffusion and adoption of farming innovations using ICTs. Rogers (2010) explains that for the diffusion of an innovation to be successful there needs to be change agents who can identify opinion leaders who in turn influence others in the social system to adopt the innovation. Extension workers act as change agents and hence their absence or limited role (4.8%) on a social system can hamper the diffusion of ICT innovations to smallholder farmers.

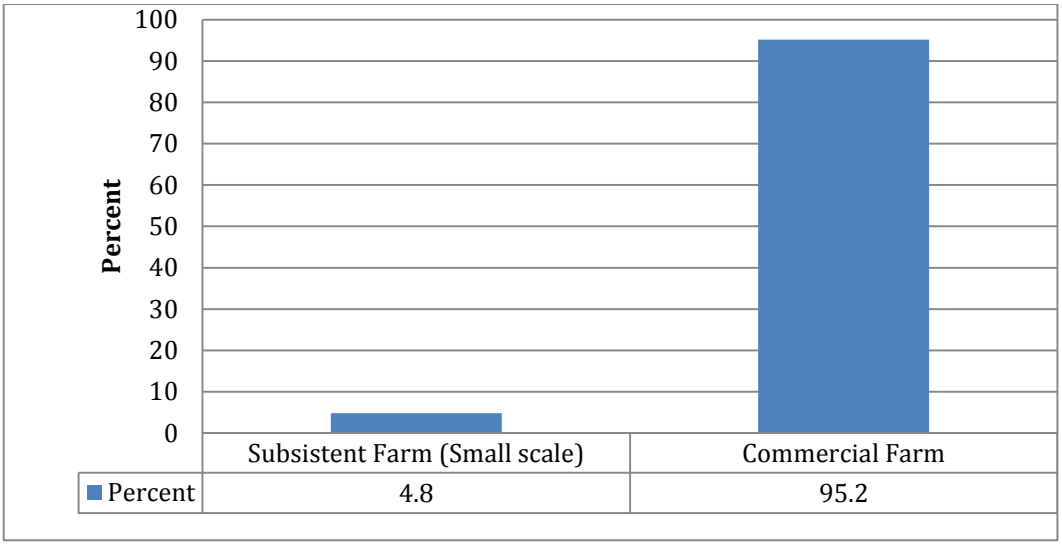


Figure 33: Farm Type Extension Officers Service

5.2.16 Area Where Extension Officers Grew Up

The study shows that all extension officers were of African origin and that 78% of the extension officers grew up in rural areas (Figure 34) while 14.6% of the extension officers grew up in semi-urban areas. It also shows that only 7.3% of the extension officers grew up in urban areas. This result can be considered to be advantageous in that the majority of the extension officers are familiar with issues that exist within their working environment and can have a positive role in developing Afrocentric solutions for the smallholder farmer as they are already aware of the value systems and culture (Buthelezi & Hughes, 2014; Duveskog, Friis-Hansen, & Taylor, 2011). Rogers (2010) contends that innovation adoption decisions are subject to compatibility issues with the values, beliefs and past experiences of individuals in the social system.

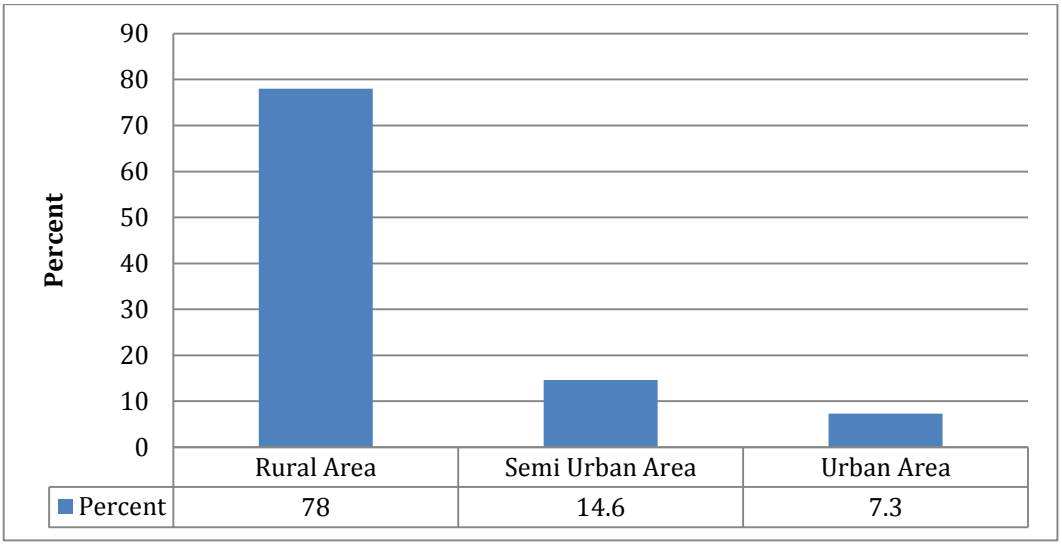


Figure 34: Area Where The Extension Officers Grew Up

5.2.17 Age of Extension Officer

The extension officers age distribution is presented in Figure 35 below.

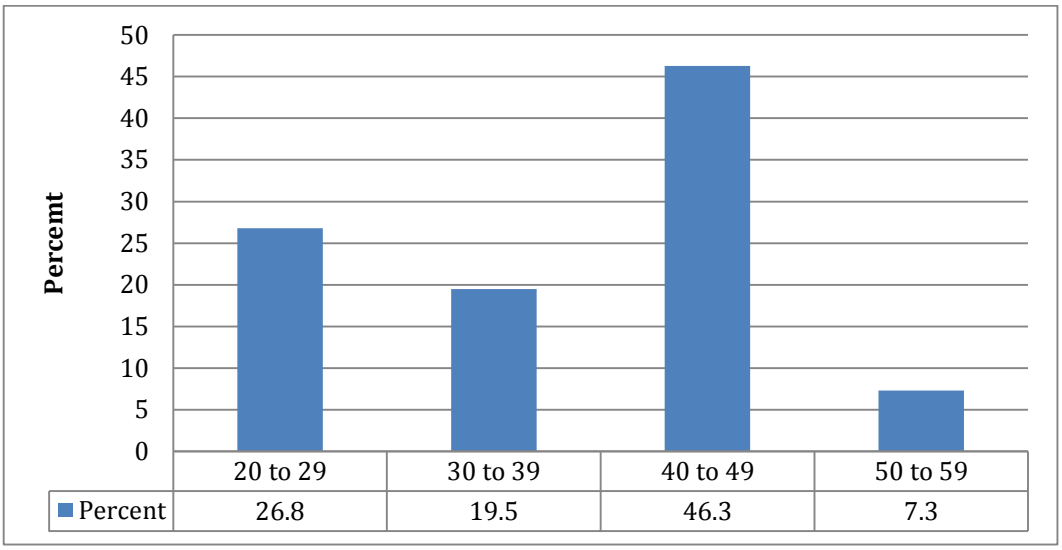


Figure 35: Age Distribution of Extension Officers

Figure 35 suggests that the majority of extension officers in iLembe district municipality of KwaZulu-Natal province are between 40-49 years, followed by a sizeable number between the age groups of 20-29 years.

5.2.18 Extension Officers Experience in Farming Activities

Figure 36 shows how experienced the extension officers are.

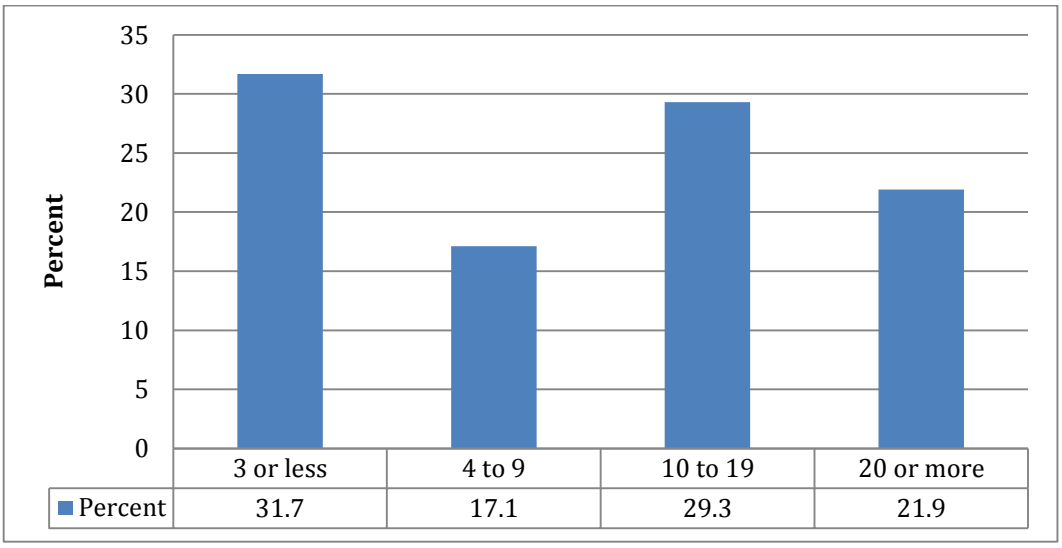


Figure 36: Years of Experience in farming activities

5.2.19 Education of Extension Officer

Figure 37 shows that only 2.3% of the extension officers did not have any formal qualification. The finding that most extension officers have a degree is a welcome development as this has a positive role on adoption, an assertion that is supported by Fosu-

Mensah, Vlek, and MacCarthy (2012) who concluded that there was a need for education and training of extension officers.

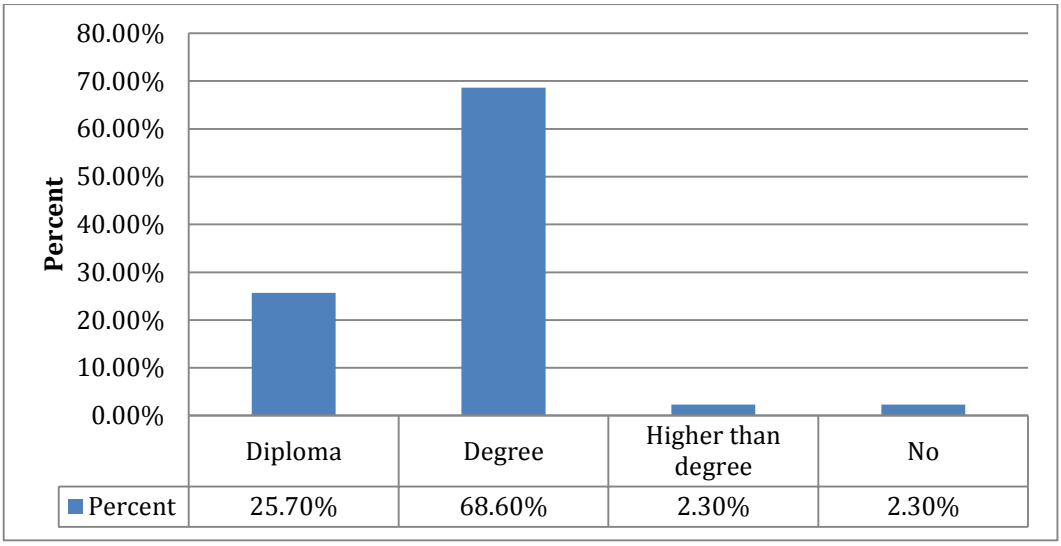


Figure 37: Formal education of extension officers

5.2.20 Extension Officer Frequency in Supplying Reading Materials to Smallholder Farmers

By implication, formal education of smallholder farmers aids them to access agricultural information from reading materials supplied by the extension officers. This accessing of information from sources such as newsletters increases the chance of ICT based innovation adoption amongst the smallholder farmers (Ibitoye & Onje, 2013). A majority of the extension officers (Figure 38) stated that reading material is supplied randomly (62.5%) to smallholder farmers. This finding corroborates with that of the smallholder farmers survey (Figure 39) that revealed that the majority of farmers do not receive any reading material. The difference in response to this question "How often do you receive reading materials from the extension officer responsible for your ward?" can be attributed to the problem of literacy; where available materials are in English and when distributed at whatever interval, the smallholder farmers do not make use of this material. Lloyd, Anne, Thompson, and Qayyum (2013) expound that the lack of literacy acts as a barrier to information access and leads to social exclusion. In this case it can lead to exclusion of vital agricultural information that can affect the smallholder farmers' activities negatively. The lack of literacy is not only a barrier to accessible information but also a factor which can hinder adoption of an innovation (Katengeza, Okello, & Jambo, 2011). It is therefore, necessary to take the aspect of literacy into consideration whenever an innovation is being introduced to a particular society.

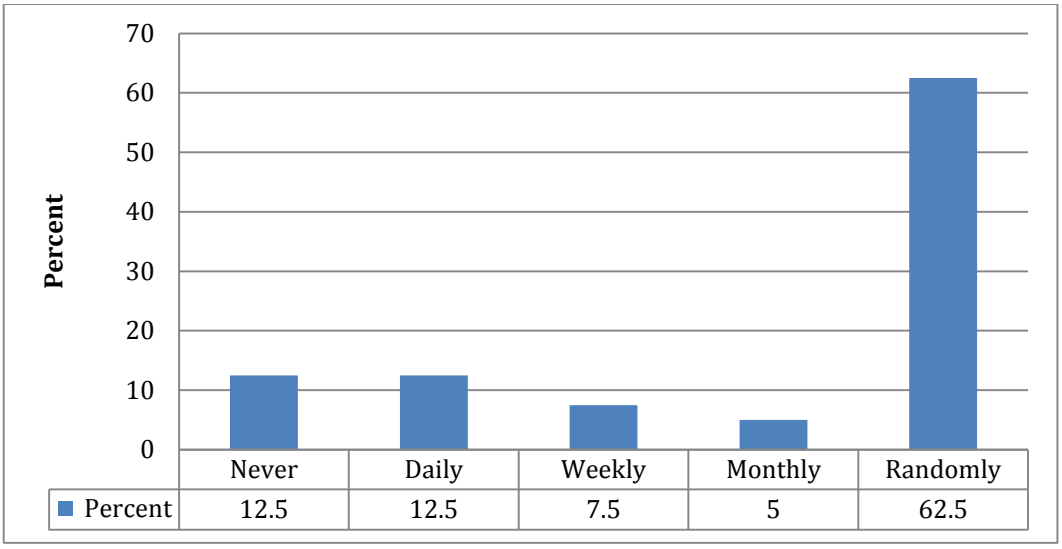


Figure 38: Frequency Extension officers' supply reading materials to farmers

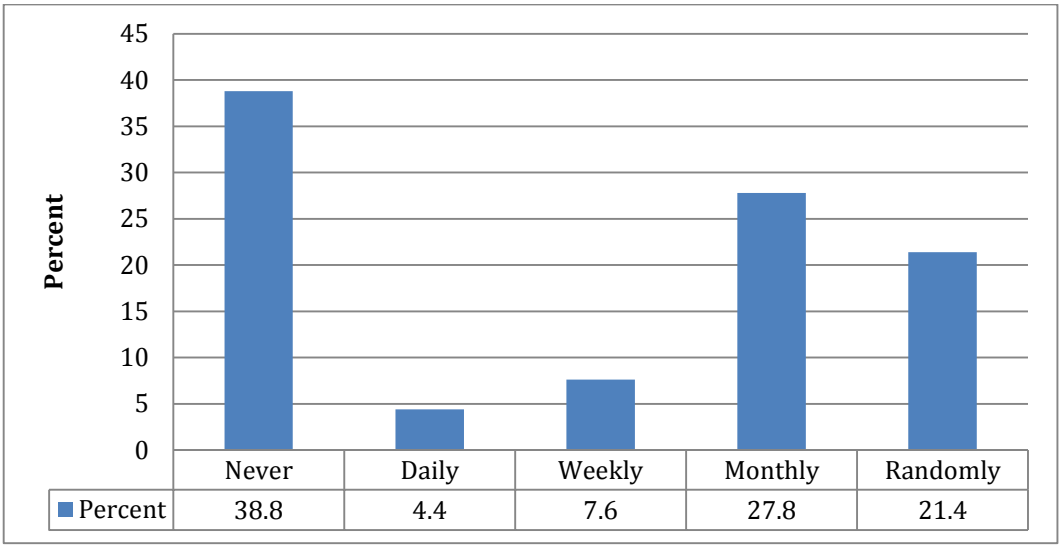


Figure 39: Frequency of Smallholder farmers' receiving reading materials from extension officers

5.2.21 How often do Smallholder Farmers visit offices of Extension Officers

The question 8, 'how often do farmers visit your offices?' that was put to extension officers revealed (Figure 40) that majority of smallholder farmers visit extension officers frequently (6 to 10 times a month). This is indicative of a high reliance of smallholder farmers on extension services. The extension officers role is key as they train farmers in the various agricultural practices such as the use of herbicides (Ngwira, Thierfelder, & Lambert, 2013). When the smallholder farmer and extension officers' responses were compared, it was found that a discrepancy existed in the results in that the majority of farmers indicated that they visit the extension officers' offices once a month while majority of extension officers indicated

that farmers visit extension officers frequently (6 to 10 times a month), this is an area for further interrogation.

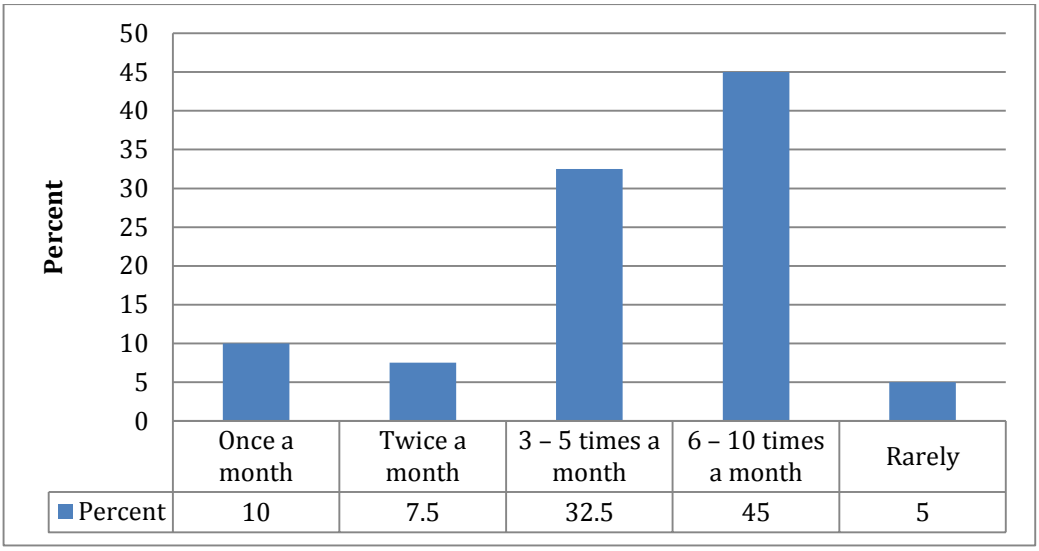


Figure 40: How often do Smallholder Farmers visit Extension Officers

5.2.22 Effectiveness of Information Provided in English

The OECD (2000) defines literacy as the "ability to read and write a short and simple statement with understanding." There is no single measure of adult literacy as it is also commonly measured by using the level of formal education attained (Aitchison & Harley, 2004). Pretorius (2002) identifies that reading involves a combination of decoding and comprehension components. In Figure 41 the majority of the extension officers (80.5%) objected to the assertion that information provided to farmers in English is more effective than information provided in indigenous languages. This result is similar to that provided by smallholder farmers who also in a majority (53.5%) rejected this assertion.

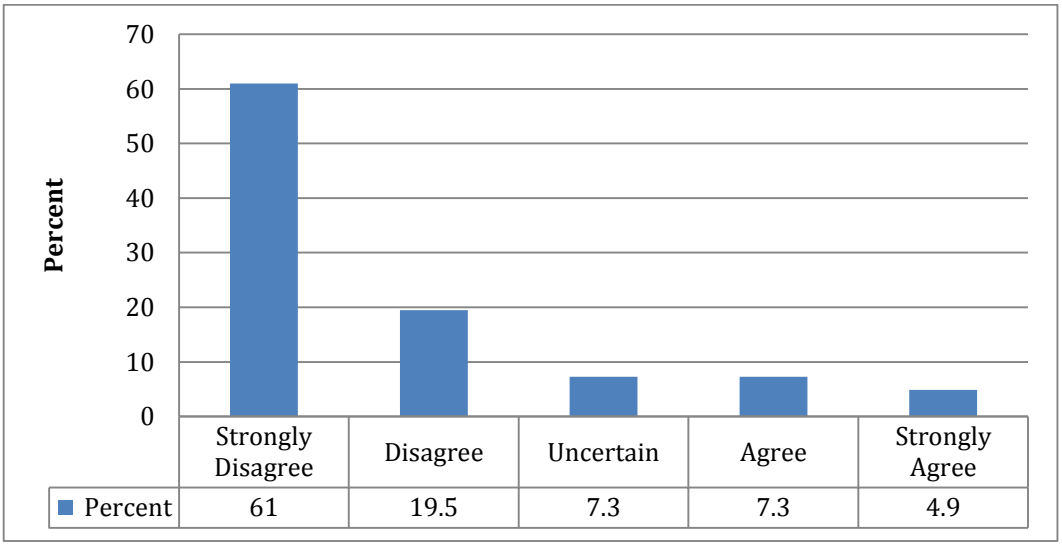


Figure 41: Effectiveness of Information provided to smallholder farmers in English

5.2.23 The Extent of Farmer Dependency on Extension Officer

The study shows that 74.3% of extension officers disagreed that smallholder farmers depend on them only for farming information (Figure 42). Agricultural extension is a very important service and provides required skills and best practices to farmers who are in need of them, these usually being smallholder farmers (Biswas, Tortajada, Biswas-Tortajada, Joshi, & Gupta, 2014). This response is concerning and it is important for extension officers to understand their role and the important function they play in this process. When implementing innovations, an understanding of indigenous knowledge systems is vital to the success of an innovation (Rogers, 2010). Mashavave et al. (2013) postulate that social networks play an important role in the diffusion of innovations and hence the proximity of extension officers in relation to the smallholder farmers is of great importance in influencing their adoption decision.

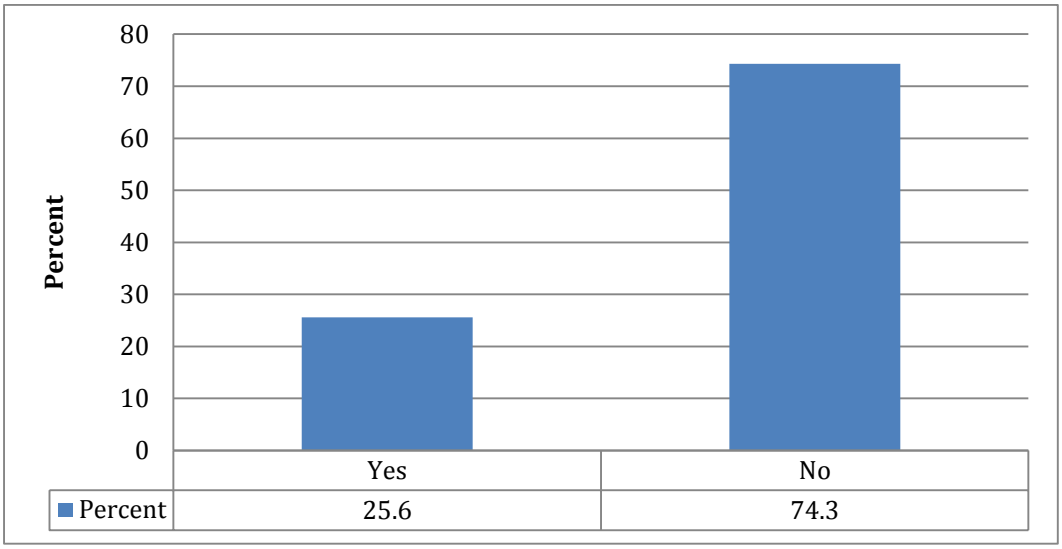


Figure 42: Dependency of Smallholder Farmers on Extension Officers for farming information - Extension Officer responses

5.3 Motivation for ICT Adoption and Diffusion Amongst Smallholder Farmers

The study reveals (Figure 43) that prowess to solve problems (39.6%) and the desire for innovation (29.6%) were the main factors in influencing smallholder farmers to adopt ICTs. The desire for new technology accounted for 19.1% of this decision while 13.9% were driven by the fear of being left behind and 6.2% where driven by institutional pressures.

In comparison Figure 44 shows that extension officers were influenced to adopt ICTs due to the desire to be innovative (38.6%) and the drive to acquire new technology (31.8%). The

desire to solve problems accounted for 22.7% of this decision while 4.5% were driven by the fear of being left behind and 2.3% by institutional pressures.

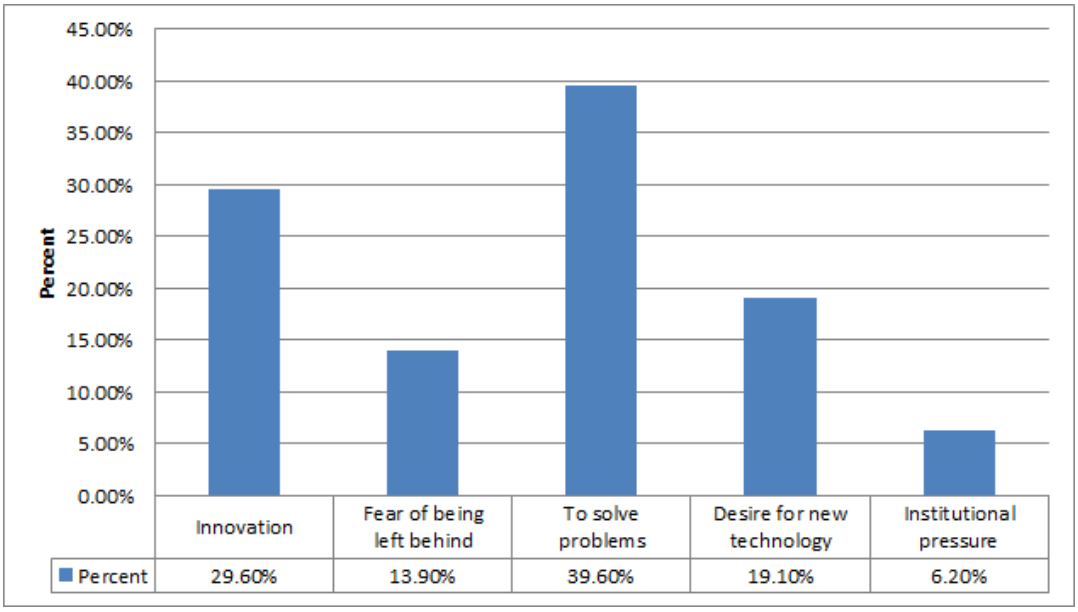


Figure 43: ICT adoption amongst Smallholder Farmers

			Formal Education				Total
			Yes (Certificate)	Yes (Degree)	Yes (Higher than Degree)	No	
ICT adoption	Desire to be innovative	Count	36	11	2	108	157
		% of Total	22.2%	6.8%	1.2%	66.7%	96.9%
	Avoid being left behind by others	Count	0	0	0	2	2
		% of Total	0.0%	0.0%	0.0%	1.2%	1.2%
	Desire to use new technology	Count	1	0	1	1	3
		% of Total	0.6%	0.0%	0.6%	0.6%	1.9%
Total		Count	37	11	3	111	162
		% of Total	22.8%	6.8%	1.9%	68.5%	100.0%

Table 34: ICT adoption amongst Smallholder Farmers and Formal Education of Smallholder Farmers

The results shown in Table 34 reveal that the more educated farmers choose to adopt ICT due to a desire to be innovative. The chi-square statistic was 18.161 with a p-value of .006 revealing a significant relationship between educational levels and the adoption of ICTs. The cross tabulation between gender and reason for ICT adoption reveals that more females than males adopted ICT due to a desire to be innovative. The chi-square test revealed a non-significant relationship. The cross tabulation between ICT adoption amongst smallholder farmers and age range of smallholder farmers shows that more older farmers than younger farmers adopted ICT due to a desire to be innovative. The chi-square test revealed a non-significant relationship.

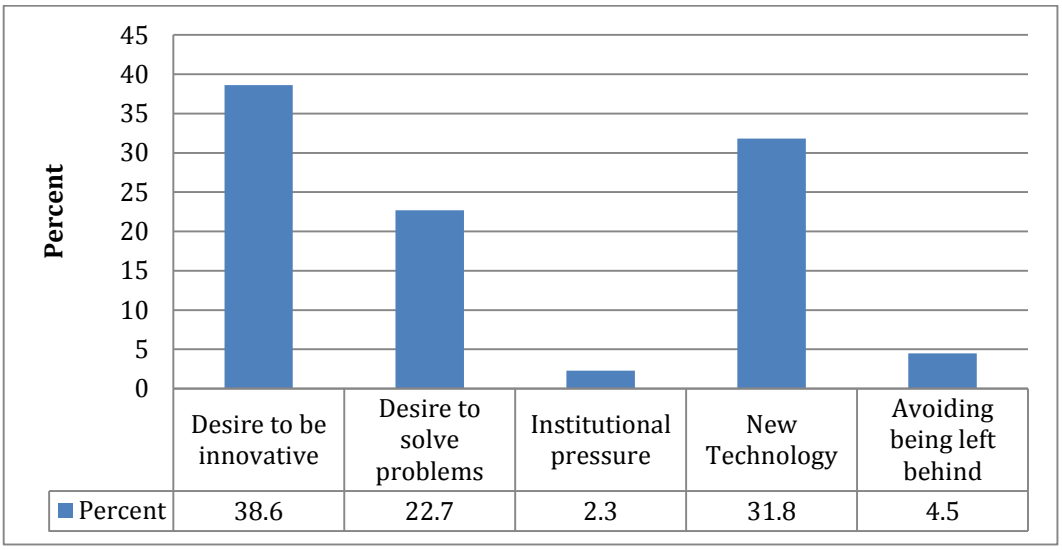


Figure 44: ICT adoption amongst Extension officers

5.3.1 Willingness to adopt new communication media for accessing farming information

The results of the statement "I am willing to adopt new communication media to access information" (Figure 45) show a very encouraging trend in that 59.4% and 36.5% of smallholder farmers agreed and strongly agreed that they are willing to adopt new communication media to access information. Similarly, an encouraging aspect of this study (Figure 46) is that 43.6% and 51.3% of the extension officers agreed and strongly agreed that they are willing to adopt new communication media to access information.

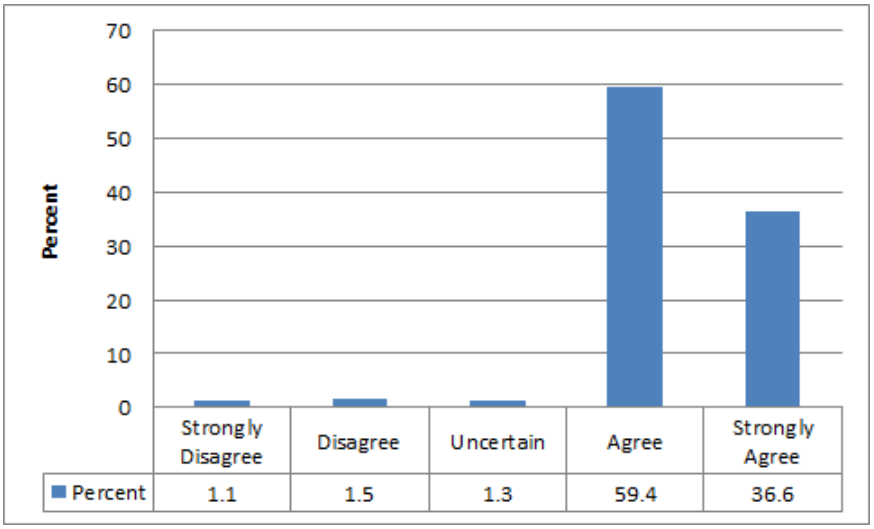


Figure 45: Willingness to adopt new communication media for accessing farming information – Smallholder Farmer responses

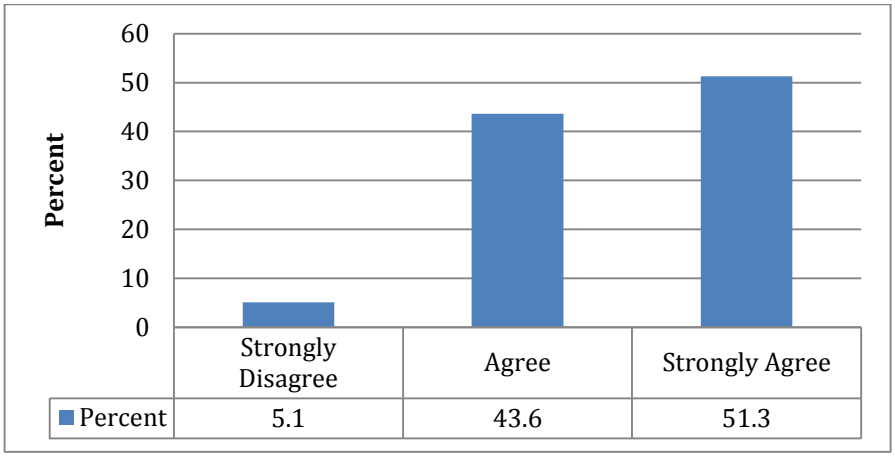


Figure 46: Willingness to adopt new communication media for accessing farming information - Extension Officer responses

5.3.2 Willingness to adopt new communication media for sharing farming information

The study (Figure 47) reveals that an overwhelming majority of the smallholder farmers (97.9%) are willing to adopt new communication media for the purposes of agricultural information sharing. A comparison with the data from the extension officers (Figure 48) reveals similar results that 95% of extension officers are willing to adopt new communication media to share information.

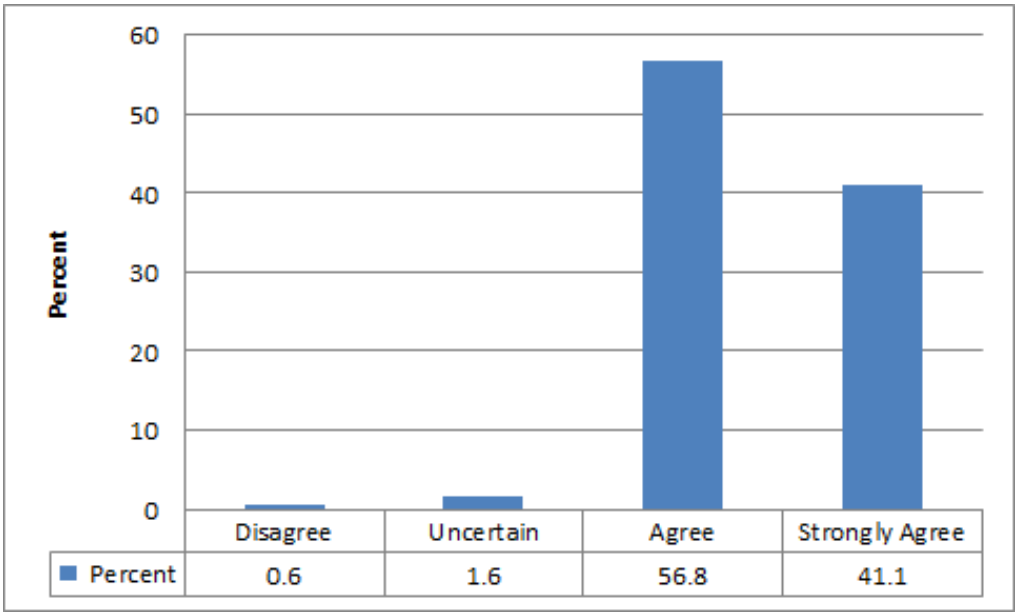


Figure 47: Willingness to adopt new communication media for sharing farming information - Smallholder Farmer responses

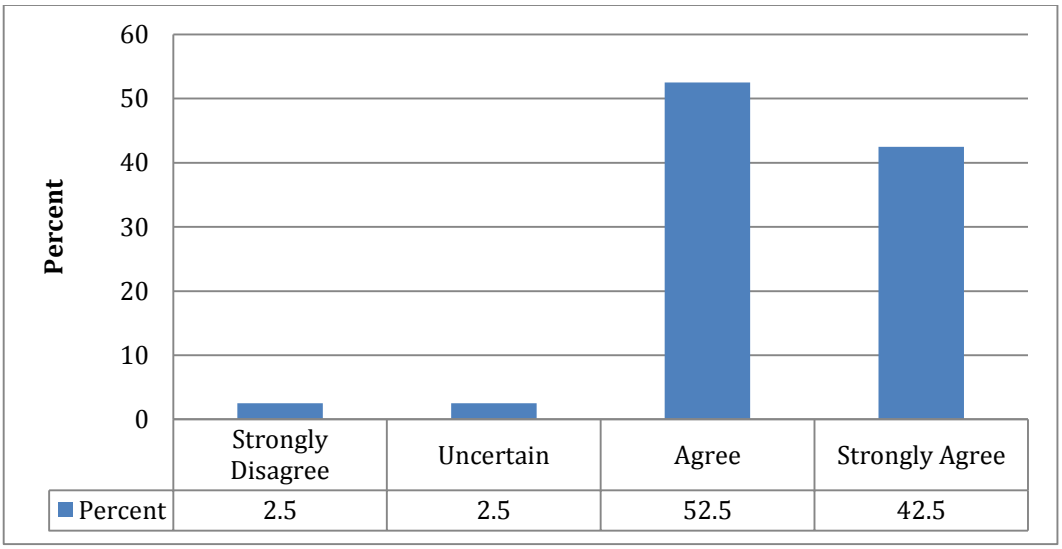


Figure 48: Willingness to adopt new communication media for sharing farming information - Extension Officer responses

5.3.3 Smallholder Farmer Communication Media of Preference

	Mean preference ranking
Cellphone	1.837
Smartphone	4.6
Local Radio	3.763
Gatherings	3.812
Telephone	3.295
Websites	5.805

Table 35: Ranking of Communication Media Preferred by smallholder farmers

The results shown in Table 35 reveal that the top three media type preferred by smallholder farmers are cell phones, telephones and local radios while the media least preferred by smallholder farmers were websites and smartphones. The mean preference ranking was calculated as the average of the ranks with respect to the communication media preferred by smallholder farmers.

	Mean preference ranking
Telephone	3.61
Cell phone	3.71
Local radio	4.77
Newspapers	4.97
Smart phone	5.06
E-mail	5.64
Websites	7.24

Table 36: Ranking of Communication Media Preferred by Extension Officers

The study also shows (Table 36) that the top three media preferred by extension officers were ranked as telephones, cell phones and local radios while the top three least preferred media of preference were smart phones, email and websites. Based on these results of both the farmers and extension officers, it is evident that cell phones and telephones are popular amongst ICTs

amongst smallholder farmers and extension officers. The results also revealed that the least preferred media was websites; this can be attributed to their perceived ease of use (Okello, 2013).

5.4 ICT Innovation Decision

In order to understand the innovation decision of the smallholder farmers with regards to the use of ICTs a cross tabulation analysis (

Table 37) of the question 'I have the following number of years of experience in farming' and question 17, 'When did you decide to start using ICTs' was carried out. The analysis revealed that for farmers with 3 years or less experience in farming activities 35.2% of them adopted ICTs within a period of 0 to 2 years. The data reveals that for smallholder farmers who have 4 to 9 years' experience 19.9% started using ICTs 4 to 6 years ago. According to Rogers (2010) the 35.2% of smallholder farmers who adopted ICTs within a period of 0 to 2 years are classified as early adopters as they adopted the innovation one year after starting their farming activities. The smallholder farmers who have 4 to 9 years' experience and started using ICTs 4 to 6 years ago are classified as innovators as they started using ICTs at least as soon as they started farming. An example of late adopters or what is referred to as late mass can be seen by the smallholder farmers who have 10 to 19 years farming experience but only started using ICTs between 0 to 2 years ago.

The analysis in Table 38 shows that there are no innovators amongst extension officers and is evidenced by the data showing that there are no extension officers who have 4 to 9 years' experience and started using ICTs 4 to 6 years ago. The data also reveals that 15.4% of the extension officers who have 3 years or less experience in farming activities are early adopters. The extension officer data generally shows that majority of the extension officers are classified under late mass. A point to note for both smallholder farmers and extension officers is that some individuals from both groups adopted ICTs before they got involved in farming activities. This is evident with the 23.9% of smallholder farmers with 3 years or less farming experience but started using ICTs more than 6 years ago or the 15.4% of extension officers with 3 years or less farming experience but started using ICTs more than 6 years ago.

Experience in Farming Activities * Begin using ICTs

			Begin using ICTs					
			Do not use ICTs	0-2 year ago	2-4 years ago	4-6 years ago	More than 6 years ago	Total
Experience in Farming Activities	3 or less	Count	15	31	10	11	21	88
		% within Experience in Farming Activities	17.0%	35.2%	11.4%	12.5%	23.9%	100.0%
		% within Begin using ICTs	26.8%	29.2%	8.3%	11.0%	19.3%	17.9%
		% of Total	3.0%	6.3%	2.0%	2.2%	4.3%	17.9%
	4 to 9	Count	8	36	60	32	25	161
		% within Experience in Farming Activities	5.0%	22.4%	37.3%	19.9%	15.5%	100.0%
		% within Begin using ICTs	14.3%	34.0%	49.6%	32.0%	22.9%	32.7%
		% of Total	1.6%	7.3%	12.2%	6.5%	5.1%	32.7%
	10 to 19	Count	12	18	32	25	35	122
		% within Experience in Farming Activities	9.8%	14.8%	26.2%	20.5%	28.7%	100.0%
		% within Begin using ICTs	21.4%	17.0%	26.4%	25.0%	32.1%	24.8%
		% of Total	2.4%	3.7%	6.5%	5.1%	7.1%	24.8%
	20 or more	Count	21	21	19	32	28	121
		% within Experience in Farming Activities	17.4%	17.4%	15.7%	26.4%	23.1%	100.0%
		% within Begin using ICTs	37.5%	19.8%	15.7%	32.0%	25.7%	24.6%
		% of Total	4.3%	4.3%	3.9%	6.5%	5.7%	24.6%
Total		Count	56	106	121	100	109	492
		% within Experience in Farming Activities	11.4%	21.5%	24.6%	20.3%	22.2%	100.0%
		% within Begin using ICTs	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	11.4%	21.5%	24.6%	20.3%	22.2%	100.0%

Table 37: ICT Innovation Adoption- Farmer

Experience in Farming Activities * Begin using ICTs

			Begin using ICTs					Total
			Do not use ICTs	0-2 year ago	2-4 years ago	4-6 years ago	More than 6 years ago	
Experience in Farming Activities	3 or less	Count	5	2	4	0	2	13
		% within Experience in Farming Activities	38.5%	15.4%	30.8%	0.0%	15.4%	100.0%
		% within Begin using ICTs	62.5%	11.1%	57.1%	0.0%	50.0%	33.3%
		% of Total	12.8%	5.1%	10.3%	0.0%	5.1%	33.3%
	4 to 9	Count	2	5	0	0	0	7
		% within Experience in Farming Activities	28.6%	71.4%	0.0%	0.0%	0.0%	100.0%
		% within Begin using ICTs	25.0%	27.8%	0.0%	0.0%	0.0%	17.9%
		% of Total	5.1%	12.8%	0.0%	0.0%	0.0%	17.9%
	10 to 19	Count	0	8	1	1	1	11
		% within Experience in Farming Activities	0.0%	72.7%	9.1%	9.1%	9.1%	100.0%
		% within Begin using ICTs	0.0%	44.4%	14.3%	50.0%	25.0%	28.2%
		% of Total	0.0%	20.5%	2.6%	2.6%	2.6%	28.2%
	20 or more	Count	1	3	2	1	1	8
		% within Experience in Farming Activities	12.5%	37.5%	25.0%	12.5%	12.5%	100.0%
		% within Begin using ICTs	12.5%	16.7%	28.6%	50.0%	25.0%	20.5%
		% of Total	2.6%	7.7%	5.1%	2.6%	2.6%	20.5%
Total		Count	8	18	7	2	4	39
		% within Experience in Farming Activities	20.5%	46.2%	17.9%	5.1%	10.3%	100.0%
		% within Begin using ICTs	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	20.5%	46.2%	17.9%	5.1%	10.3%	100.0%

Table 38: ICT Innovation Adoption - Extension officer

5.5 Perceived Attributes of Innovation

5.5.1 Relative Advantage

The research shows (Figure 49) that majority of smallholder farmers (53.5%) do not agree with the statement that information provided to them in English is more effective than information provided in indigenous language. It was also found that 34.7% of smallholder

farmers agreed with this statement. This agreement can be attributed to a perception bias were illiterate smallholder farmers felt that information in English has a greater value.

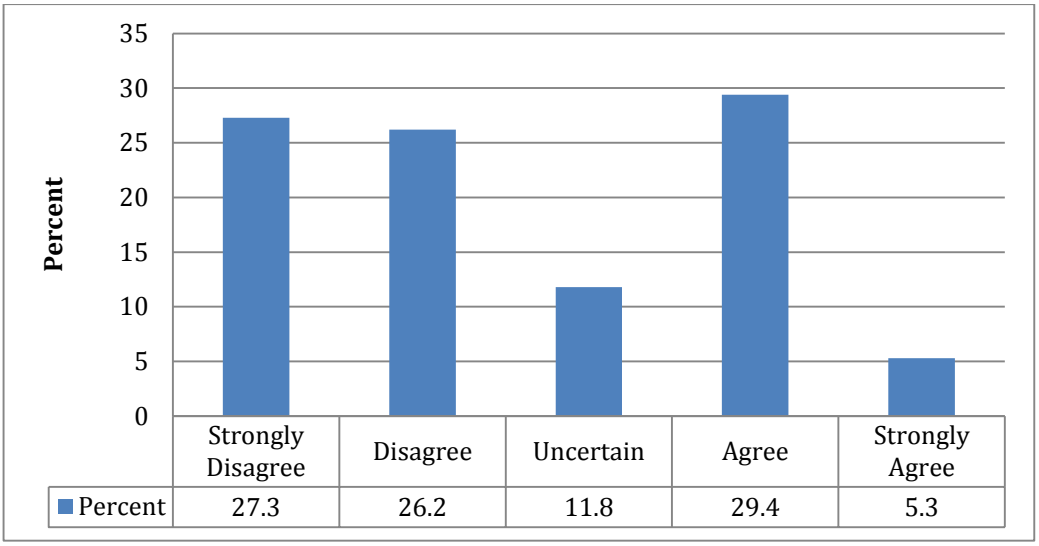


Figure 49: Effectiveness of information in English

			Formal Education				Total
			Yes (Certificate)	Yes (Degree)	Yes (Higher than Degree)	No	
Effectiveness of Information Provided in English	Strongly Disagree	Count	21	1	1	120	143
		% of Total	4.0%	0.2%	0.2%	23.0%	27.4%
	Disagree	Count	15	2	1	119	137
		% of Total	2.9%	0.4%	0.2%	22.8%	26.2%
	Uncertain	Count	12	2	0	48	62
		% of Total	2.3%	0.4%	0.0%	9.2%	11.9%
	Agree	Count	51	12	1	88	152
		% of Total	9.8%	2.3%	0.2%	16.9%	29.1%
	Strongly Agree	Count	9	1	1	17	28
		% of Total	1.7%	0.2%	0.2%	3.3%	5.4%
Total		Count	108	18	4	392	522
		% of Total	20.7%	3.4%	0.8%	75.1%	100.0%

% of farmers who agree with statement from each education classification	47%	67%	25%	22%	

Table 39: Effectiveness of Information Provided in English and Formal Education

A finding from this study (Table 39) showed that mostly smallholder farmers who have a degree (67%) are of the view that information provided in English is effective. It can be observed that smallholder farmers without formal education (22%) are in the least agreement with this statement. It should also be noted that smallholder farmers without formal education form the largest group of farmers (22.8%) who disagree with this statement. The chi square statistic was 50.384 with a p-value= .000 meaning that effectiveness of information provided in English and education are related.

5.5.2 Compatibility

Compatibility was analysed based on a number of statements that form Table 40. Rogers (2003, p. 15) identifies compatibility as one of the attributes of innovation and defines it as "the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters." It is important that an innovation is perceived to be compatible with existing norms and values in order to obtain a positive uptake by its adopters. The study reveals (Table 40) that majority of the smallholder farmers (85.6%) are of the view that ICTs are compatible with their business needs on the farm. The majority of the farmers (89.6%) are in agreement with the statement that ICTs are compatible with the information needs of farming. The analysis further reveals that a total of 88.4% of smallholder farmers are in agreement that ICTs are compatible with the cultural norms of farming while a total of 79% of the smallholder farmers also are in agreement that ICTs are compatible with the existing infrastructure at the farms.

A similar analysis of the perceptions of compatibility was conducted on extension officers (Table 41) and it revealed similar results to those of smallholder farmers. The study revealed that the majority of extension officers (83.4%) are of the view that ICTs are compatible with the business needs of a farm. A total of 94.8% of the extension officers also are of the view that ICTs are compatible with the information needs of farming and 76.3% of the extension officers felt that ICTs are compatible with the cultural norms of farming. A total of 81.6% of extension officers felt that ICTs are compatible with the existing infrastructure on farms. The results indicate that both smallholder farmers and extension officers are positive about the compatibility of ICTs and agricultural practices. This positive attitude should be considered with caution, as it is known that infrastructure is one of the main barriers to ICT penetration in rural area. It also can be noted that these smallholder farmer and extension officer

perceptions on compatibility of infrastructure are formed mainly around what we earlier in the literature review referred to, as old ICTs mainly the mobile phone, landline telephone and radio.

		Frequency	Percent
ICTs are compatible with the business needs of the farm	Strongly Disagree	3	0.6%
	Disagree	12	2.3%
	Uncertain	61	11.6%
	Agree	324	61.5%
	Strongly Agree	127	24.1%
ICTs are compatible with the information needs of farming	Strongly Disagree	6	1.2%
	Disagree	5	1.0%
	Uncertain	43	8.3%
	Agree	318	61.3%
	Strongly Agree	147	28.3%
ICTs are compatible with the cultural norms of farming	Strongly Disagree	3	0.6%
	Disagree	9	1.7%
	Uncertain	48	9.3%
	Agree	312	60.2%
	Strongly Agree	146	28.2%
ICTs are compatible with the existing infrastructure at the farms	Strongly Disagree	3	0.6%
	Disagree	12	2.4%
	Uncertain	92	18.1%
	Agree	285	56.0%
	Strongly Agree	117	23.0%

Table 40: Compatibility of ICTs - Farmers

		Frequency	Percent %
ICTs are compatible with the business needs of the farm	Strongly Disagree	1	2.6%
	Disagree	0	0.0%
	Uncertain	5	13.2%
	Agree	24	63.2%
	Strongly Agree	8	21.1%
ICTs are compatible with the information needs of farming	Strongly Disagree	0	0.0%
	Disagree	1	2.6%
	Uncertain	1	2.6%
	Agree	27	71.1%
	Strongly Agree	9	23.7%

ICTs are compatible with the cultural norms of farming	Strongly Disagree	0	0.0%
	Disagree	5	13.2%
	Uncertain	4	10.5%
	Agree	24	63.2%
	Strongly Agree	5	13.2%
ICTs are compatible with the existing infrastructure at the farms	Strongly Disagree	1	2.6%
	Disagree	3	7.9%
	Uncertain	3	7.9%
	Agree	28	73.7%
	Strongly Agree	3	7.9%

Table 41: Compatibility of ICTs - Extension officers

5.5.3 Complexity

The analysis made use of two questions to determine the complexity variable these being question 14, 'To what extent do you use ICTs on your farm?' and question 15, 'How easy do you find ICTs are to use in your work?' The results to the question 14.1, 'To what extent do you use ICTs on your farm?' that was posed to smallholder farmers are shown in Table 42. The analysis reveals that that 58.4% of the smallholder farmers use ICTs extensively on their farms while 33.1% of the farmers hardly use ICTs on their farms. This is a positive finding as it shows that ICT adoption is relatively high at over 50% of the sample, with a 0.8% missing response rate on this question for farmers.

A similar question to that put to smallholder farmers was put to extension officers and the results to the question "To what extent do you use ICTs in your agricultural extension activities?" are displayed in Table 43. The results reveal similarities to that of smallholder farmers as they show that majority extension officers (64.1%) use ICTs extensively in their agricultural extension activities as well. The results also reveal that a total of 33.3% of extension officers rarely use ICTs and only use them to a small extent. The similarities in responses from the two sample groups show that the change agents (extension officers) and their opinion leaders have a significant positive influence on the social system.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very small extent	35	6.6	6.6	6.6
	Small extent	141	26.5	26.7	33.3
	Never	44	8.3	8.3	41.6
	Large extent	281	52.7	53.1	94.7
	Very large extent	28	5.3	5.3	100.0
	Total	529	99.2	100.0	
Missing	System	4	.8		

Total	533	100.0		

Table 42: Extent of ICT use on farm - Farmer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very small extent	6	1.1	15.4	15.4
	Small extent	7	1.3	17.9	33.3
	Never	1	.2	2.6	35.9
	Large extent	22	4.1	56.4	92.3
	Very large extent	3	.6	7.7	100.0
	Total	39	7.3	100.0	

Table 43: Extent of ICT use on farm - Extension officer

The data in Table 44 is based on the question Q15, 'How easy do you find ICTs are to use in your work?' The results reveal that a majority of smallholder farmers (54.4%) find using ICTs in their work quite easy while 15.3% of the smallholder farmers find using ICTs in their work quite hard.

The study also shows (Table 45) that extension officers in response to the question 14.1, 'How easy do you find ICTs are to use in your work?' found using ICTs in their extension work to be easy (64.9%). It is important to note that the ICT adoption rates can be improved even further by improving smallholder farmer literacy levels which is a position that is held by Aleke, Ojiako, and Wainwright (2011) who identified low levels of literacy as being a barrier to ICT adoption and suggested the use of indigenous languages in content.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Extremely hard	16	3.0	3.0	3.0
	Quite hard	81	15.2	15.3	18.3
	Neither	144	27.0	27.2	45.6
	Quite easy	246	46.2	46.5	92.1
	Extremely easy	42	7.9	7.9	100.0
	Total	529	99.2	100.0	
Missing	System	4	.8		
Total		533	100.0		

Table 44: Ease of ICT use on farm – Farmer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Extremely hard	2	.4	5.4	5.4

	Quite hard	9	1.7	24.3	29.7
	Quite easy	24	4.5	64.9	94.6
	Extremely easy	2	.4	5.4	100.0
	Total	37	7.0	100.0	

Table 45: Ease of ICT use on farm - Extension officer

5.5.4 Trialability

The trialability variable was determined using question 27, 'Being given a chance to physically experience the use and functions of ICTs over a prescribed test period allows me to adopt them easily'. Rogers (2003, p. 16) identifies trialability as another attributes of innovation and defines it as "the degree to which an innovation may be experimented with on a limited basis." Sahin (2006) argues that there is a positive relationship between trialability and rate of adoption. The author is of the opinion that the more an innovation is tried the faster it is adopted.

The analysis (Figure 50) shows results of farmer's perceptions towards trialability of ICT innovations. A majority of smallholder farmers (84%) agree with this statement and are of the view that given a chance to physically experience the use and functions of ICTs over a prescribed test period it would make adoption easy. Similarly, (Figure 51) an analysis on data from extension officers reveals that majority of the extension officers (82.5%) are of a similar view to that of smallholder farmers. The extension officers concur with the smallholder farmers regarding the use of ICTs and ease of adoption. The positive responses from both farmers and extension officers are an encouraging result towards the successful diffusion and adoption of ICT initiatives in the farming sector.

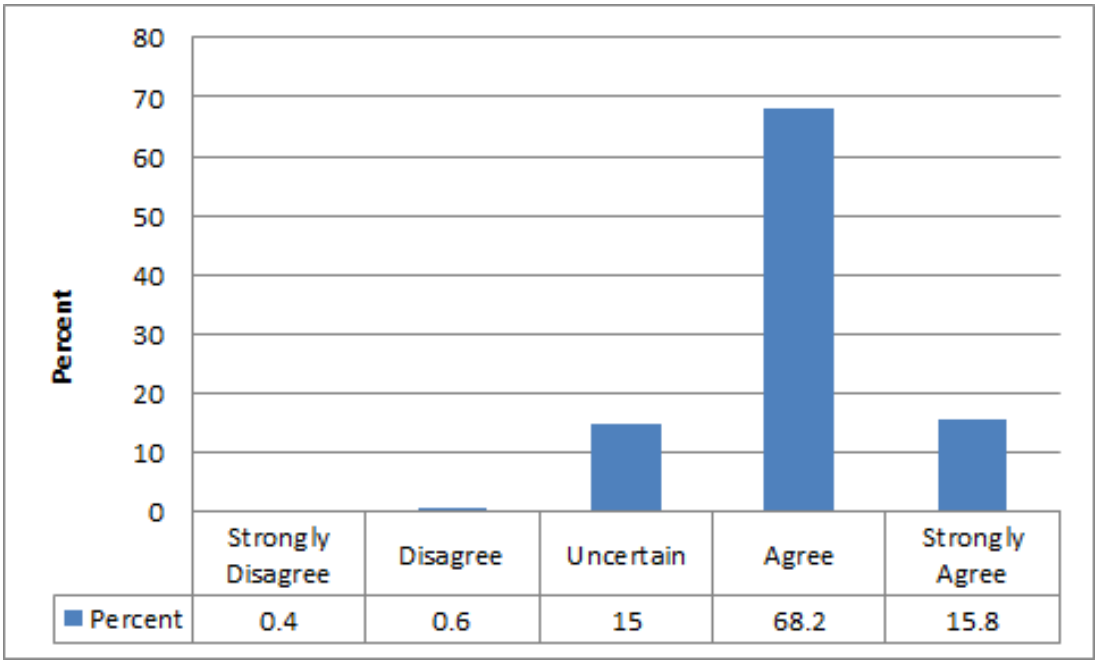


Figure 50: Trialability of ICTs – Farmers

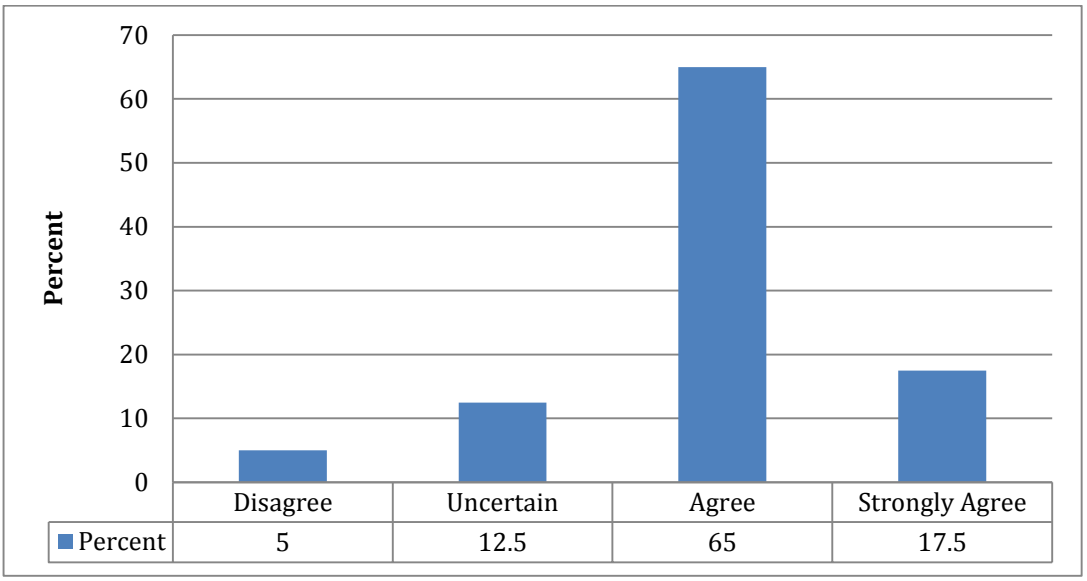


Figure 51: Trialability of ICTs - Extension officers

5.5.5 Observability

The observability variable was determined using question 28, 'Being able to see ICTs in use encouraged me to adopt them'. Rogers (2003, p. 16) identifies observability as another attribute of innovation and defines it as "the degree to which the results of an innovation are visible to others." Observability is also positively correlated to the rate of adoption of an innovation (Sahin, 2006). Analysis of the data collected, (Figure 52) shows a total of 90.5% of smallholder farmers concur with the view that being able to see ICTs in use encouraged them to adopt these ICTs while 97.5 of the sample of extension officers (Figure 53) are of the same opinion. The similar results from smallholder farmers and extension officers shows a high degree of willingness to adopt new ICT initiatives as long as they are given the opportunity to take part in demonstrations of how the new innovation functions. This result also underscores the need for training before new ICT innovations can be implemented in order to eliminate fear and increase the likelihood of adoption and diffusion of the innovation.

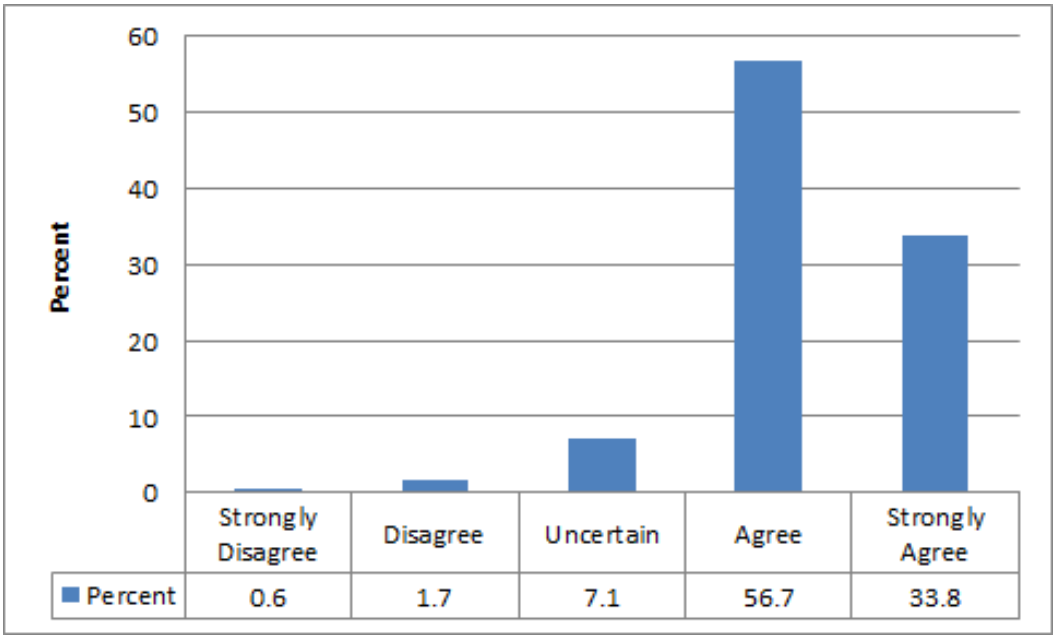


Figure 52: Observability of ICTs – Farmers

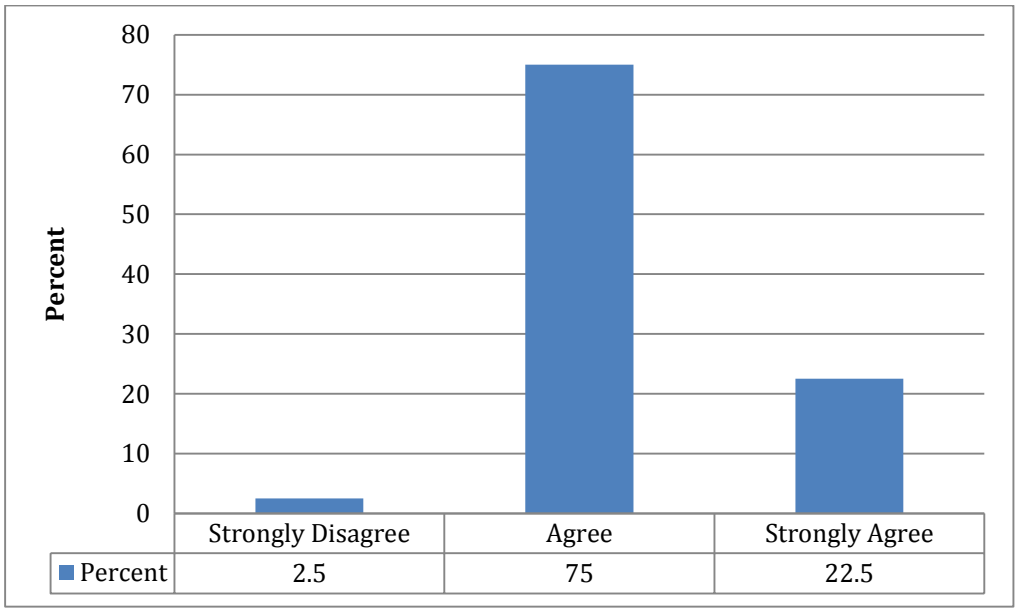


Figure 53: Observability of ICTs - Extension officers

5.6 Nature of the Social System

5.6.1 Norms

The norms variable was determined using question 10, 'How often do you receive reading materials from the extension officer responsible for your ward (e.g. magazines, newsletters)?' The resulting analysis reveals that reading material is supplied usually on a monthly (27.8%) basis. The results reveal that a significant number of smallholder famers (38.8%) state that they do not receive any reading material from extension officers (Figure 54). This result is

indicative that the supply of agricultural materials has to be improved to access as many smallholder farmers as possible. Furthermore, there should be increased frequency in supply of these materials. As has been alluded to earlier, production of content in local languages should be considered in order to increase uptake of the information.

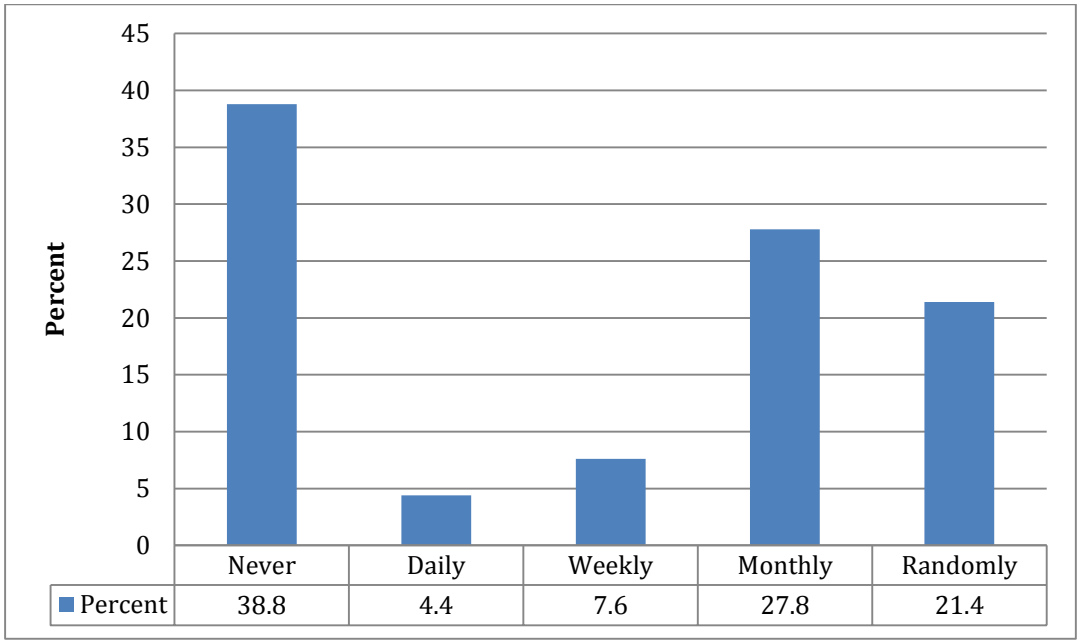


Figure 54: Frequency of receiving reading material

			Formal Education				Total
			Yes (Certificate)	Yes (Degree)	Yes (Higher than Degree)	No	
Receive reading materials from extension officers	Never	Count	36	4	1	162	203
		% of Total	6.9%	0.8%	0.2%	31.0%	38.8%
	Daily	Count	1	4	1	16	22
		% of Total	0.2%	0.8%	0.2%	3.1%	4.2%
	Weekly	Count	8	4	0	28	40
		% of Total	1.5%	0.8%	0.0%	5.4%	7.6%
	Monthly	Count	34	4	1	107	146
		% of Total	6.5%	0.8%	0.2%	20.5%	27.9%
	Randomly	Count	30	1	1	80	112
		% of Total	5.7%	0.2%	0.2%	15.3%	21.4%
Total		Count	109	17	4	393	523
		% of Total	20.8%	3.3%	0.8%	75.1%	100.0%

% of farmers who responded never to the statement from each education classification	33%	24%	25%	41%	

Table 46: Receive reading materials from extension officers and Formal Education

The cross tabulation (Table 46) reveals that the majority of the smallholder farmers (38.8%) irrespective of education status do not receive reading materials from the extension officer. The cross tabulation also reveals that 41% of smallholder farmers with no education stated that they do not receive reading materials. The chi square statistic was 35.494 with a p-value=.000 meaning educated smallholder farmers acknowledged receiving reading material from extension officers.

5.6.2 Change Agents

Rogers (1995, p. 39) defines a change agent as "an individual who attempts to influence clients innovation-decisions in a direction that is deemed desirable by a change agency". In this study the change agent was identified to be the extension officer as he/she is the main link in the provision of extension services from government, and is also responsible for communicating agricultural innovations to smallholder farmers. The study sought to investigate the existence of a relationship between the smallholder farmer and the extension officer who was identified to be the change agent. Using question 9, 'By estimation, how often do you visit the agricultural extension officer responsible for your ward?' the study shows that (Figure 55) smallholder farmers visit the offices of extension officers mostly once a month (37.6%). In order to increase interaction between smallholder farmers and extension officers, ICTs can assist to close this gap thereby providing a solution of "last mile" extension services to smallholder farmers (Anoop et al., 2015; A. Davis, A. Tall, & D. Guntuku, 2014).

An analysis of question 12, 'To what extent do you depend on the extension officer responsible for your ward for farming information?' reveals that (Figure 56) a total of 64.3% of the smallholder farmers depend to a large extent on the extension officer responsible for their ward for farming information. The analysis also revealed that a total of 29.5% of smallholder farmers felt that they hardly ever depend on the extension officers for farming information. This high dependence of smallholder farmers on extension services can be seen as an indicator of the need for government to increase the amount of support provided to smallholder farmers through increased numbers of extension officers. This demand for extension services by smallholder farmers can be mitigated through the use of ICTs in providing extension services, thereby increasing smallholder farmers reach and availability (Anoop et al., 2015; Magesa, Michael, & Ko, 2014).

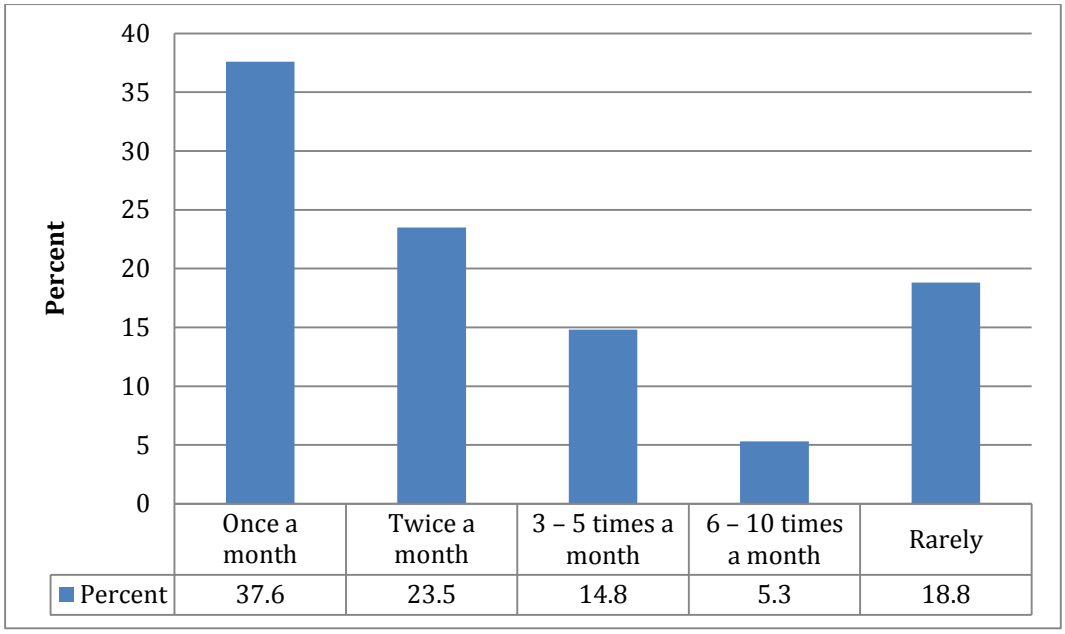


Figure 55: Frequency of farmer visits to extension officer offices

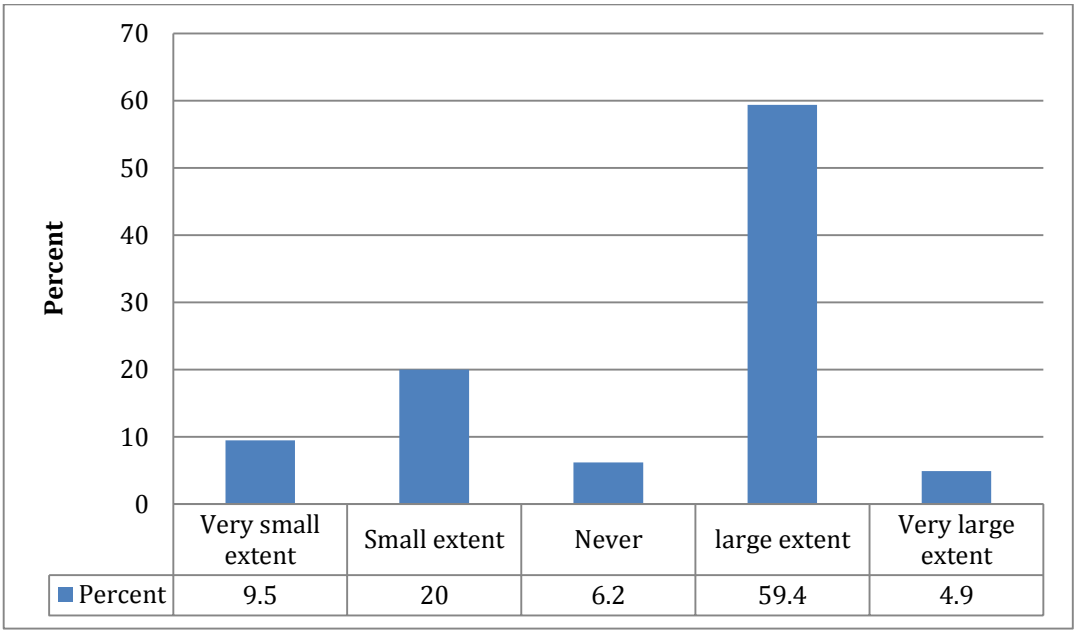


Figure 56: Extent of dependency of farmers on extension officers for farming information

5.6.3 Type of Innovation Decision

Rogers (2003) explains that an individual goes through a number of stages before they decide on an innovation that is called the innovation decision process. An individual first moves from the knowledge stage where they are exposed to the innovation and its functionality, then the attitude formation stage where they form an attitude on the innovation, then to the decision stage where they decide on either adopting or rejecting the innovation to implementation of the innovation, and finally confirmation of their decision through reinforcement of the decision.

The study reveals (Figure 57) that prowess to solve problems (39.6%) and the desire for innovation (29.6%) were the main factors in influencing smallholder farmers to adopt ICTs. It was also revealed that 19.1% where driven by the desire for new technology, while 13.9% where driven by the fear of being left behind and 6.2% where driven by institutional pressures. This low level of institutional pressures supports a previously made assertion as to the explanation of why the majority of smallholder farmers and extension officers said that they seldom use ICTs to share information. This calls for the need of policy frameworks that integrate the use of ICTs; this would significantly improve adoption rates by both farmers and extension officers.

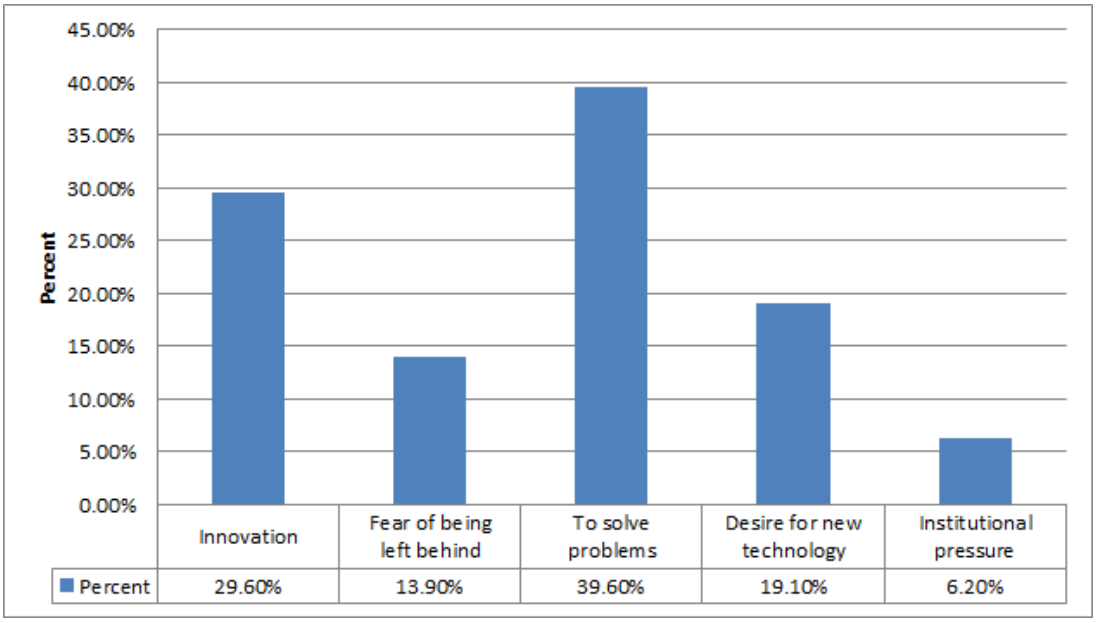


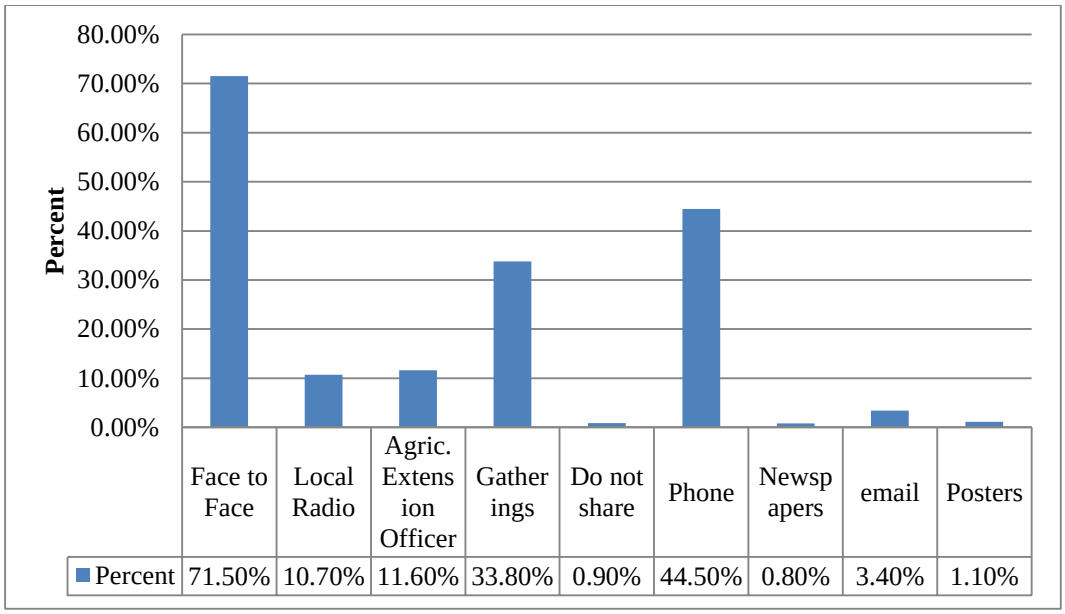
Figure 57: Influence of ICT adoption – Farmers

5.6.4 Communication Channels

ICTs the world over are hailed as innovative technologies which have great potential to change societies although if this potential is to be realised and be adopted these technologies need to provide information which is relevant in the context of the society it exists in (Glendenning & Ficarelli, 2012). The following questions 19, 20, 21 and 24 sought to investigate aspects of communication channels in relation to smallholder farmers.

The analysis of question 19, 'What means do you use to share information with fellow farmers?' (Figure 58) which allowed the smallholder farmers to make multiple responses to this question reveals that the means of sharing farming information with fellow farmers is primarily through face-to-face (71.5%) communication. This is followed by phones (44.5%) and gatherings (33.8%) as the preferred choices by smallholder farmers. This data shows that a total of 55.2% of smallholder farmers use ICT based innovations (phones and radios) to share information. These findings are in support of the data shown in Table 52 that 71.9% of

the farmers collectively agree to find ICTs in relation to their work (farming activities) to be useful. This question provided 9 options that included non-technological means of information sharing and was developed to allow multiple options from a respondent. The majority of respondents indicated that they still prefer face-to-face communication; this can be seen as an indication of lack of capacity to use and procure an ICT based innovation such as a mobile phone. It is encouraging to see that in terms of ICTs the phones are seen to be very popular amongst farmers.



	Face to Face	Local Radio	Agric. Extension Officer	Gatherings	Do not share	Phone	Newspapers	email	Posters
Percent	71.50%	10.70%	11.60%	33.80%	0.90%	44.50%	0.80%	3.40%	1.10%

Figure 58: Means of information sharing with fellow farmers

The analysis of question 20, 'what means do you use to share information with your extension officer?' (Figure 59) reveals that information is shared between smallholder farmers and extension officers mainly via face-to-face communication (70%). The second most preferred method of sharing information with the extension officer is via phones (47.3%) followed by gatherings (32.8%). The results reveal that at least half (51.1%) of the farmers in the study use phones to share information with the extension officers (ICT innovations).

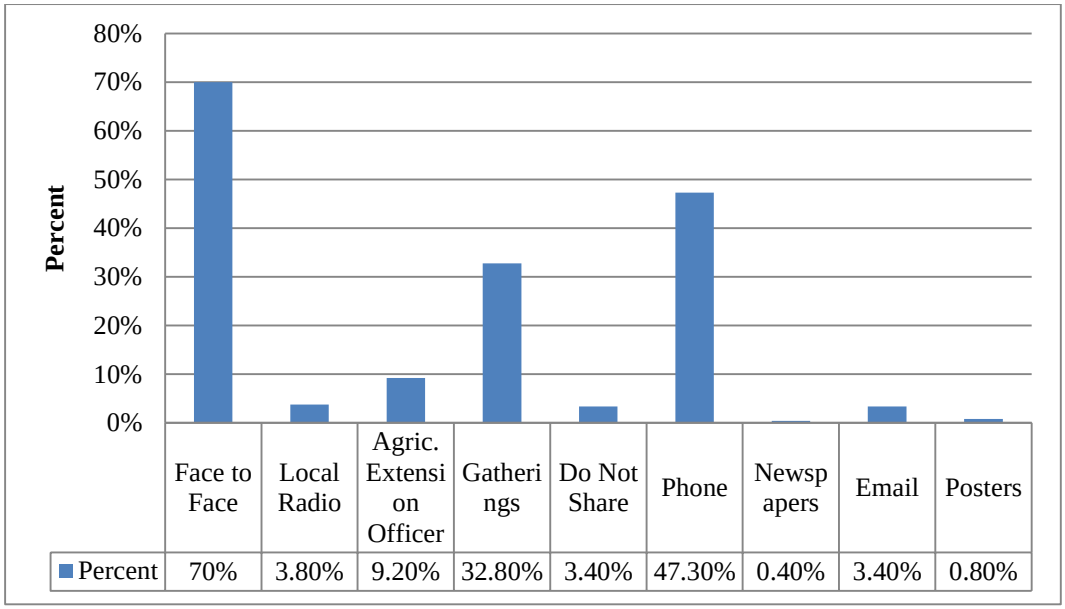


Figure 59: Means of information sharing with extension officer

Using question 21.1, 'To what extent do you use ICTs to share information with fellow farmers?' the study (Figure 60) reveals that 73.4% of smallholder famers in total share information with their fellow farmers to a large extent. Mashavave et al. (2013) explains the importance of social networks in supporting communication channels for sharing of information. In this study it is evident from the data (73.4%) that communication channels exist amongst farmers through social networking platforms such as face-to-face contact, phones and gatherings (Figure 58).

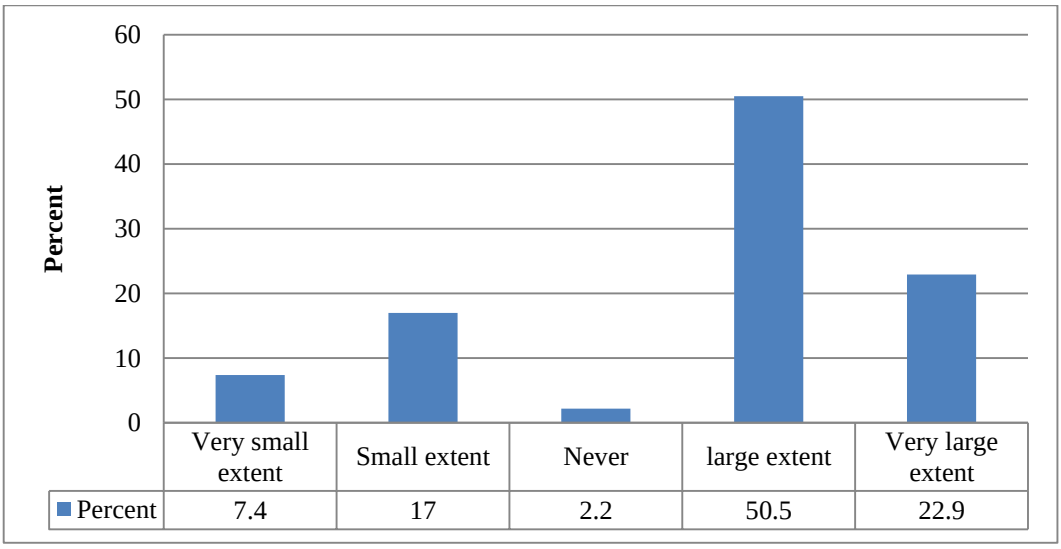


Figure 60: Extent of information sharing with fellow farmers

		Female	Male
Face to Face	Count	240	133
	% of Total	64.3%	35.7%
Local Radio	Count	10	10
	% of Total	50.0%	50.0%
Agric. Extension Officer	Count	32	17
	% of Total	65.3%	34.7%
Gatherings	Count	94	81
	% of Total	53.7%	46.3%
Do Not Share	Count	14	4
	% of Total	77.8%	22.2%
Phone	Count	159	93
	% of Total	62.8%	36.8%
Newspapers	Count	2	
	% of Total	100.0%	
Email	Count	5	13
	% of Total	27.8%	72.2%
Posters	Count	3	1
	% of Total	75.0%	25.0%

Table 47: Sharing information and Gender

The results (Table 47) reveal that smallholder farmers still predominantly use non-technological methods to share information (face to face). With regards to question 21.2, 'To what extent do you use ICTs to share information with the extension officer?' the analysis (Figure 61) indicates that a total of 50.3% of smallholder farmers use ICTs to share information with extension officers at least 2-3 times a week. The data also reveals that 37.6% seldom use ICTs for information sharing and 12% do not use ICTs.

An analysis of the extension officer data on a similar question to the smallholder farmers reveals that 61.1% of extension officers use ICTs to share information with smallholder farmers they provide extension services to (Figure 62). The results also reveal that a significant number of extension officers seldom use ICTs to share information with farmers (36.1%) and a small number of extension officers do not use ICTs completely (2.8%). A point to note is that for both samples of smallholder farmers and extension officers, the majority of respondents to a single option stated that they seldom use ICTs. There can be a number of reasons that can be attributed to the low usage of ICTs to share agricultural information amongst smallholder farmers and extension officers. One such reason advanced by Rogers (2010) is that the extension officers from the ICT innovation perspective who are considered change agents have a weak promotional effort. This weak promotional effort in turn can be due to a lack of institutional influence to support ICT adoption and deployment.

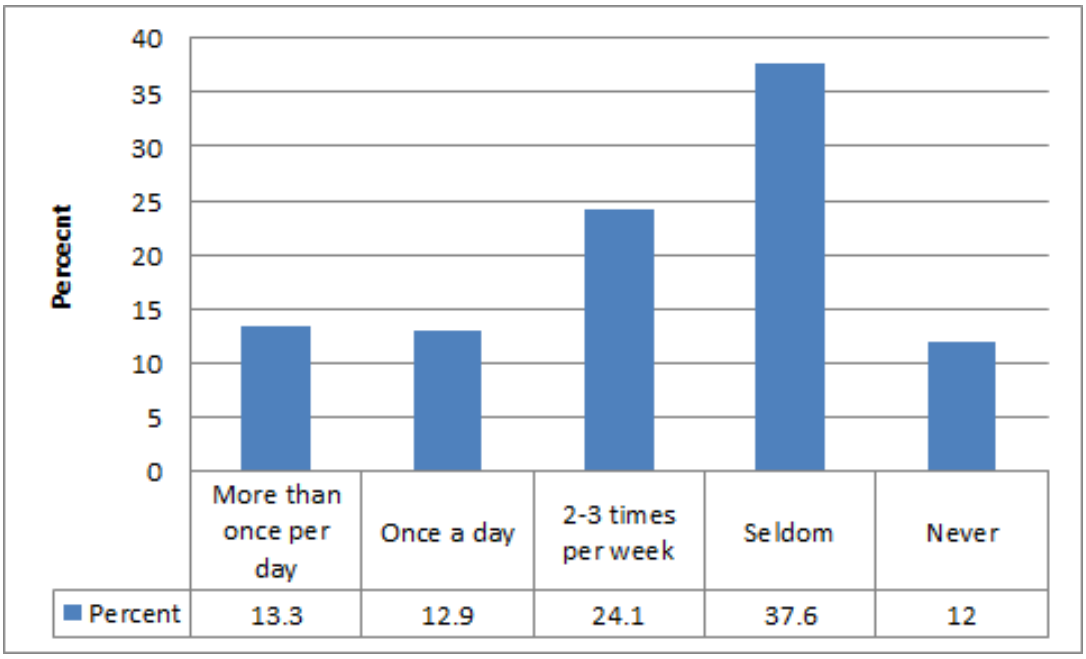


Figure 61: Extent of use of ICTs to share information with extension officers

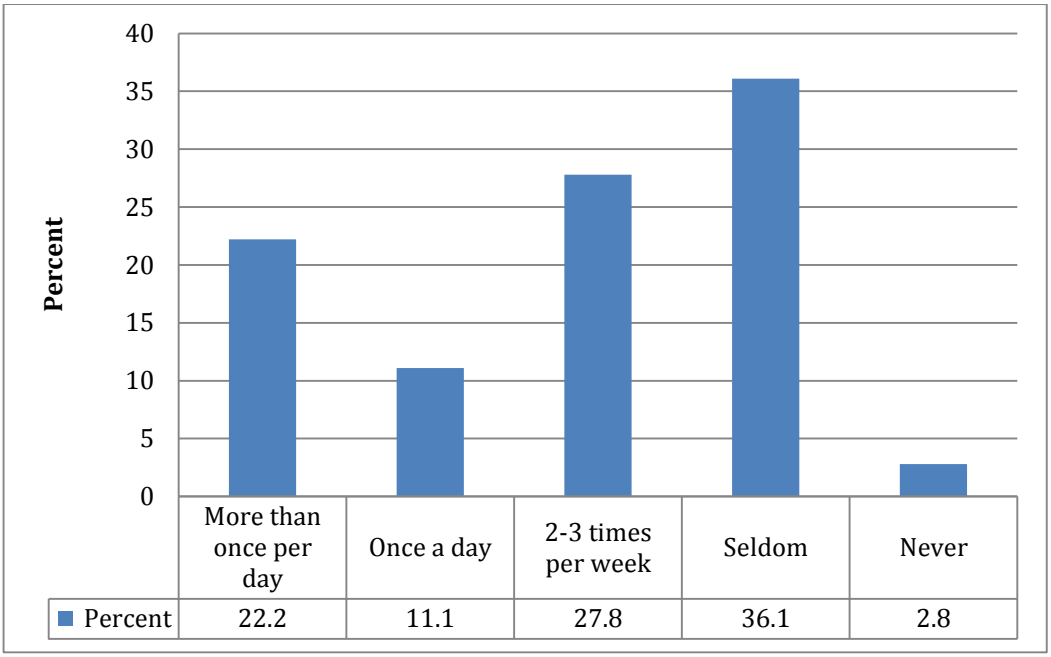


Figure 62: Extent of use of ICTs to share information with farmers

Based on question 24.1 to 24.9, 'How often do you use the following: Mobile Phones (SMS & voice calls only), Desktop Computers, Laptop or tablet computer, Smart phone (internet services), Satellite data, Fixed line internet, Television, Landline, Radio?' the analysis produced the following results. Smallholder farmers (Table 48) use mobile phones more than once a day (76.7%), desktop computers are not used (78.6), laptop or tablet computers are not used (77.8%), smart phones are not used (62.1%), satellite data are not used (83.1%) and fixed line internet are also not used (82.8%). The results show that a total of 54% of smallholder farmers use television at least 2-3 times a week while 30.4% not use it. Smallholder farmers (63.9%) state that they not use landlines and while 20.5% say they seldom use landlines. The smallholder farmers also indicated that they listen to the radio more than once a day (66.7%). This could be an opportunity to consider the use of the radio for ICT based innovations as a means of sharing agricultural information.

The study (Table 49) shows that extension officers use mobile phones more than once a day (70.3%), desktop computers are not used (30%), laptop and tablet computers are used more than once a day (44.4%), smart phones are used more than once a day (30.6%), satellite data is not (48.6%) used and fixed line internet is also not (59.6%) used. Results from both Table 48 and Table 49 show that both smallholder farmers and extension officers reveal that use mobile phones are frequently used more than once a day (76.7% and 70.3%).

According to the Census 2011 Municipal report of KwaZulu-Natal (StatsSA, 2012) the iLembe district municipality has a population of 596 791 people living in 157 692 households. Based on this census data distribution in 2001, 68.2% of households owned a

radio and 61.8% in 2011. In 2001, 37.9% owned a television and 58.0% in 2011 while in 2001, 3.4% owned a computer and 10.6% in 2011. The statistics also show that in 2001 15.8% owned a landline/telephone and it later dropped to 9.6% in 2011. In 2001, 20.5% owned a mobile phone and in 2011 the percentage increased to 83.8%. There are no previously recorded statistics for, access to Internet and it was only recorded in 2011 at 27.6%. The results show an increase with regards to the number of households owning televisions, computers and mobile phones and a reduction in the number of households owning landlines and radios. This mobile phone penetration in the district is the highest ICT penetration with a difference of 63.3% between 2001 and 2011.

		Frequency	Percent
Use of Mobile phones (sms & voice calls)	More than once per day	399	76.7%
	Once a day	48	9.2%
	2-3 times per week	31	6.0%
	Seldom	23	4.4%
	Never	17	3.3%
	7.0	2	0.4%
Use of Desktop Computer	More than once per day	18	3.5%
	Once a day	5	1.0%
	2-3 times per week	15	2.9%
	Seldom	73	14.1%
	Never	407	78.6%
Use of Laptop or Tablet Computer	More than once per day	13	2.5%
	Once a day	11	2.1%
	2-3 times per week	17	3.3%
	Seldom	74	14.3%
	Never	402	77.8%
Use of Smart Phone (internet services)	More than once per day	69	13.3%
	Once a day	31	6.0%
	2-3 times per week	21	4.0%
	Seldom	76	14.6%
	Never	323	62.1%
Use of Satellite Data	More than once per day	6	1.2%
	Once a day	4	0.8%
	2-3 times per week	7	1.4%
	Seldom	70	13.6%
	Never	427	83.1%

Use of Fixed line internet	More than once per day	10	2.0%
	Once a day	10	2.0%
	2-3 times per week	6	1.2%
	Seldom	60	12.0%
	Never	414	82.8%
Television	More than once per day	154	30.0%
	Once a day	75	14.6%
	2-3 times per week	48	9.4%
	Seldom	80	15.6%
	Never	156	30.4%
Landline	More than once per day	28	5.8%
	Once a day	24	5.0%
	2-3 times per week	23	4.8%
	Seldom	98	20.5%
	Never	306	63.9%
Radio	More than once per day	343	66.7%
	Once a day	68	13.2%
	2-3 times per week	41	8.0%
	Seldom	30	5.8%
	Never	32	6.2%

Table 48: Frequency of use – Farmers

		Frequency	Percent%
Use of Mobile phones (sms & voice calls)	More than once per day	26	70.3%
	Once a day	2	5.4%
	2-3 times per week	4	10.8%
	Seldom	4	10.8%
	Never	1	2.7%
Use of Desktop Computer	More than once per day	8	22.2%
	Once a day	5	13.9%
	2-3 times per week	4	11.1%
	Seldom	8	22.2%
	Never	11	30.6%

Use of Laptop or Tablet Computer	More than once per day	16	44.4%
	Once a day	3	8.3%
	2-3 times per week	8	22.2%
	Seldom	6	16.7%
	Never	3	8.3%
Use of Smart Phone (internet services)	More than once per day	11	30.6%
	Once a day	3	8.3%
	2-3 times per week	7	19.4%
	Seldom	9	25.0%
	Never	6	16.7%
Use of Satellite Data	More than once per day	1	2.7%
	Once a day	3	8.1%
	2-3 times per week	5	13.5%
	Seldom	10	27.0%
	Never	18	48.6%
Use of Fixed line internet	More than once per day	2	5.4%
	Once a day	1	2.7%
	2-3 times per week	4	10.8%
	Seldom	8	21.6%
	Never	22	59.5%

Table 49: Frequency of use - Extension officers

5.7 Culture

Hofstede (1984) asserts that history has an influence on culture and that value systems influence societal norms. Hofstede's view point is supported by authors such as Williamson (2000) who illustrated that the institutional culture of a particular country is influenced by history. This study made use of five questions based on Hofstede's cultural dimensions to investigate the existence and type of relationship between the smallholder farmers and extension officers. Table 50 presents the results and reveals that 42% of the smallholder famers feel that extension officers are closely involved with the day-to-day running of their farms. The smallholder farmers (70.3%) agreed that they are on a first name basis with extension officers and 62.3% of the smallholder farmers concur that extension officers remove unease in situations in which there are no clear guidelines. The study also revealed that 46.7% of the smallholder farmers agreed that farming innovations lead by females are usually not adopted by smallholder farmers and 86.9% of the farmers collectively are of the view that the extension officers encourage planning only on a seasonal basis.

Based on these results, it is evident that smallholder farmers acknowledge that extension officers help remove unease and this shows that the farmers have a low uncertainty avoidance meaning that they are more focused on practice instead of rules and are more open to deviating from norms. This means that the smallholder farmers are open to accepting new innovations in their farming activities and are not threatened by them. The study further shows that most smallholder farmers are closely involved with the day-to-day running of their farms with extension officers and this suggests that the level of interconnectedness of society is high and closely knit. The study shows that there is closeness in relations between extension officers and smallholder farmers in that most smallholder farmers refer to extension officers by their first name. This suggests a small distance of power between the two groups thus having an equal power relationship and a more flat structure of power distribution. The planning only on a seasonal basis indicates that this is normative in society.

		Percentage	Frequency
I am closely involved with the day-to-day running of my farm with the extension officer	Strongly Disagree	8.7%	46
	Disagree	33.7%	178
	Uncertain	8.5%	45
	Agree	42.0%	222
	Strongly Agree	7.0%	37
I am on first name basis with the extension officer	Strongly Disagree	4.6%	24
	Disagree	13.9%	73
	Uncertain	4.9%	26
	Agree	70.3%	370
	Strongly Agree	6.3%	33
Extension officers help remove unease in situations in which there are no clear guidelines	Strongly Disagree	3.6%	19
	Disagree	5.3%	28
	Uncertain	9.3%	49
	Agree	62.3%	329
	Strongly Agree	19.5%	103
Farming innovations lead by females are usually not adopted by farmers	Strongly Disagree	4.7%	25
	Disagree	15.2%	80
	Uncertain	23.0%	121
	Agree	46.7%	246
	Strongly Agree	10.4%	55
The extension officer encourages planning only on a seasonal basis	Strongly Disagree	4.0%	21
	Disagree	3.8%	20
	Uncertain	5.3%	28
	Agree	50.3%	265
	Strongly Agree	36.6%	193

Table 50: Summary showing the role of culture

Based on Table 51 the data reveals that 68.3% of the extension officers are closely involved with the day-to-day running of farms and that 71.8% of the extension workers concur that they are on a first name basis with farmers/employees. The analysis shows that 63.2% of the extension officers agreed that they remove unease in situations in which there are no clear guidelines. The extension officers (33.3%) disagree with the view that farming innovations lead by females are usually are not adopted by farmers and 55.9% of extension officers collectively state that they encourage planning on seasonal basis.

An analysis of the responses from extension officers in Table 51 against those of the smallholder farmers in Table 50, reveal similarities in terms of the majority of responses to each of the five statements. It is observed that the first sub statement 13.1 I am closely involved with the day-to-day running of my farm with the extension officer, in the smallholder farmer questionnaire has the highest total negative responses (42.4%).

		Frequency	Percent
I am closely involved with the day-to-day running of farms	Strongly Disagree	1	2.4%
	Disagree	3	7.3%
	Uncertain	0	0.0%
	Agree	28	68.3%
	Strongly Agree	9	21.9%
I am on first name basis with farmers/employees	Strongly Disagree	2	5.1%
	Disagree	0	0.0%
	Uncertain	3	7.7%
	Agree	28	71.8%
	Strongly Agree	6	15.4%
I help remove unease in situations in which there are no clear guidelines	Strongly Disagree	1	2.6%
	Disagree	0	0.0%
	Uncertain	3	7.9%
	Agree	24	63.2%
	Strongly Agree	10	26.3%
Farming innovations lead by females are usually not adopted by farmers	Strongly Disagree	7	19.4%
	Disagree	12	33.3%
	Uncertain	4	11.1%
	Agree	11	30.6%
	Strongly Agree	2	5.6%
I encourage planning only on a seasonal basis	Strongly Disagree	7	20.6%
	Disagree	8	23.5%
	Uncertain	0	0.0%
	Agree	11	32.4%
	Strongly Agree	8	23.5%

Table 51: Summary showing the role of culture

5.8 Perceived Usefulness

Based on question 16 from the smallholder farmer survey, the results of the question 16, 'How useful do you find ICTs are in relation to your work?' are presented in Table 52 and reveal that 71.3% of the farmers collectively find ICTs to be quite useful and extremely useful in relation to their work (farming activities). Grunfeld and Houghton (2013) recognise the usefulness of ICTs in smallholder farming and go further to assert that the usefulness of ICTs to smallholder farmers is dependent on others factors such as a farmers capacity to act on the information gathered using ICTs.

The results in Table 53 show that 89.5% of extension officers find ICTs to be useful in relation to their extension activities. A comparison with the results from the smallholder farmers (Table 52) and the extension officers (Table 53) makes it evident that ICTs are perceived to be useful by both smallholder farmers and extension officers. Anoop et al. (2015) explicates that the extension officers interactions with smallholder farmers has a positive role on ICT adoption by farmers. In the case of this study, the positive opinion of the extension officers (89.5%) towards the usefulness of ICTs is extremely encouraging towards adoption of ICT based innovations.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Extremely useless	12	2.3	2.3	2.3
	Quite useless	26	4.9	4.9	7.2
	Neither	110	20.6	20.8	28.0
	Quite useful	250	46.9	47.3	75.4
	Extremely useful	130	24.4	24.6	100.0
	Total	528	99.1	100.0	
Missing	System	5	.9		
Total		533	100.0		

Table 52: Usefulness of ICTs in relation to the work – Smallholder Farmers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Extremely useless	1	.2	2.6	2.6
	Quite useless	1	.2	2.6	5.3
	Neither	2	.4	5.3	10.5
	Quite useful	26	4.9	68.4	78.9

	Extremely useful	8	1.5	21.1	100.0
	Total	38	7.1	100.0	

Table 53: Usefulness of ICTs in relation to the work – Extension Officer

5.9 Perceived Ease of Use

The results of the study revealed that the media most preferred by smallholder farmers and extension officers are cell phones, telephones and radio with the mobile phone being the most popular choice of ICT for both groups. During the fieldwork stage of this study, as the researcher collected data from the smallholder farmers it was revealed that these three preferred media were the (established ICTs) ICTs that the farmers were most familiar. It is with this knowledge and their experiences of these ICTs, that the farmers used to respond to section 5.7 and section 5.8. ICTs such as GIS technology, knowledge management systems and traceability systems (emerging ICTs) were more familiar to extension officers (Figure 64 and Figure 68).

In order to determined ease of use question 15, 'How easy do you find ICTs are to use in your work?' is used and the analysis reveals that 46.5% of smallholder farmers find using ICTs in their work quite easy and 15.3% of smallholder farmers find that using ICTs for their farming activities to be quite hard (Table 54). Extension officers (Table 55) in response to the question 14, 'How easy do you find ICTs are to use in your work?' found using ICTs in their work to be quite easy (64.9%) to use and 24.3% found them quite hard to use. Majority of smallholder farmers and extension officers found ICTs easy to use. Aleke et al. (2011) identifies low literacy rates as being a barrier to ICT adoption and suggest the use of indigenous languages to break these barriers and develop relevant content and interest to use ICTs. This could help improve the adoption by both groups especially smallholder farmers who are mostly not educated. The use of indigenous languages would make the use of ICTs easier especially for smallholder farmers who are very proficient in that language as opposed to English.

The fieldwork of this study revealed that the Department of Agriculture was piloting the implementation of a new ICT based innovation known as the digital pen. The digital pen is meant to provide benefits such as evidence of actual farm visits by extension officers via GPS coordinates of where an entry took place. It is also is meant to keep a more organized record of farm visits and eliminates the usage of paper records which are problematic to maintain. The analysis revealed that of the 53.8% of extension officers, the innovation has been rolled out to a majority (52.2%) of the extension officers and they find the innovation easy to use. A significant number of extension officers (49.4%) indicated that they did not appreciate its use. The newness of the innovation amongst the extension officers has revealed a need for the

benefits of the usage of the digital pen to be re-emphasized. This can be done through workshops where the technology can be demonstrated and the extension officers familiarized with the innovation.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Extremely hard	16	3.0	3.0	3.0
	Quite hard	81	15.2	15.3	18.3
	Neither	144	27.0	27.2	45.6
	Quite easy	246	46.2	46.5	92.1
	Extremely easy	42	7.9	7.9	100.0
	Total	529	99.2	100.0	
Missing	System	4	.8		
Total		533	100.0		

Table 54: Ease of ICT use on farm – Farmer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Extremely hard	2	.4	5.4	5.4
	Quite hard	9	1.7	24.3	29.7
	Quite easy	24	4.5	64.9	94.6
	Extremely easy	2	.4	5.4	100.0
	Total	37	7.0	100.0	

Table 55: Ease of ICT use on farm - Extension officer

5.10 An analysis of ICT Variables with Food Insecurity levels amongst Smallholder Farmer Households

A Spearman's correlation was carried out between the food insecurity levels of smallholder farmer households and several of the ICT variables related to the theoretical constructs in order to identify significant relationships. The results are summarized in Table 56 below.

Correlations			
			Food Insecurity
Spearman's rho	Innovation	Correlation Coefficient	.047
		Sig. (2-tailed)	.553
	To solve problems	Correlation Coefficient	.084
		Sig. (2-tailed)	.222
	Desire for new technology	Correlation Coefficient	.091
		Sig. (2-tailed)	.367

	Institutional pressure	Correlation Coefficient	.066
		Sig. (2-tailed)	.717
	Willingness to adopt new communication media to access information	Correlation Coefficient	-.337**
		Sig. (2-tailed)	.000
	Willingness to adopt new communication media to share information	Correlation Coefficient	-.369**
		Sig. (2-tailed)	.000
	ICTs are compatible with the business needs of the farm	Correlation Coefficient	-.201**
		Sig. (2-tailed)	.000
	ICTs are compatible with the information needs of farming	Correlation Coefficient	-.283**
		Sig. (2-tailed)	.000
	ICTs are compatible with the cultural norms of farming	Correlation Coefficient	-.310**
		Sig. (2-tailed)	.000
	ICTs are compatible with the existing infrastructure at the farms	Correlation Coefficient	-.266**
		Sig. (2-tailed)	.000
	Trialability of ICTs	Correlation Coefficient	-.034
		Sig. (2-tailed)	.440
	Observability of ICTs	Correlation Coefficient	-.361**
		Sig. (2-tailed)	.000
	Extent of GIS use	Correlation Coefficient	.015
		Sig. (2-tailed)	.734
	Extent of use of early warning systems	Correlation Coefficient	-.215**
		Sig. (2-tailed)	.000

Table 56: Summary showing spearman correlations between Food Insecurity and ICT variables

The study (Table 56) revealed that a number of variables are significantly correlated with food insecurity. These variables are as follows:

- Willingness to adopt new communication media to access information
- Willingness to adopt new communication media to access information
- ICTs are compatible with the business needs of the farm
- ICTs are compatible with the information needs of farming
- ICTs are compatible with the cultural norms of farming
- ICTs are compatible with the existing infrastructure at the farms
- Observability of ICTs, and
- Extent of use of early warning systems

All of the above relationships are significant at the 5% level and they are inverse relationships meaning that as food insecurity in the smallholder households reduces, the rest of the relationships increases and vice versa. A further analysis of the data (Table 57) reveals that there is a significant weak relationship between food insecurity variables from the HFIAS survey and use of desktop computer, laptop or tablet computer, smart phone, satellite data and fixed line internet. There is also a significant negative linear relationship between the food security variables and television, landlines and radios. This means that food insecurity decreases with increased usage of television, landlines and radios and vice versa.

Correlations

			Use of Mobile phones (sms & voice calls)	Use of Desktop Computer	Use of Laptop or Tablet Computer	Use of Smart Phone (internet services)	Use of Satellite Data	Use of Fixed line internet	Television	Landline	Radio
Spearman 's rho	Did you worry that your household would not have enough food?	Correlation Coefficient	.081	.159**	.116**	.116**	.016	.128**	.042	.040	-.046
		Sig. (2-tailed)	.066	.000	.008	.008	.726	.004	.346	.379	.297
	Were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	Correlation Coefficient	.069	.146**	.149**	.183**	.072	.166**	.079	.054	-.032
		Sig. (2-tailed)	.119	.001	.001	.000	.106	.000	.073	.238	.475
	Did you or any household member have to eat a limited variety of foods due to a lack of resources?	Correlation Coefficient	.058	.097*	.106*	.129**	.061	.125**	.011	.003	-.129**
		Sig. (2-tailed)	.187	.027	.016	.003	.165	.005	.801	.945	.003
	Did you or any household member have to eat some foods that you really did not	Correlation Coefficient	.083	.162**	.140**	.139**	.076	.147**	.043	.028	-.110*
		Sig. (2-tailed)	.058	.000	.001	.001	.087	.001	.328	.536	.013

	want to eat because of a lack of resources to obtain other types of food?										
	Did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	Correlation Coefficient	.081	.139**	.134**	.178**	.037	.156**	.002	.061	-.136**
		Sig. (2-tailed)	.065	.002	.002	.000	.406	.000	.957	.186	.002
	Did you or any household member have to eat fewer meals in a day because there was not enough food?	Correlation Coefficient	.084	.166**	.123**	.164**	.015	.133**	.026	.100*	-.076
		Sig. (2-tailed)	.057	.000	.005	.000	.732	.003	.554	.028	.085
	Was there ever no food to eat of any kind in your household because of a lack of resources to get food?	Correlation Coefficient	.183**	.017	-.018	.264**	-.046	-.030	-.163**	-.132**	.028
		Sig. (2-tailed)	.000	.702	.679	.000	.301	.507	.000	.004	.529
	Did you or any household member go to sleep at night hungry because there was not enough food?	Correlation Coefficient	.140**	.012	-.021	.257**	-.023	.003	-.141**	-.082	-.003
		Sig. (2-tailed)	.001	.791	.627	.000	.611	.947	.001	.074	.942
	Did you or any household member go a whole day and night without eating anything because	Correlation Coefficient	.226**	-.031	.001	.157**	-.090*	-.090*	.063	.055	.126**
		Sig. (2-tailed)	.000	.478	.985	.000	.041	.044	.152	.229	.004

	there was not enough food?										

Table 57: Summary showing correlations between Food Insecurity variables and specific ICTs

5.11 An analysis of specific ICTs and their role in Food Security

5.11.1 Geographic Information Systems (GIS) and its role in Food Security

The study (Figure 63) reveals that over half of smallholder farmers do not use geographic information systems (GIS). The study also reveals that 26.5% of the smallholder farmers use this ICT innovation (GIS) to a large extent. These results suggest the existence of innovators amongst the sample of smallholder farmers although the innovation is still at a knowledge stage of the innovation decision process (Rogers, 2003). At the knowledge stage of the innovation decision process, some farmers have been exposed to the innovation for the first time but lack information about the ICT innovation. Figure 64 reveals that majority of extension officers use GIS technology only to a small extent (43.2%). Despite this finding a significant number of extension officers (29.7%) do use GIS technology in their extension activities.

Rogers (2010) suggests that an innovation goes through a critical mass. This is a threshold at which an innovation is able to become self-sustaining. At this point, a critical mass of an ICT innovation would include aspects such as widespread support through the availability of supporting infrastructure and sufficient users Based on the data analysed from this study, it can be suggested that this innovation of GIS has not yet reached its critical mass. This low uptake (Lwoga, Stilwell, & Ngulube, 2011) is despite the benefits GIS brings and perhaps the benefits of GIS should be more exemplified to the smallholder farmers and extension workers through educational workshops.

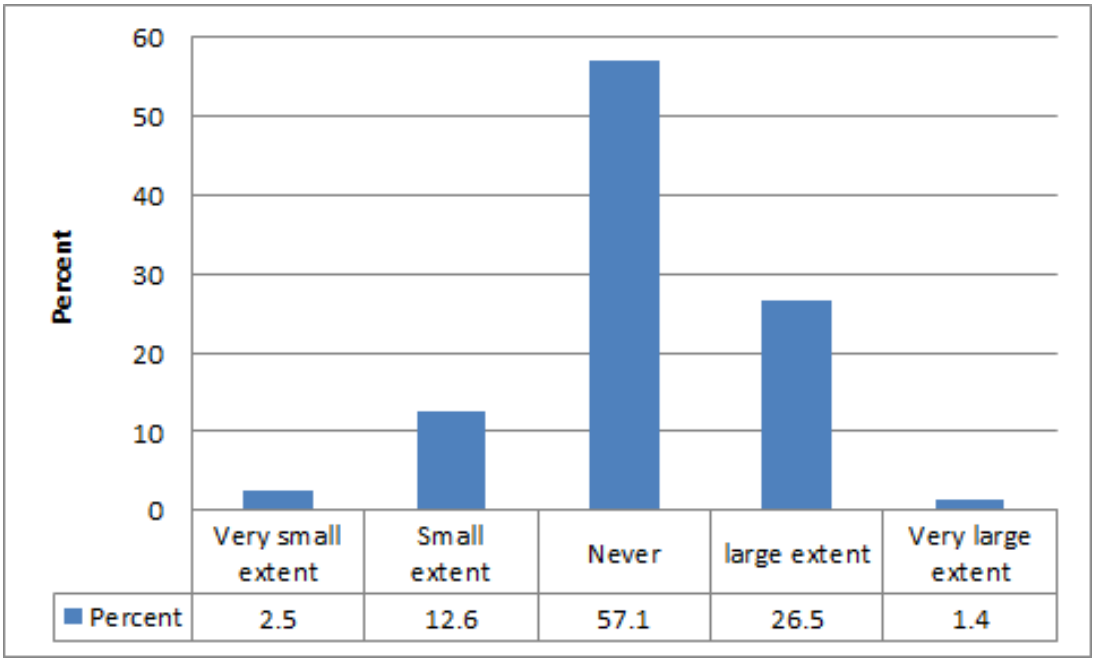


Figure 63: Extent of GIS use - Farmers

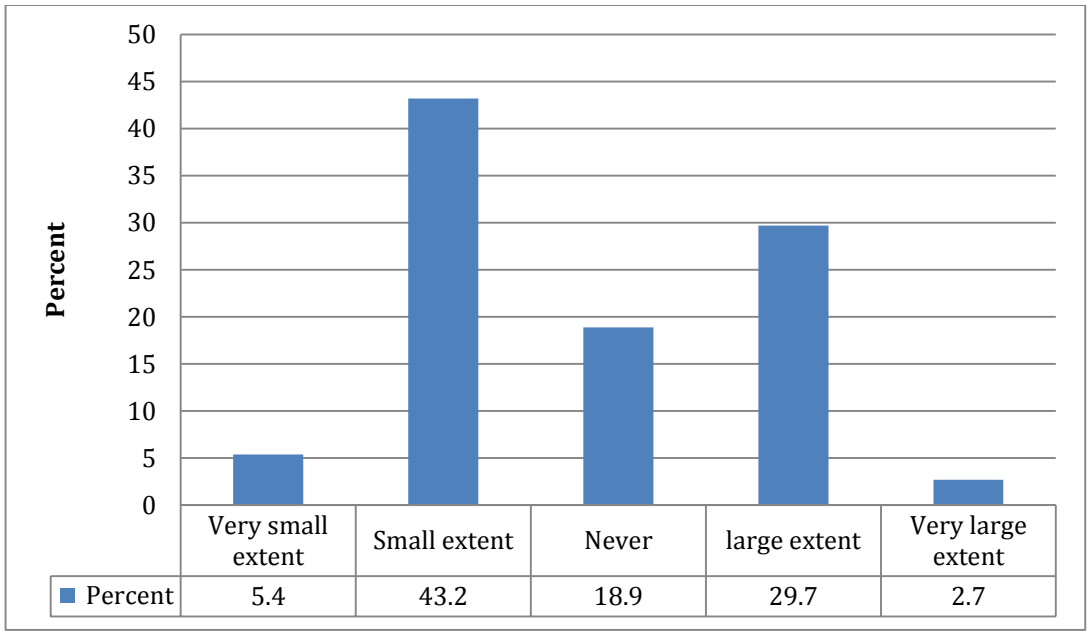


Figure 64: Extent of GIS use - Extension officers

Table 58 (see below) shows that the smallholder farmers who have adopted this innovation use GIS predominantly for detecting crop diseases especially in larger sized farms (34.7%) and determining suitable areas for growth of crops (34%). This ICT is also used for conducting suitability analysis of farmland (34%), assessing the health of crops using satellite imagery (32.3%) and plotting the farms in order to determine fertilizer and crop seed use (33.2%).

An analysis of data from extension officers reveals that they use GIS (Table 59) predominantly for determining suitable areas for growth of crops (40.9%) and conducting suitability analysis of farmland (47.7%). The data also reveals that they also use GIS for

mapping resources on farms (45.5%) and identifying needy areas in terms of food supply by mapping populations (36.4%).

Due to the differing responsibilities and roles of smallholder farmers and extension officers, differences in the use of GIS are expected. It is observed that there is a commonality in the use of GIS between the two groups. This commonality in use is in determining suitable areas for growth of crops and conducting suitability of farmland e.g. soil and rainfall. The extension officers who use GIS also state that they use this innovation in food security analysis activities (Identifying needy areas in terms of food supply by mapping populations).

	Frequency	Percent
Determining suitable areas for growth of crops	181	34%
Assessing the health of crops using satellite imagery	172	32.3%
Detecting crop diseases (especially large farms)	185	34.7%
Detecting vulnerable areas to natural disasters	169	31.7%
Conducting suitability analysis of farm land	181	34%
Plotting the farms in order to determine fertilizer and crop seed use	177	33.2%
Estimating crop yields	156	29.3%
Identifying needy areas in terms of food supply by mapping populations	153	28.7%
Identifying areas where consistent access to healthy food is limited	171	32.1%
Mapping resources on farms	166	31.1%
Determining easiest access routes to markets	142	26.6%

Table 58: GIS use - Farmers

	Frequency	Percent
Determining suitable areas for growth of crops	18	40.9%
	1	2.3%
Assessing the health of crops using satellite imagery	10	22.7%
Detecting crop diseases (especially large farms)	10	22.7%
Detecting vulnerable areas to natural disasters	14	31.8%
Conducting suitability analysis of farm land	21	47.7%
Plotting the farms in order to determine fertilizer and crop seed use	14	31.8%

Estimating crop yields	14	31.8%
Identifying needy areas in terms of food supply by mapping populations	16	36.4%
Identifying areas where consistent access to healthy food is limited	8	18.2%
Mapping resources on farms	20	45.5%
Determining easiest access routes to markets	12	27.3%

Table 59: GIS use - Extension officers

5.11.2 Testing for Significant Differences

Due to the non-parametric nature of the data, in order to test for significant differences between the demographic variables the researcher made use of the Mann Whitney U test and the Kruskal Wallis test.

MANN WHITNEY U TEST

H_0: there is no difference between males and females in their perceptions with respect to GIS

H_1: there is a difference between males and females in their perceptions with respect to GIS

	Mann-Whitney U	Z	Asymp. Sig. (2-tailed)
Extent of GIS use	30087.000	-1.055	.291
Determining suitable areas for growth of crops	4092.000	-2.341	.019
Assessing the health of crops using satellite imagery	3690.000	.000	1.000
Detecting crop diseases (especially large farms)	4272.000	.000	1.000
Detecting vulnerable areas to natural disasters	3560.000	.000	1.000
Conducting suitability analysis of farm land	4089.000	.000	1.000
Plotting the farms in order to determine fertilizer and crop seed use	3901.000	.000	1.000
Estimating crop yields	3040.000	.000	1.000
Identifying needy areas in terms of food supply by mapping populations	2905.000	.000	1.000

Identifying areas where consistent access to healthy food is limited	3652.000	.000	1.000
Mapping resources on farms	3432.000	.000	1.000
Determining easiest access routes to markets	2502.500	-1.521	.128

Table 60: Summary of significance (Mann Whitney U) between age group and GIS

KRUSKAL WALLIS TEST

H_0: there is no difference between age group in their perceptions with respect to GIS

H_1: there is a difference between age group in their perceptions with respect to GIS

Test Statistics[a,b]

	Chi-Square	df	Asymp. Sig.
Extent of GIS use	5.305	4	.257
Determining suitable areas for growth of crops	4.370	4	.358
Assessing the health of crops using satellite imagery	.000	4	1.000
Detecting crop diseases (especially large farms)	.000	4	1.000
Detecting vulnerable areas to natural disasters	.000	4	1.000
Conducting suitability analysis of farm land	.000	4	1.000
Plotting the farms in order to determine fertilizer and crop seed use	.000	4	1.000
Estimating crop yields	.000	4	1.000
Identifying needy areas in terms of food supply by mapping populations	.000	4	1.000
Identifying areas where consistent access to healthy food is limited	.000	4	1.000
Mapping resources on farms	.000	4	1.000
Determining easiest access routes to markets	4.891	4	.299
a. Kruskal Wallis Test			
b. Grouping Variable: Age Range			

Table 61: Summary of significance (Kruskal Wallis) between age group and GIS

At the 5% significance level the researcher rejected H_0 (questions whose p-values are less than 0.05- whose values are in red in Table 60 and Table 61) and the researcher concluded that for these questions only there is a difference in the age group in their perceptions with respect to GIS.

5.11.3 Knowledge Management Systems (KMS) and its role in Food Security

Successful knowledge management systems adoption takes cognizance of the fact that smallholder farmers should be recognized not only as recipients of information but also as

creators of that information (Dileepkumar, Holz-Clause, & Aruna Sai, 2011). It was found in the study (Table 62) that over half of the smallholder farmers (53.9%) use indigenous knowledge. The study also reveals that 66.8% of smallholder farmers also use knowledge that is shared with them by extension officers (institutional knowledge). In order to determined the role the different types of knowledge had on the choice of ICTs, it was found that both indigenous knowledge (73.9%) and knowledge that is shared with farmers by extension officers (81.5%) influenced the choice of ICTs they use. This finding can be useful in determining what information to transmit using what type of ICT innovation. A total of 82.3% of the smallholder farmers positively acknowledged their involvement in knowledge management practices.

An analysis of the data on extension officers with regard to knowledge management reveals that (Table 63) 60% of extension officers use indigenous knowledge in their extension activities. Based on the analysis it was found that a large majority of the extension officers (94.8%) use institutional knowledge to support their extension activities. The analysis further revealed that over half of the extension officers (57.5%) were of the view that indigenous knowledge does not influence their choice of ICTs for use to support their extension activities. Over half of the extension officers were of the view that institutional knowledge does have an influence in their choice of ICTs to support their farming activities. A total of 76.3% of extension officers stated that they were involved in knowledge management practices.

Based on the data from smallholder farmers and extension officers on geographic information systems, both groups use indigenous knowledge and institutional knowledge in knowledge management systems to a large extent and very large extent. Unlike smallholder farmers, the majority of extension officers felt that indigenous knowledge does not influence the choice of ICT to use. Both groups indicate a positive involvement in knowledge management practices.

		Frequency	Percent
Extent of indigenous knowledge use	Very small extent	40	7.6%
	Small extent	72	13.8%
	Never	34	6.5%
	Large extent	282	53.9%
	Very large extent	95	18.2%
Extent of institutional knowledge use	Very small extent	7	1.3%
	Small extent	40	7.6%
	Never	29	5.5%
	Large extent	350	66.8%
	Very large extent	98	18.7%
Extent indigenous	Very small extent	18	3.4%

knowledge influencing choice to use ICTs	Small extent	62	11.9%
	Never	56	10.7%
	Large extent	285	54.6%
	Very large extent	101	19.3%
Extent institutional knowledge influencing choice to use ICTs	Very small extent	11	2.1%
	Small extent	44	8.4%
	Never	42	8.0%
	Large extent	310	59.2%
	Very large extent	117	22.3%
Extent of involvement in knowledge management practices	Very small extent	14	2.7%
	Small extent	28	5.3%
	Never	51	9.7%
	Large extent	273	52.0%
	Very large extent	159	30.3%

Table 62: Summary on Knowledge Management Systems – Farmers

		Frequency	Percent %
Extent of indigenous knowledge use	Very small extent	2	5.0%
	Small extent	14	35.0%
	Large extent	19	47.5%
	Very large extent	5	12.5%
Extent of institutional knowledge use	Very small extent	0	0.0%
	Small extent	2	5.1%
	Never	0	0.0%
	Large extent	30	76.9%
	Very large extent	7	17.9%
Extent indigenous knowledge influencing choice to use ICTs	Very small extent	0	0.0%
	Small extent	23	57.5%
	Never	4	10.0%
	Large extent	12	30.0%
	Very large extent	1	2.5%
Extent institutional knowledge influencing choice to use ICTs	Very small extent	0	0.0%
	Small extent	6	15.8%
	Never	2	5.3%
	Large extent	27	71.1%
	Very large extent	3	7.9%

Extent of involvement in knowledge management practices	Very small extent	3	7.9%
	Small extent	4	10.5%
	Never	2	5.3%
	Large extent	22	57.9%
	Very large extent	7	18.4%

Table 63: Summary on Knowledge Management Systems - Extension officers

5.11.4 Testing for Significant Differences

Due to the non-parametric nature of the data, in order to test for significant differences between the demographic variables the researcher made use of the Mann Whitney U test and the Kruskal Wallis test.

MANN WHITNEY U TEST

H_0: there is no difference between males and females in their perceptions with respect to KMS

H_1: there is a difference between males and females in their perceptions with respect to KMS

	Mann-Whitney U	Z	Asymp. Sig. (2-tailed)
Extent of indigenous knowledge use	27983.000	-2.738	.006
Extent of institutional knowledge use	27520.000	-3.351	.001
Extent indigenous knowledge influencing choice to use ICTs	27462.500	-2.875	.004
Extent institutional knowledge influencing choice to use ICTs	26640.000	-3.755	.000
Extent of involvement in knowledge management practices	29229.500	-2.007	.045
Use of ICTs in Knowledge Management Practices	22898.000	-2.487	.013
Websites	697.000	.000	1.000
Spread sheets	135.000	.000	1.000
Databases	1032.000	.000	1.000
Notebooks	9024.000	-.949	.342
Traditional stories	11193.000	-.820	.412
Do not use any	1464.500	.000	1.000
Crop cultivation	14994.000	.000	1.000
Fertilizer application	10948.000	.000	1.000
Pest management	11254.500	.000	1.000

Harvesting	7755.000	.000	1.000
Post-harvest handling	5117.500	.000	1.000
Transporting of food/products	1456.000	.000	1.000
Packaging	1820.000	.000	1.000
Food preservation	3450.500	.000	1.000
Food processing	864.000	-1.139	.255
Food quality management	1404.500	.000	1.000
Food safety	1858.500	.000	1.000
Food storage	3905.000	-1.236	.216
Food marketing	1750.000	-.839	.401
Do not use in any area	747.500	-.590	.555
Use farm produce traceability systems	24896.500	-3.695	.000
RFID tags	21.500	-.834	.404
Smart packaging	2664.000	.000	1.000
Branding	943.000	.000	1.000
Do not use any	11278.500	-1.183	.237

Table 64: Summary of significance (Mann Whitney U) between age group and KMS

KRUSKAL WALLIS TEST

H_0: there is no difference between age group in their perceptions with respect to KMS

H_1: there is a difference between age group in their perceptions with respect to KMS

Test Statistics[a,b]

	Chi-Square	df	Asymp. Sig.
Extent of indigenous knowledge use	3.694	4	.449
Extent of institutional knowledge use	2.145	4	.709
Extent indigenous knowledge influencing choice to use ICTs	1.720	4	.787
Extent institutional knowledge influencing choice to use ICTs	2.913	4	.572
Extent of involvement in knowledge management practices	4.372	4	.358
Use of ICTs in Knowledge Management Practices	17.639	4	.001
Websites	.000	4	1.000
Spread sheets	.000	4	1.000
Databases	.000	4	1.000
Notebooks	5.585	4	.232
Traditional stories	2.290	4	.683
Do not use any	.000	4	1.000
Crop cultivation	.000	4	1.000
Fertilizer application	.000	4	1.000

Pest management	.000	4	1.000
Harvesting	.000	4	1.000
Post-harvest handling	.000	4	1.000
Transporting of food/products	.000	4	1.000
Packaging	.000	4	1.000
Food preservation	.000	4	1.000
Food processing	2.400	4	.663
Food quality management	.000	4	1.000
Food safety	.000	4	1.000
Food storage	9.111	4	.058
Food marketing	2.361	4	.670
Do not use in any area	6.417	4	.170
Use farm produce traceability systems	.979	4	.913
RFID tags	3.018	3	.389
Smart packaging	.000	4	1.000
Branding	.000	4	1.000
Do not use any	3.935	4	.415
a. Kruskal Wallis Test			
b. Grouping Variable: Age Range			

Table 65: Summary of significance (Kruskal Wallis) between age group and KMS

At the 5% significance level the researcher rejected H_0 (questions whose p-values are less than 0.05 whose values are in red in Table 64 and Table 65). The researcher then concluded that for these questions only there is a difference in the age group in their perceptions of ICTs with respect to KMS.

5.11.5 Use of ICTs in Knowledge Management Practices

The study reveals that when question 29, 'Do you use ICTs in your knowledge management practices?' 74.8% stated that they do use ICTs. Similarly when this question was put to the extension officers 88.6% responded that they do use ICTs in their knowledge management practices. Adams and Lamont (2003) postulate that the technological aspect of knowledge management systems is necessary in order to attain and sustain competitive advantage. It therefore, can be assumed that smallholder farmers who make use of ICTs have a competitive advantage over their non-use of ICT counterparts in knowledge management systems and practices. Based on this one can conclude that adopting ICTs in knowledge management systems and practices play a positive role in food security. Mohrman, Finegold, and Klein (2002) cautions against an excessive focus on the technology and overlooking the people themselves who use the technology. Gloet and Terziovski (2004) also put across a similar point of view by stating that in order to reap the full benefits of ICTs in knowledge management systems and practices, there is a need to focus on both the technology and the human resource.

5.11.6 Factors in adoption of ICTs in the application of Knowledge Management Practices

In order to identify factors that influence ICT adoption in the application of Knowledge Management practices the researcher fit a generalized linear model in the form of a logistic regression to a binary response variable and several categorical variables that are the explanatory variables in this study. The binary response variable used was question 32 from the farmer's questionnaire 'Do you use ICTs in your knowledge management practices?' The explanatory variables used were age, formal education, experience in farming activities and gender.

Logistic regression is a special case of the GLM where the response variable is binary or dichotomous. The researcher modelled the level of happiness of the respondents, i.e. whether they are currently using ICTs in knowledge management practices or not, by having a dichotomous or 2-level factor against all of the demographic variables.

Allison (2005) states that the logit model is popular because the coefficients have a simple interpretation in terms of the odds ratios, the logit model has desirable sampling properties and the model can be easily generalized to allow for multiple, unordered categories for the dependent variable. The the logit transformation of the probability, p, is made use of by the logistic regression during an event and in this case is the adoption of ICTs in knowledge management practices:

$$\text{logit}(p) = \ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k .$$

In the above equation, the βs are regression coefficients, and *X*s are a set of predictors along with the intercept term, β_0. The βs are typically estimated by the maximum likelihood (ML) method, which is preferred over the weighted least squares approach. Statistically, the Hosmer-Lemeshow test is accepted as being a test for the goodness of fit between the model and the data. The interpretation of this test is such that if the p-value in the test is non-significant at the 5% level then this indicates a good fit of the model to the data, or if the p-value is significant, then the model does not fit the data well.

Thus when the logistic model is applied to the data, the equation is as follows:

$\text{logit}(p)=\beta_0+ \beta_1$*Age+ β_2*formal education + β_3*experience in farming+ β_4*Gender

The forward logistic regression is applied which eliminates all non-significant variables and retains the most parsimonious yet best model. The model was fitted using SPSS version 21 and the results are summarized as follows:

	Coefficient B	Sig.	Odds Ratio	95% C.I.for EXP(B)	
				Lower	Upper
Reference=Female					
Male	.705	.005*	2.025	1.237	3.314
Age (Reference=>60 yrs)		.000*			
20-29 yrs	-1.368	.008*	.255	.093	.700
30-39 yrs	-1.915	.000*	.147	.058	.373
40-49 yrs	-.988	.003*	.372	.194	.715
50-59 yrs	-.685	.029*	.504	.273	.931
Constant	-.770	.005*	.463		

Table 66: Summary of logistic regression analysis on knowledge management systems

The analysis (Table 66) revealed that the older farmers are more likely to use ICTs in knowledge practices than the younger farmers and that only gender and age have a role on ICT use in knowledge management practices. The Hosmer and Lemeshow statistic was 0.537 with a non-significant p-value of 0.999 indicating that the model fitted the data well. It was found that males are 2.025 times more likely than females to use ICTs in knowledge management practices. The overall effect of age was significant in the model. It was found that the 20-29 years group was 0.255 times less likely than the >60 years group to use ICTs in knowledge management practices, the 30-39 years were 0.147 times less likely than the >60 years group to use ICTs in knowledge management practices, the 40-49 years group were 0.372 times less likely than the >60 years group to use ICTs in knowledge management practices and the 50-59 years group were 0.504 times less likely than the >60 years group to use ICTs in knowledge management practices. These findings are consistent with those of Venkatesh et al. (2003, p. 469) whose findings suggested that age and gender are key moderating influences which is also consistent with sociology and social psychology literature (Levy, 1988). Although literature largely points out that older people find the use of technology more challenging than younger ones (Czaja et al., 2006), the study findings show an opposite scenario where older people seem to use technology more (Table 66). This could be due to older smallholder farmers who form a greater part of the study population being more familiar with the farming processes and can more easily see the technology fit in the processes. Morris and Venkatesh (2000, p. 392) state that "older workers are more motivated by social and process factors" also due to them being more well established in the smallholder farming sector they have better financial capacity to acquire these technologies than younger farmers. Mponela, Jumbe, and Mwase (2011) in their study found age to be a determinant for adoption showing that the older the farmer, the more experienced they were and the greater the likelihood of adopting an innovation. The findings of this study create an opportunity for further investigation of the role of age on technology adoption.

5.11.7 Knowledge Management System (KMS) Preference

The study reveals (Figure 65) that smallholder farmers predominantly do not use any ICT based Knowledge Management Systems with 57.2% using traditional stories and 50.5% using notebooks to manage their knowledge; in this study the use of the word notebook referred to diaries. A significant number of smallholder farmers do not use any system (25.0%) to manage their knowledge. With the benefits of using ICTs in Knowledge Management practices which have been articulated by a number of authors (Adams & Lamont, 2003; Alavi & Leidner, 2001; Dalkir, 2013; Davenport, 2013) it is evident that smallholder farmers are not taking advantage of these technological tools which have a potential to reduce food insecurity. Extension officers on the other hand (Figure 66) predominantly use websites (65.9%) to manage their knowledge. The significant use of websites in knowledge creation in knowledge management practices is encouraging although the use of notebooks (40.9%) still is an indicator that the extension officers are not fully utilizing ICTs to an extent that can convince smallholder farmers to join in the practice.

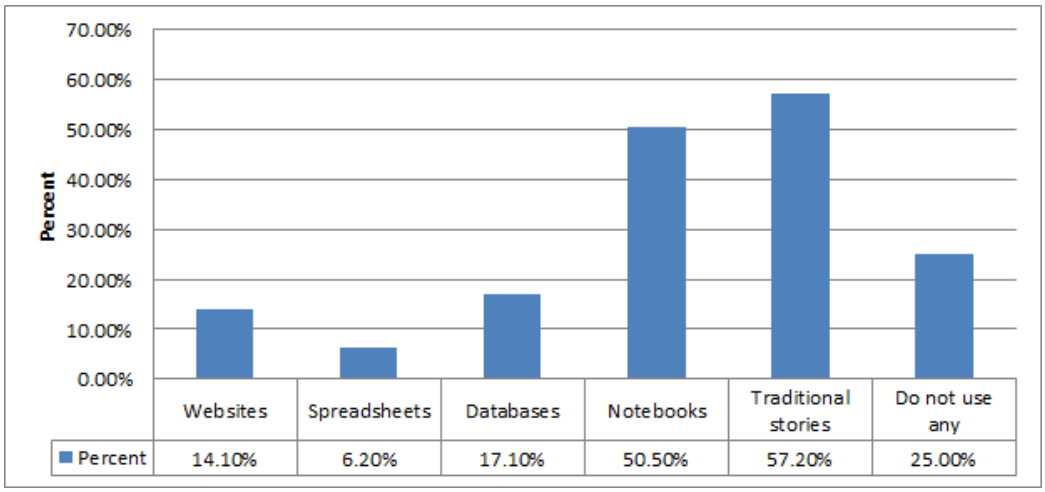


Figure 65: Preference of KMS - Farmers

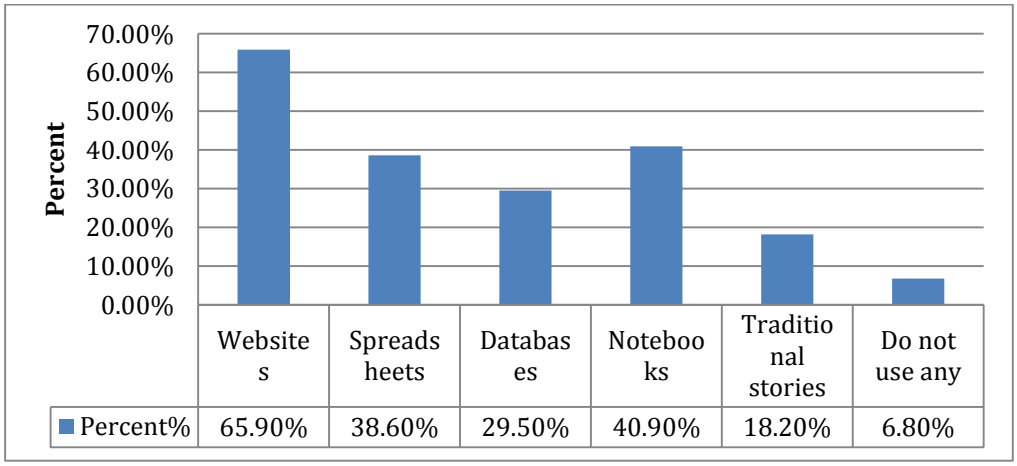


Figure 66: Preference of KMS - Extension officers

5.11.8 Areas in which Knowledge Management System (KMS) are used

The study (Table 67) reveals that the smallholder farmers use KMS predominantly (over 50% of the sample of farmers) in crop cultivation (65.9%), pest management (57.4%) and fertilizer application (56.8%). Knowledge management systems are used to the least extent (lowest 3 areas) in transporting of food/products (20.3%), food quality management (19.9%) and food processing (15.8%). A significant number of smallholder farmers indicated that they do not use any KMS (16.5%) in their farming activities. The results show that the smallholder farmers' focus is mainly in the production processes rather than the top end of the value chain of outbound logistics (transportation of goods to markets and quality issues). The data validates the very nature of smallholder farmers to be farmers with limited financial capacity and hence their contribution to food security is from the aspect of food availability rather than food safety that focuses on quality. The use of ICTs in knowledge management practices can contribute to the improvement of quality by supporting the various knowledge management processes including the collection of effective farming practices and in the dissemination of information to smallholder farmers that can assist in producing a high quality yield (Dalkir, 2013) .

Over half of the extension officers (Table 68) indicate that they encouraged smallholder farmers to use KMS in crop cultivation (84.1%), fertilizer application (72.7%) and pest management (72.7%). The extension officers encouraged KMS use to the least extent (lowest 3 areas) in food preservation (45.5%), post-harvest handling (43.2%), and food marketing (43.2%). A significantly lower number of extension officers do not use any KMS (6.8%) in their farming activities compared to smallholder farmers.

	Frequency	Percent
Crop cultivation	351	65.9%
Fertilizer application	303	56.8%
Pest management	306	57.4%
Harvesting	259	48.6%
Post-harvest handling	204	38.3%
Transporting of food/products	108	20.3%
Packaging	121	22.7%
Food preservation	170	31.9%
Food processing	84	15.8%
Food quality management	106	19.9%
Food safety	122	22.9%
Food storage	181	34.0%
Food marketing	120	22.5%

Do not use in any area	88	16.5%

Table 67: Area of KMS application - Farmers

	Frequency	Percent %
Crop cultivation	37	84.1%
Fertilizer application	32	72.7%
Pest management	32	72.7%
Harvesting	25	56.8%
Post-harvest handling	19	43.2%
Transporting of food/products	21	47.7%
Packaging	24	54.5%
Food preservation	20	45.5%
Food processing	21	47.7%
Food quality management	21	47.7%
Food safety	22	50.0%
Food storage	22	50.0%
Food marketing	19	43.2%
Do not encourage in any	3	6.8%

Table 68: Area of KMS application - Extension officers

5.11.9 The Extent of Traceability Systems use

Smallholder farmers (45%) in the study (Figure 67) to a large extent agree that they use systems that will allow for the tracing of the movement of their farm products. A significant number of smallholder farmers (42.6%) indicate that they do not use traceability systems. Figure 68 shows responses of extension officers indicating the extent to which they encourage smallholder farmers to use systems that will allow for the tracing of the movements of their farm products. The extension officers stated that they encourage the use of traceability systems for farm products to a large extent (54.3%). It is noted that a total of 31.5% of extension officers indicated that they only encourage them to a small extent. This lack of encouragement to use traceability systems can be attributed to a lack of knowledge of traceability systems and poor capacity to acquire such innovations on the part of the smallholder farmers.

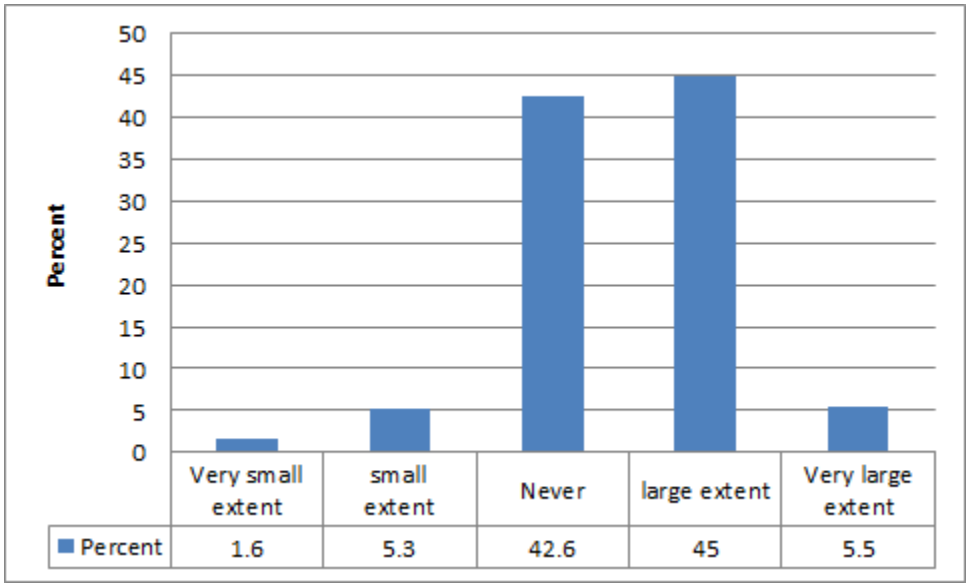


Figure 67: Extent of use of traceability systems - Farmers

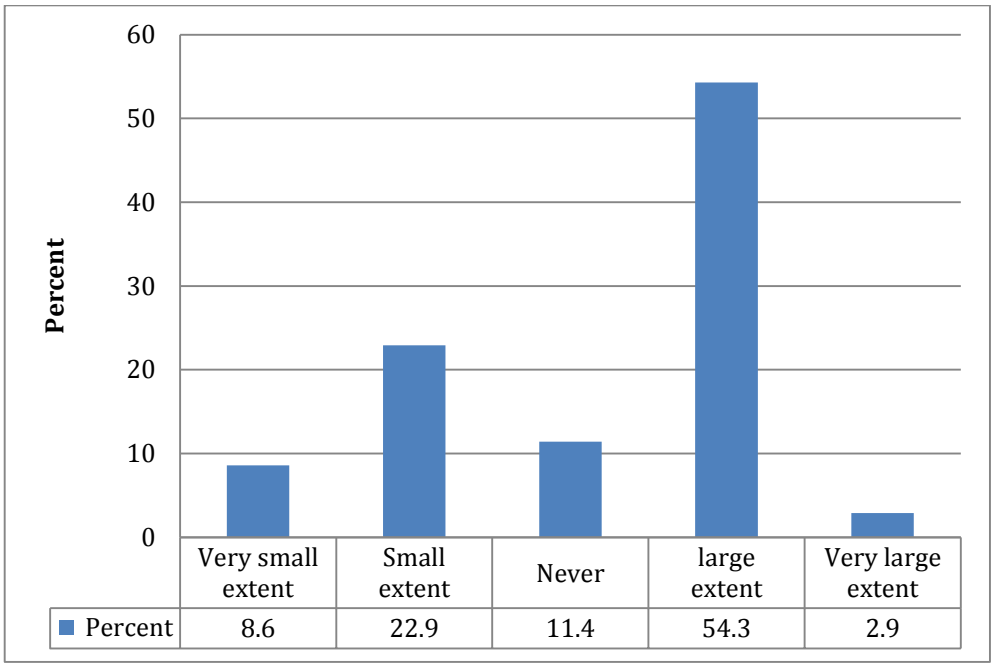


Figure 68: Extent of encouragement to use traceability systems - Extension officers

5.11.10Traceability Tools of Preference

The study revealed (Figure 69) that majority of smallholder farmers (60.4%) do not use any traceability tools or techniques. Just over a quarter of smallholder farmer's use smart packaging (27.40%) which was an interesting result in this study, as this technology is relatively new. Upon further interrogation of this particular response from smallholder farmers, it was revealed that this option had a translation error (was translated directed from English to Zulu) referring to smallholder farmers packing their produce in an organized manner rather than the smart packaging technology. Due to this translation error the option was invalidated and the researcher in the interpretation of the data ignored the option (Q36.2).

The use of branding which (16.3%) was the second highest option was then considered the highest response in terms of use of traceability tools. The low uptake of this technology is not surprising as these are new ICTs that might not have diffused to the smallholder farmer level yet.

This result revealed in Figure 69 showing that majority of smallholder farmers do not use any traceability tools is buttressed with those from Figure 67 showing the extent of use of traceability tools, were 42.6% of farmers do not use traceability tools. The results also indicate some degree of contradiction in responses to those in Figure 68 where the extension officers indicate that they encourage to a large extent (54.3%) the use of traceability systems. It is also important to remember that Figure 67 whose highest response is smallholder farmers use traceability systems to a large extent (45%) was identified to contain a translation error during the data analysis. This also compared with the results in Figure 69 that reveals that (60.40%) of smallholder farmers do not use any traceability tools.

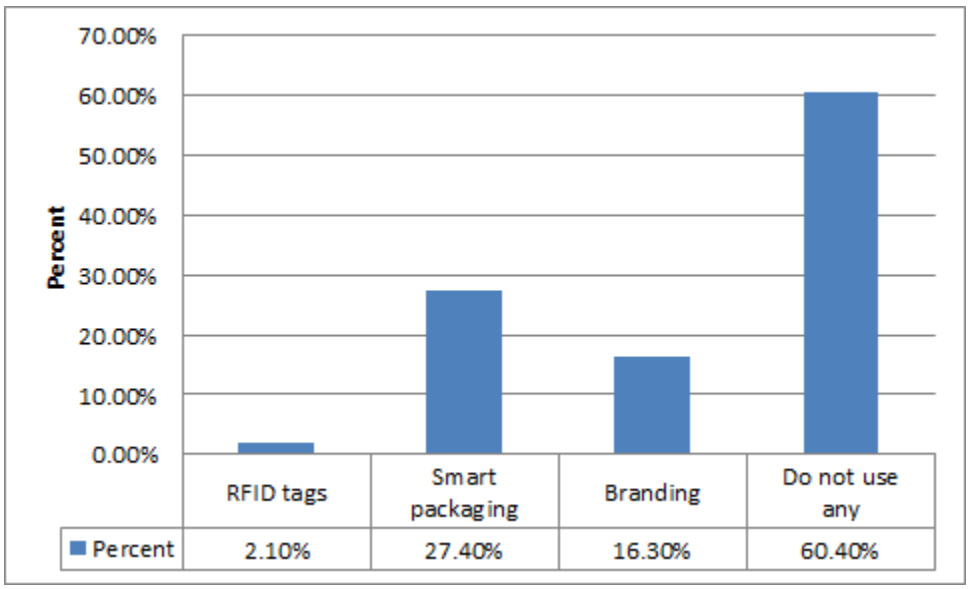


Figure 69: Traceability tools of preference – Farmers

5.11.11Extent of Early Warning Systems and their role in Food Security

The survey of smallholder farmers (Figure 70) revealed that early warning systems (EWS) are used to a large extent (47.2%). Notably so a significant number of farmers indicated that they use EWS and to a small extent (32.9%) in their farming activities. Furthermore, Figure 71 reveals that EWS are used to a small extent (32.4%). The results also revealed that a noticeable number of extension officers do not (29.7%) use EWS in their agricultural extension activities. Almost a quarter of the sample of extension officers (24.3%) acknowledged use of EWS ranging from a large extent to a very large extent. An analysis of the two data sets (farmers and extension officers) revealed contradictory information. Data

from smallholder farmers shows that 47.2% of farmers use EWS to a large extent while data from extension officers show that 32.4% use EMS to a small extent. A possible explanation of the higher adoption of EWS by smallholder farmers compared to extension officers can be due to other change agents being introduced into the social system (e.g. iLembe enterprise which provides extension services on projects it supports) and hence showing an independence from the low influence of these systems by the change agents from the Department of Agriculture. Therefore, it can be observed that innovation adoption might be higher with farmers than extension officers employed by the Department of Agriculture. Smallholder farmers by their nature practice rain fed agriculture and hence rely heavily on climate conditions. Climate change therefore places great stress on smallholder farming activities and has a negative role in food security. It is therefore, important that smallholder farmers are equipped with information in advance to allow them to increase disaster preparedness for climate changes (Cherotich, Saidu, & Bebe, 2012).

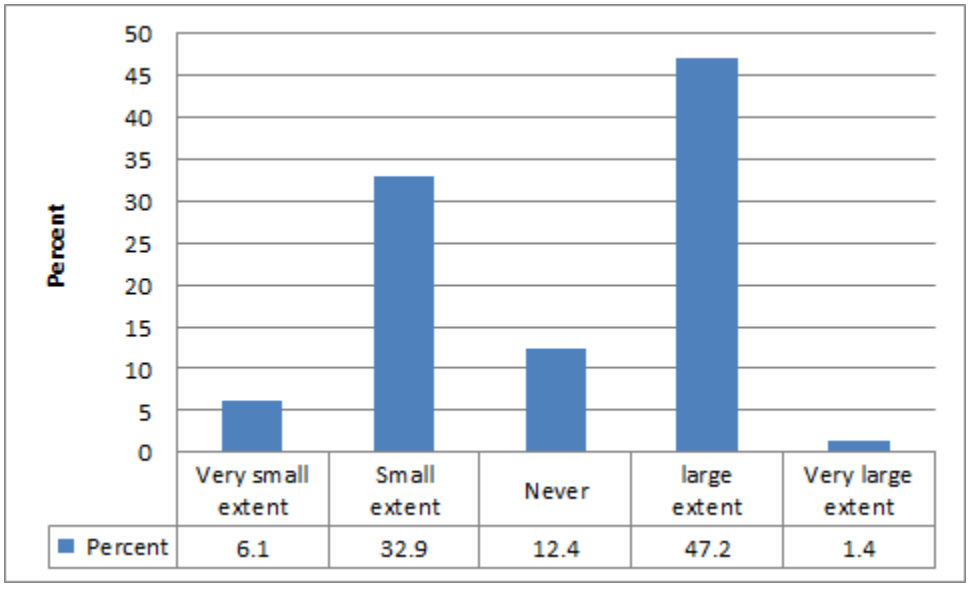


Figure 70: Extent of use of early warning systems in farming activities - Farmers

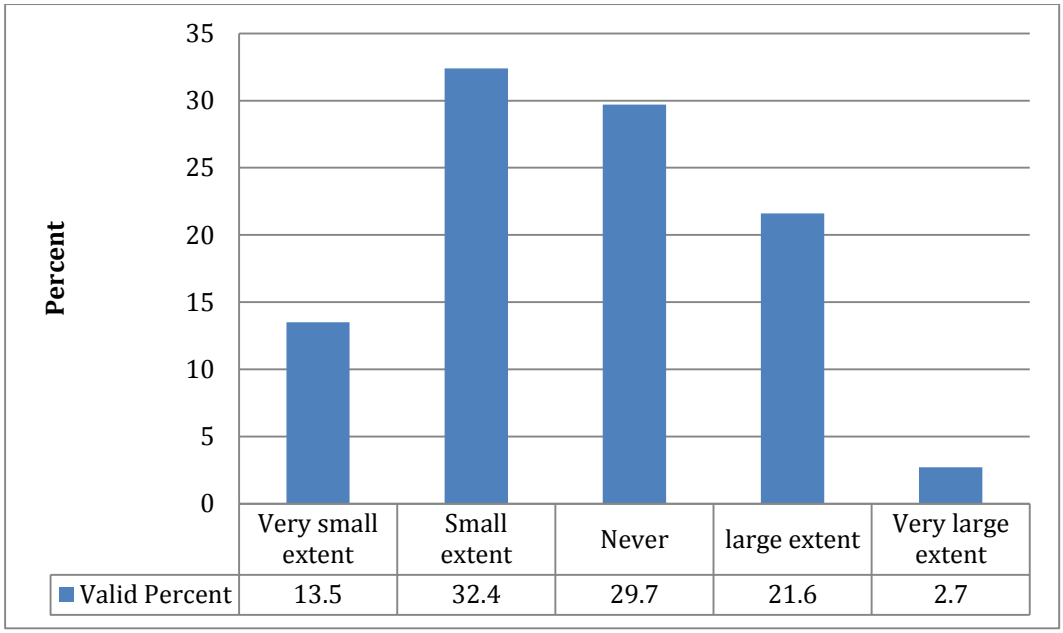


Figure 71: Extent of use of early warning systems in extension activities - Extension officers

5.11.12 Testing for Significant Differences

Due to the non-parametric nature of the data, in order to test for significant differences between the demographic variables the researcher makes use of the Mann Whitney U test and the Kruskal Wallis test.

MANN WHITNEY U TEST

H_0: there is no difference between males and females in their perceptions with respect to EWS

H_1: there is a difference between males and females in their perceptions with respect to EWS

	Mann-Whitney U	Z	Asymp. Sig. (2-tailed)
Extent of use of early warning systems	24572.000	-3.919	.000
Websites	11.500	-.825	.409
Phones	3712.500	-1.222	.222
Radio	17307.500	-.863	.388
Two way radios	5719.500	-.866	.386

Table 69: Summary of significance (Mann Whitney U) between age group and EMS

KRUSKAL WALLIS TEST

H_0: there is no difference between age group in their perceptions with respect to EWS

H_1: there is a difference between age group in their perceptions with respect to EWS

Test Statistics[a,b]

	Chi-Square	df	Asymp. Sig.
Extent of use of early warning systems	4.564	4	.335
Websites	3.452	3	.327
Phones	6.051	4	.195
Radio	2.040	4	.728
Two way radios	4.711	4	.318
a. Kruskal Wallis Test			
b. Grouping Variable: Age Range			

Table 70: Summary of significance (Kruskal Wallis) between age group and EWS

Using significance levels of 5%, the researcher rejected H_0 for questions which had a p-values of less than 0.05 – and are highlighted in red

Table 69 and Table 70 and the researcher concluded that for the extent of use of early warning systems there is a difference in the age group in smallholder farmer perceptions with respect to EWS.

5.11.13Ranking of Early Warning System

Figure 72 shows that EWS's that are predominantly used by smallholder farmers are radios (70.5%), two way radios (40.5%) and phones (32.6%). The smallholder farmer data shows high penetration of old ICTs such as the radio compared to newer ICTs like the mobile phone. The extension officer data on the other hand (

Figure 73) shows that the EWS that are predominantly used are phones (43.2%), radios (34.1%) and websites (31.8%). A point of note is that there is a difference in popularity of ICTs and this can be attributed to be due to the varying responsibilities and roles smallholder farmers and extension officers have. A comparison of results between smallholder farmers and extension officers reveal that popularity of ICTs is different between the two data sets of smallholder farmers who can be considered information recipients and extension officers who can be considered information providers.

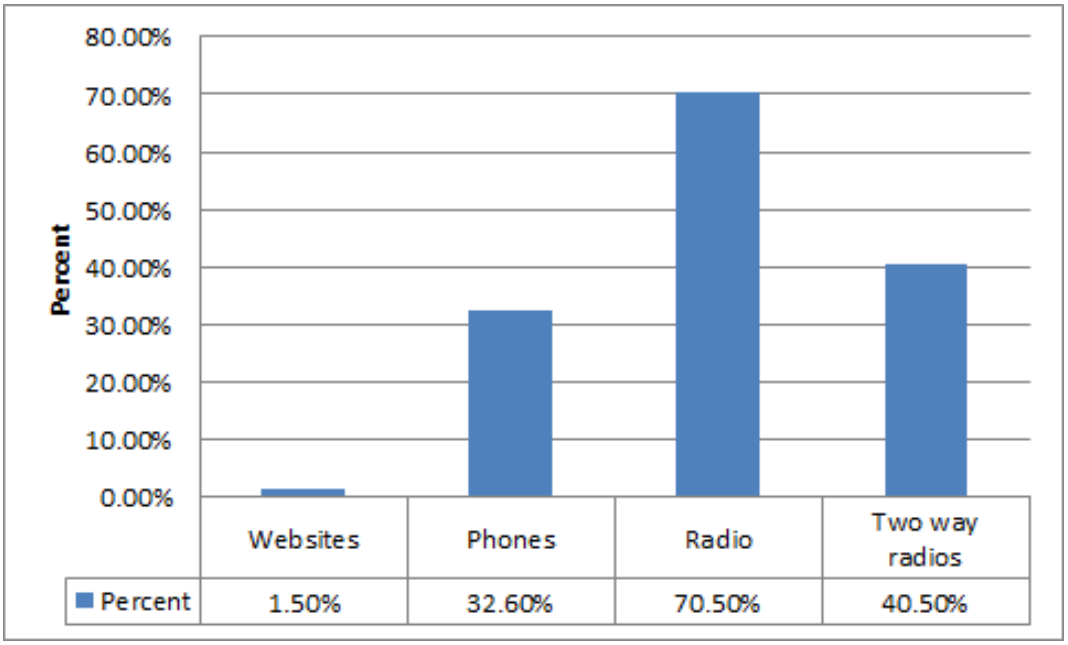


Figure 72: Ranking of Early Warning System – Farmers

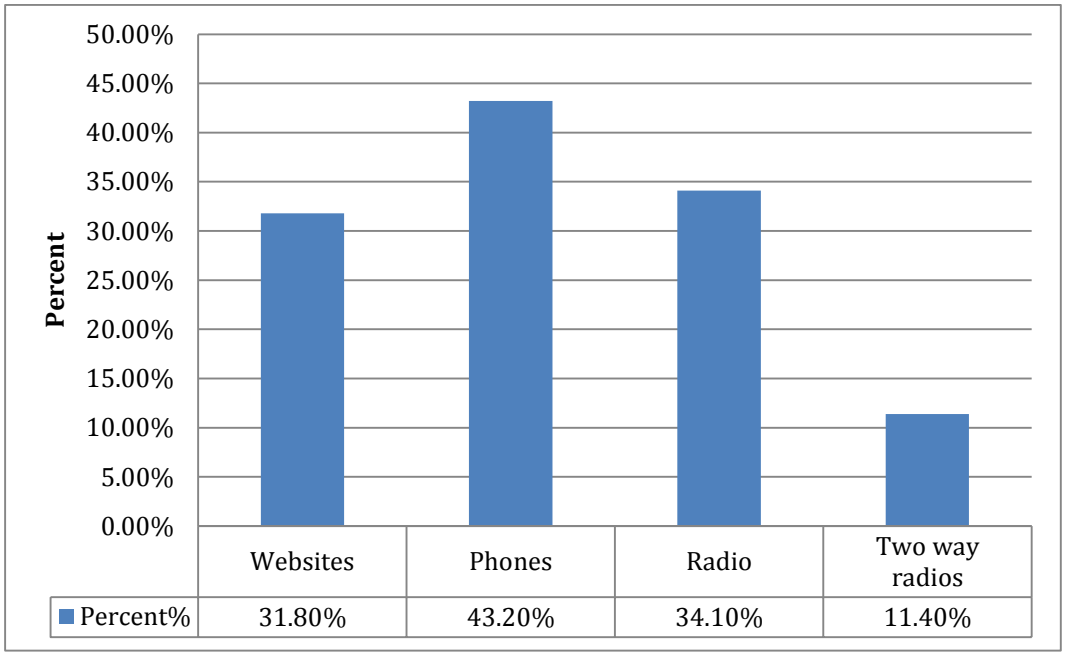


Figure 73: Ranking of Early Warning System - Extension officers

5.12 Validation of the proposed model

6 At the onset of the research the researcher developed a theoretical model that was the lens through which diffusion and adoption of ICTs was investigated. Structural Equation Modelling (SEM) was used in the validation of the proposed framework due to it being a confirmatory technique that allowed for the testing of hypothesized relationships between latent variables and between latent (adoption of ICTs in food security) and measured variables (Perceived attributes of innovation, Nature of the social system, Culture,

Perceived Usefulness and Perceived Ease of Use). This technique was deemed appropriate because it allowed for the use of multiple measured variables (constructs from the theoretical frameworks) to be used to better understand ICT adoption in food security (Schumacker & Lomax, 2004). Research question 5, 'Which of the constructs borrowed from the theoretical models of diffusion of innovation, technology acceptance model and Hofstede's model are direct determinants of the adoption of ICTs in food security in KwaZulu-Natal?' lent itself to the use of SEM. SEM also proved to be an appropriate analysis technique in that it allowed for the hypothesized model to be analysed to provide estimates of the degree to which the model fit the data (Schreiber, Nora, Stage, Barlow, & King, 2006). The theorized model was analysed in AMOS as:

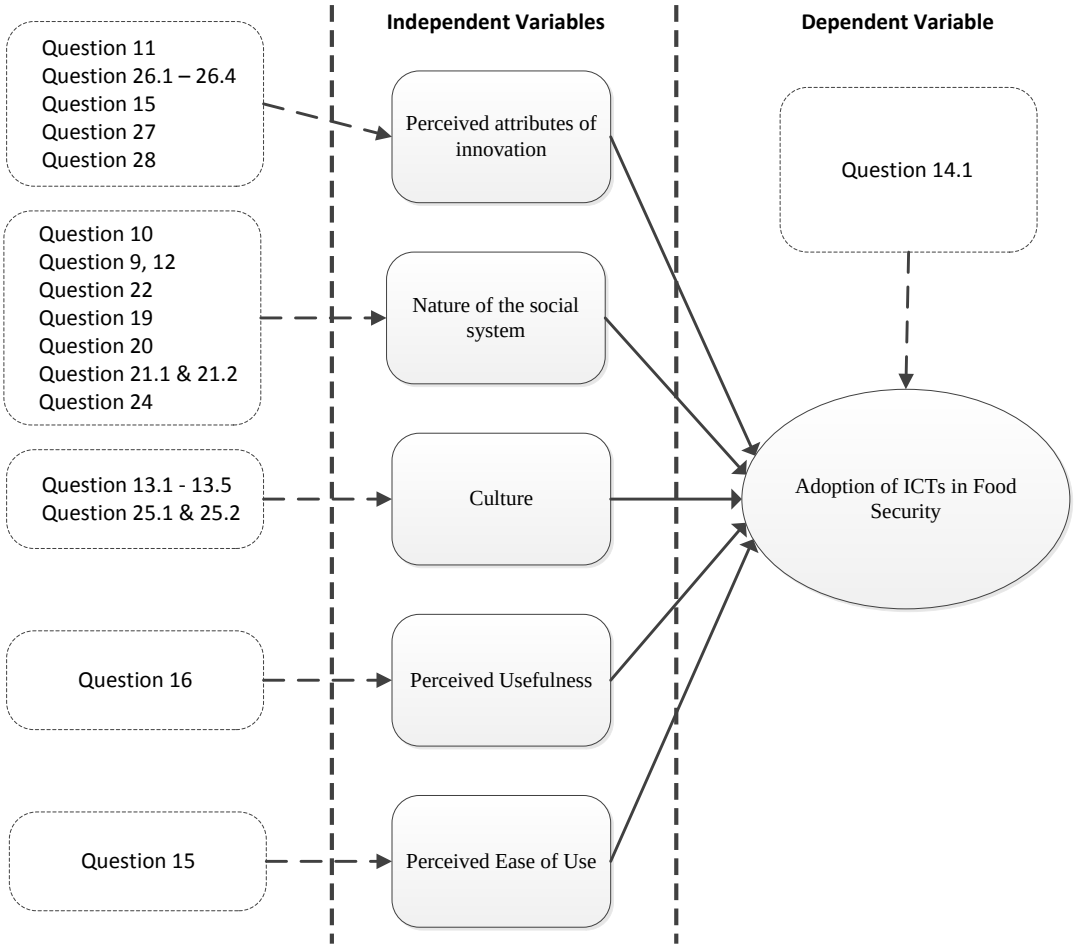


Figure 74: Theorized research model

The structural equation modelling analysis revealed that the theorized model did not fit the data well due to a significant chi-square test statistic i.e χ^2=524.695 and a p-value of -.000. Byrne (2013) states that structural equating modelling (SEM) uses a confirmatory approach and allows for a theorized model to be statistically tested for goodness of fit with the data. Some of the identified tests in this regard are the chi-square test, Relative Fit Index (RFI),

Root Mean Square Error of Approximation (RMSEA) and, Incremental Fit Index (IFI). These identified tests were taken into consideration with regards to the fit of the model to the data. SEM is a popular methodology for non-experimental research that does not have well developed methodologies of testing theories (Byrne, 2013).

In order to be able to judge the statistical significance of a theorized model a number of model fit criteria are applied. A Root Mean Square Error of Approximation (RMSEA) of 0.05 or less is considered acceptable with a p-value that is greater than 0.05. A Relative Fit Index (RFI) close to 0.95 represents a good model fit and a goodness of fit value of close to 0.95 also reflects a good fit. Model sample size is related to the Incremental Fit Index (IFI) and it also a reflection of the goodness of fit that has been stated earlier ought to be close to 0.95 to represent a good model fit (Byrne, 2013; Schumacker & Lomax, 2004).

The initial chi-square test statistic was 3.423 with 3 degrees of freedom and, a p-value = 0.133, which is non-significant at the 5% level, thus the structural equation modelling (SEM) revealed a poor fit to data of the theorized model. This prompted a revision of the model and it was found that the revised new model had a good fit with the data (Bollen, 2014; Byrne, 2013). Furthermore, the RFI was 0.971, the RMSEA was 0.008 with a p-value (PCLOSE) of 0.899 and, the IFI was reported as 0.959, this provided more confirmation of a good fit of the new revised model. Based on the results of the analysis the model was then revised as follows:

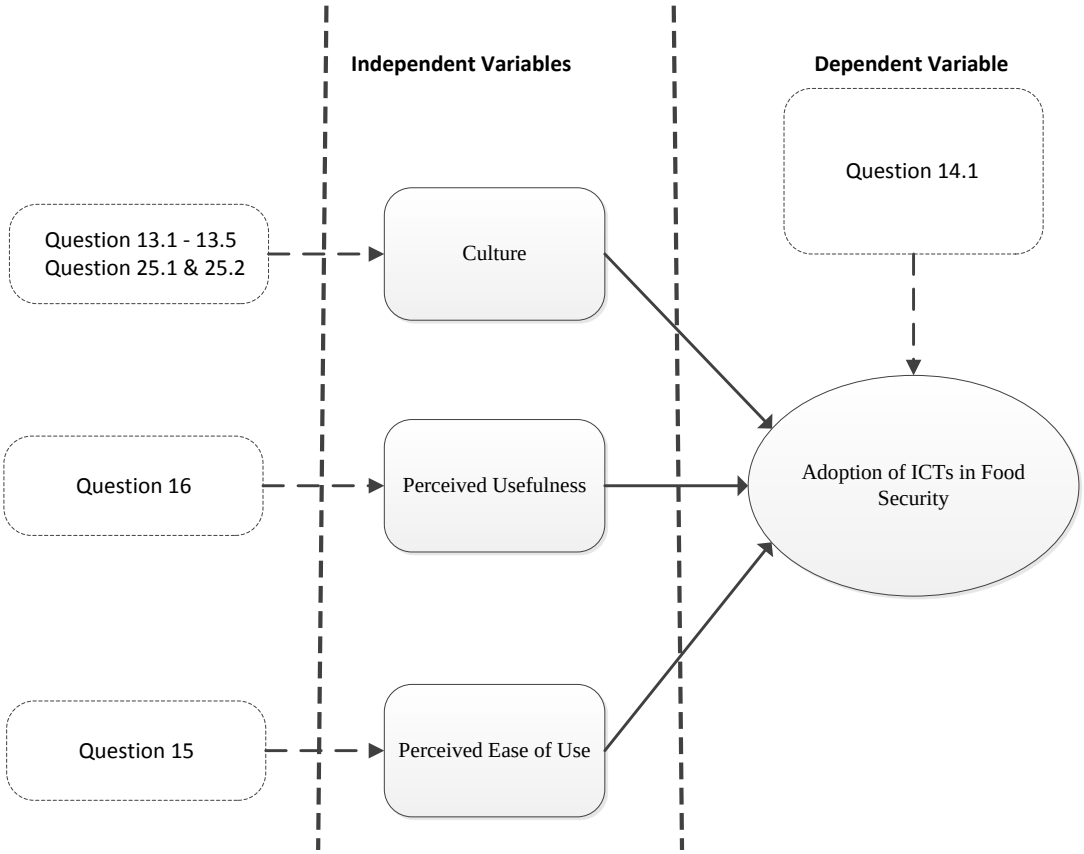


Figure 75: Revised Model for ICT Adoption in Food Security

A further analysis in AMOS (version 21) revealed the following results:

Regression Weights:

			Estimate	S.E.	C.R.	P
Role of ICT	<---	Culture	.318	.074	4.310	.000
Role of ICT	<---	Perceived usefulness	.131	.043	3.060	.002
Role of ICT	<---	Perceived ease of use	.516	.042	12.405	.000

The revised model with regression weights of the SEM model:

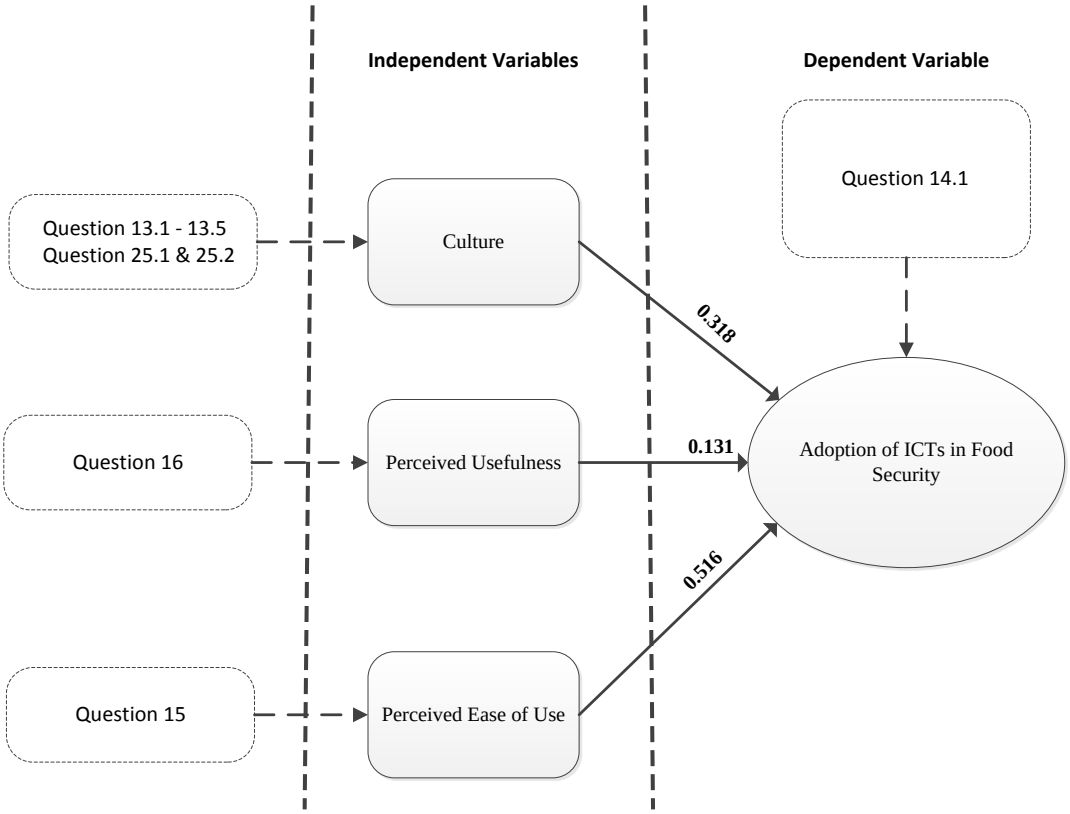


Figure 76: Revised Model for ICT Adoption in Food Security showing weights

The results reveal the following:

1. Perceived Ease of Use has the highest role on ICT adoption in food security
    - Teo and Noyes (2011) identify Perceived Ease of Use and Perceived Usefulness as being antecedents to a user's attitude regarding the use of technology. The results revealed that Perceived Ease of Use is a direct determinant to the role of ICTs in food security. Davis, Bagozzi, and Warshaw (1989) postulate that even though ease of use is a significant variable in the intention to use technology, this variable tends to reduce over time. Perceived ease of use not only has a direct effect on attitude but also can affect smallholder farmers attitudes indirectly through usefulness (Davis et al., 1989). It is therefore, important that as ICTs are introduced to smallholder farmers they should be developed with this factor in mind because when the farmers are using ICTs and they find them hard to use, this will develop a negative attitude in them with regards to the ICT innovation, but if smallholder farmers find it easy to use adoption becomes higher (Aubert, Schroeder, & Grimaudo, 2012).
2. Culture significantly has a significant role on ICT adoption in food security
    - Hofstede (1980a) postulates that technology plays a role in social systems in which they are implemented although they cannot explain its use in these

social systems and that there is a need to understand the cultural ideologies which exist. The results of this study shown in Table 50 and the SEM results that culture is also a direct determinant to the role of ICTs in food security and that there is a relationship between smallholder farmers and extension officers. Bagchi (2001) believes that culture has an influence on technology adoption and diffusion in a country and it is important to understand the culture that exists in a social system before an attempt to diffuse technology in that social system. The results (Table 50) reveal that there is low uncertainty avoidance in the smallholder farming community as extension officers remove unease in situations were no clear guidelines are available. This low uncertainty avoidance creates an environment that allows for the introduction of innovations and removes any perceptions of the innovations being a threat.

3. Perceived Usefulness has a significant role on ICT adoption in food security
    - Perceived Usefulness is a direct determinant to the role of ICTs in food security and is identified as a major determinant in predicting the acceptance of technology (Davis, 1993; Davis et al., 1989). According to Davis et al. (1989) Perceived Usefulness is impacted by Perceived Ease of Use and over time the influence of Perceived Usefulness increases amongst users while that of Perceived Ease of Use reduces. In terms of vendors it is important that vendors understand the social systems in which they would like to diffuse a technology and provide ICTs that align with the smallholders daily farming practices in order for the farmer to perceive the ICT to be useful.
4. Nature of the social system and Perceived attributes of innovation has no significant direct role on ICT adoption in food security

5.13 Conclusion

The role of ICTs in improving food security in KwaZulu-Natal is undoubtedly extremely important. However there is a sense that many of the smallholder farmers need to be coerced or persuaded through the correct means to adopt ICTs to keep them at the cutting edge of agriculture. This can be done through the Department of Agriculture having workshops, short training courses and constant interaction with the extension officers.

ICTs such as GIS, KMS and EWS are used to a reasonable extent by smallholder farmers but more can be done by way of educating these smallholder farmers in the usage, advantages and streamlining effects of these ICTs. The Department of

Agriculture must come to a place to maybe make ICT usage compulsory in order to get registration as smallholder farmers from the relevant accreditation bodies. The issue of computer literacy is thus an emerging trend in research if the smallholder farmers are computer literate, then their uptake of ICTs can greatly increase. Some possible recommendations also include the implementation of a mobile computer training school for smallholder farmers and a satellite LAN so that regular training sessions can take place in areas accessible to the farmers.

CHAPTER 6

CONCLUSIONS & RECOMMENDATIONS

Summarizing the research

"We must conduct research and then accept the results. If they don't stand up to experimentation, Buddha's own words must be rejected." The Dalai Lama

(Piburn, 1990, p. 31)

6.1 Introduction

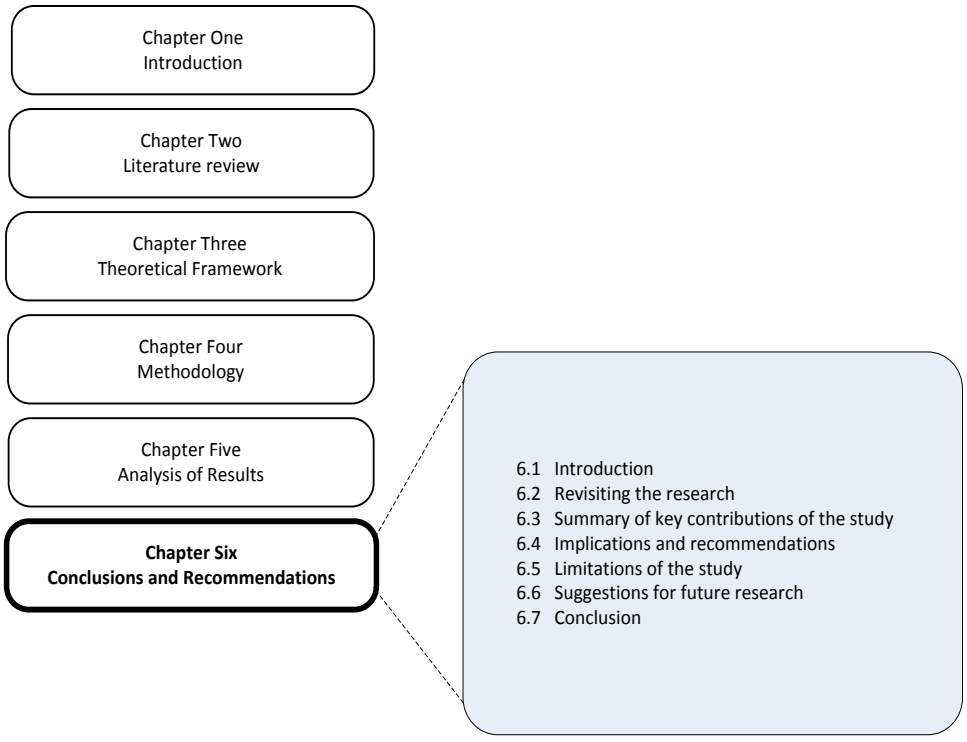


Figure 77: Chapter 6 within the overall research strategy - Phase 4 of the Study

This chapter highlights the key contributions of the study, the implications, recommendations, limitations and gaps. The study consisted of six chapters in total from the introduction of the study that discussed the study in general, the objectives and methods to be used. Chapter two dealt with the literature underpinning the study area and presented the main concepts such as ICT for development, food security and smallholder farmers. The chapter also discussed the relationship between ICTs and food security. Chapter three discussed the theroretical frameworks which underpinned this study and presented a proposed model to be used in understanding ICT adoption in food security. Chapter four discussed the data collection process and the methods employed in gathering and analysing the data. Chapter five

presented the results of the data analysis and discusses them in the context of the theoretical models used. This chapter brings to a conclusion the dissertation by discussing the key findings, implications, recommendations, limitations and gaps while proposing areas of future research.

6.2 Revisiting the research

This study investigated the adoption and diffusion of ICTs in KwaZulu-Natal amongst smallholder farmers, including advanced ICTs such as geographic information systems, knowledge management systems and early warning systems. Particularly, the study sought to understand the role of these ICTs on food security or their ability to reduce food insecurity in the province. The purpose of including the food insecurity (HFIAS) survey was to benchmark the food security status of the smallholder farmer thereby providing an overview of iLembe district in terms of its food insecurity status of smallholder farmers and to allow for a correlation of food insecurity status and various ICT variables that formed part of this study. This correlation of food insecurity status and various ICT variables provides an indication of the role of ICTs in food security in KwaZulu-Natal.

This data collection used two survey instruments that covered 533 smallholder farmers from 14 research sites across four local municipalities in the district municipality of iLembe, north of Durban in KwaZulu-Natal province. The study also included 41 agricultural extension officers deployed to the province by the department of agriculture. The inclusion of extension officers allowed the research to have a more encompassing understanding of the diffusion patterns as extension officers play a key role as innovation decision agents.

The main objective of this thesis was to explore the role of ICTs on food security in KwaZulu-Natal. Focus was also placed on validating the proposed framework for determining the factors that play a role on ICT adoption in food security. The proposed framework borrows variables from three existing frameworks that underpinned this study; the Diffusion of Innovation, the Technology Acceptance Model and Hofstede's Cultural Dimensions. The framework assisted to identify the role ICTs play in food security in the KwaZulu-Natal province and the factors to consider in ICT adoption. In order to better understand the concept of food security the smallholder farmer participant households were surveyed using a standardised measure which formed part of the smallholder farmer questionnaire (part B) to benchmark the household status and various analyses were carried out in order to gain an understanding of the links between household food security status and ICT usage.

6.3 Summary of Key Contributions of the Study

6.3.1 ICT Adoption in Food Security

The challenge of food security has gained global importance with the United Nations adopting food security as part of its millenium development goals (MDGs) and its recently adopted sustainable development goals (SDGs). The complexity of the food security challenge has called for the development of interdisciplinary solutions. The contributions provided by this study is part of the first empirical studies focusing on ICTs and food security. This study is the first of its kind with respect to ICT adoption and food security in South Africa and in the KwaZulu-Natal province.

6.3.2 Culture and ICT Adoption amongst Smallholder farmers

In celebrating the year of the family, the United Nations, through the Food and Agricultural Organisation, produced a report that highlighted the important contribution of family farming towards food security. It is estimated that 70 percent of the world's food insecurity exists in rural areas of developing nations most of whom depend on agriculture in one way or another (FAO, 2014). This study makes a unique contribution towards understanding the role of culture with regards to ICT adoption amongst smallholder farmers in KwaZulu-Natal with regard to ICT adoption for farming practices. The findings reveal that culture is a direct determinant of the role ICTs contribute in attaining food security in KwaZulu-Natal.

6.3.3 Smallholder farmer and Extension officer ICT adoption

This study provides a multi-dimensional perspective to ICT adoption research. The research makes an attempt to understand ICT adoption in food security from both the perspective of the smallholder farmer and the agriculture extension officer. This appoarch provides a better understanding of ICT adoption in food security as it not only focuses on the technology adopter but also the other stakeholders in the technology adoption decision process, the extension officer. This provides a unique viewpoint.

6.3.4 A Proposed Model for the Adoption of ICTs in Food Security

The development of a proposed model for the adoption of ICTs in food security identifies variables that suggest a relationship with ICT adoption in food security. As part of this study a model was developed which was validated statistically.

6.3.5 ICT variables and Food Insecurity in KwaZulu-Natal

A key contribution of this study was the finding that revealed a correlation between a number of ICT variables and food insecurity. The findings revealed an inverse relationship with food insecurity and are discussed below:

- Willingness to adopt new communication media to access information

  The study revealed that the more a smallholder farmer was willing to adopt new communication media to access information, the lesser food insecurity existed in that smallholder farmers household. This proved to be true also for smallholder farmers who were willing to adopt new communication media to access information. Factors such as percieved ease of use and percieved usefulness affected the willingness to adopt an ICT innovation.

- ICTs are compatible with the business needs of farming, the information needs of farming, the cultural norms of farming and with the existing infrastructure at the farms.

  Compatibility from the DOI perspective focuses on the extent to which an innovation can be said to meet the needs of its likely adopters. In order to be able to increase the probability of adoption of an innovation there has to be compatibility with regards to the value systems. These are value systems of the adopter and the values the innovation brings. The adopters must feel that the innovation addresses their needs. This study shows that the more the smallholder farmer finds ICTs to be compatible with the business needs of farming, the information needs of farming, the cultural norms of farming and with the existing infrastructure at the farms, the less food insecurity exists in their households.

- Observability of ICTs

  The findings of the study also showed that the more smallholder farmers are provided with an opportunity to see ICT innovations in action, the less food insecurity is recorded for those households. This would suggest that the smallholder farmer ends up adopting the ICT innovation which in turn plays a role in reducing the food insecurity within their household.

- Extent of use of early warning systems

  The use of early warning systems by smallholder farmers in this study also showed that the more the smallholder farmers used early warning systems, the less food insecurity is recorded in their households.

6.3.6 Age, Gender and Smallholder farmers ICT adoption for farming practices in KwaZulu-Natal

The findings showed a positive attitude towards ICTs by both males and females and is encouraging with regards to introducing ICT innovations that can contribute to food security. The study showed that gender is a key moderating influence regarding the use of ICTs and particularly in knowledge management practices. It was revealed that innovations introduced by females are usually not adopted despite females being in the majority regarding the use of technology (mainly mobile phones). Interestingly, the study revealed that there are more

female extension officers and smallholder farmers when compared to males. This can be attributed to the cultural influence as previously discussed in section 6.3.2.

Although there is a significant contribution to literature regarding the role of age and gender on ICT adoption in general, there is little literature regarding the role of age and gender on ICT adoption by smallholder farmers and its role on food security especially in the South African context. This study makes a contribution towards this identified gap in the literature. The findings showed encouraging results where the majority of farmers who use ICTs were in the worst case marginally food insecure (30% – 40% food insecurity) to food secure (0% – 25% food insecurity). The study also revealed that those smallholder farmers who do not use ICTs mainly fell within the moderate to immediate assistance required range (40% - 100% food insecurity).

6.4 Implications and Recommendations

The problem of food insecurity is a global phenomenon and involves a number of different facets. This study focused on the smallholder farmer and their households and investigated the role of ICTs in mitigating food insecurity. The findings of this study can play a significant role in contributing to government efforts of improving food security in communities. The selection of the study area, iLembe district municipality was not based on any special reasoning. Ilembe district municipality consists of mostly the same characteristics e.g economic and social factors as the other nine district municipalities in KwaZulu-Natal. It is this homogeneity in the rural communities of KwaZulu-Natal and the fact that the field study was conducted in the communities in their natural settings (on the farms) that the results can be generalised and the recommendations adopted by the other rural communities of KwaZulu-Natal. The findings of this study form the basis on which the following recommendations are presented with the view of contributing to improving food security.

Recommendation 1: Develop strategies that will incorporate culture when considering ICT adoption in food security to rural communities of KwaZulu-Natal

The use of Hosfstede's theory allowed this study to interrogate the social complexities associated with ICT adoption amongst smallholder farmers in KwaZulu-Natal. KwaZulu-Natal province which is home to the Zulu Kingdom and its indigenous inhabitants the amaZulu people who are patrilineal by culture. The male inhabitants of these rural communities leave these communities to move to bigger towns and cities to find work. This move is also considered a more masculine thing to do as farming which is the main activity of rural communities is considered to be a more feminine activity. In order to curb this male labour drain from rural communities and to improve adoption of ICTs in food security it is recommended that ICT based innovations in improving food security should be given a more

masculine perception so as to attract males. Doing so would increase the chances of ICT adoption in food security in these rural communities. It is therefore, recommended that training workshops that provide an opportunity for male farmers to physically interact with the technologies in order to increase their perception that using ICTs in food security is attractive from a masculine perspective.

Recommendation 2: Creation of an Agricultural Information Centre

There is need for an increase in the awareness of agricultural information, agricultural applications and other ICT based innovations that can be accessed using ICTs. It is further recommended that access to emerging technologies such as GIS, should be the responsibility of the extension officers as they have a greater capacity both financially and knowledge wise as they are government supported. This is in the hope of a trickle down effect of the critical information obtained fron these emerging technologies to the smallholder farmer. Due to the financial vulnerability of smallholder farmers, it cannot be expected that these farmers can easily make use of these ICTs.

It is because of this reason that emerging technologies such as GIS should be promoted at the extension officer level. In this regard, an agricultural information centre ought to be created whose main aim would be to provide support to extension officers via these emerging technologies that use satellite data. The centre should be responsible for the gathering of all relevant data for the region and coordinate its distribution to all extension officers who then can use this critical information in their extension activities.

Recommendation 3: ICT training of basic and advanced ICTs for smallholder farmers and extension officers

The analysis of the perceived attributes of innovation revealed that trialability and observability attributes are important when considering ICT adoption. The study shows that smallholder farmers feel that if given an opportunity to see how a technology functions and to experiment with the technology it would increase their chances of adoption. It is clear that the more advanced ICTs such as GIS systems bring huge benefits on food security amongst smallholder farmer communities. The study shows that the core issue regarding advanced technologies is accessibility to these technologies by rural communities.

It is based on these findings that a recommendation is made that smallholder farmers and extension officers must be exposed to the various ICTs including advanced technologies that carry greater benefits. The study shows that not all extension officers use ICTs, be it emerging or traditional ICTs. The use of emerging technologies such as GIS technology which require a greater degree of skill compared to traditional such as the mobile phone which should be

made part of the agricultural extension officer training course. This will inculcate a natural sense of uptake to these ICTs. In order to accelerate smallholder farmer buy-in, farmers should not just be trained in the use of these technologies but they should also be practically exposed to the technologies through actual trails involving the smallholder farmers. Demonstrations such as trial periods in which a select group of smallholder farmers get to test the implementation of a new ICT innovation on their farms, for a given period to show the benefits of using these technologies in their farming practices, should be considered.

Recommendation 4: National ICT Policy

Most national ICT policy focus is based on access to technology, rural communities in which smallholder farmers reside, are faced with the challenge of a lack of access to the type of ICTs (advanced ICTs) which can greatly benefit their farming practices. ICTs such as GIS, KMS and EWS are seldom accessible by these communities as evidenced in this study.

The study shows that the majority of smallholder farmers are motivated to adopt ICTs in order to solve problems and not necessarily on a voluntary basis. In order to increase access to ICTs in food security to the target population, it is recommended that ICT adoption strategies must be made obligatory as part of ICT policies. It is important to link rural ICT innovations that improve food security to national policy. Doing so would increase the technology availability to these communities as it becomes a national government priority encompassed in policy. Government has the capacity to achieve this through the operationalisation of the recommendation to create agricultural information centres in which policy can require that each Department of Agriculture district municipality office should have one. As there was no special reason for the seletion of iLembe as the study area, and the homogeneity of this district with the other nine districts in KwaZulu-Natal province, provincial and national ICT policy can require that each district office implements an agricultural information centre. This would help coordinate and distribute crucial information hence, making it readily available to all stakeholders. As much as advanced technologies are not widely spread in rural communities, it is recommended that there has to be an effort to take advantage of already existing technologies (established ICTs) and build solutions around them. Also, necessary regulatory frameworks have to be put in place to create favourable environments that encourage the adoption of ICT based innovations.

6.5 Limitations of the study

While conducting the study some limitations became apparent such as the following:

6.5.1 Limited Local Language Vocabulary (Translation)

The study population being mainly isiZulu entailed that in order for respondents to clearly understand and give accurate responses, the questionnaire had to be translated into isiZulu. It was later during data analysis that it was discovered that the questionnaire translation process resulted in some translation inaccuracies due to a lack of equivalent isiZulu terminology for the technical English words such as smart packaging.

6.5.2 Time constraints

Due to time and financial constraints it was not possible to test the proposed model through which diffusion and adoption of ICTs was investigated over an extended time period (longitudinal study) and as a result a cross-sectional approach was adopted. The HFIAS scale which formed part B of the farmer questionnaire attempted to measure household food insecurity over a time period of a month typically. However, time and finances allowing, it would be useful to conduct this measure twice (before or during planting and after or during harvest periods) which would provide a more accurate measure of the food insecurity which exists in the area under study.

6.5.3 The proposed model variables

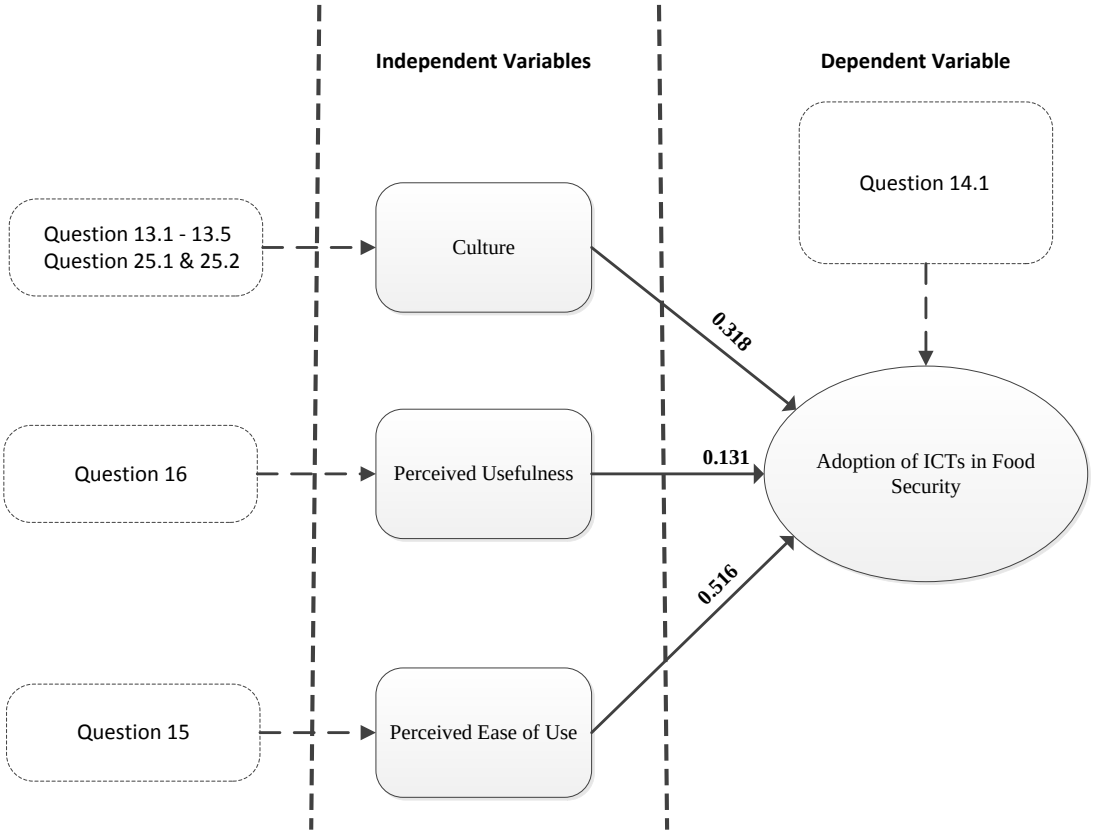
The study made use of three theoretical frameworks; the Diffusion of Innovation, the Technology Acceptance Model and Hofstede's Cultural Dimensions whose variables are blended to create the proposed model for understanding diffusion and adoption of ICTs and its role on food security in KwaZulu-Natal. The proposed model consisted of the main variables from these models and can successfully be used to determine the role of Perceived Ease of Use, Perceived Usefulness and Culture on ICT adoption in food security. However, due to overlap and similarities in the variables from the theoretical models used, not all the variables were included in the new proposed model. The proposed model also made use of only the most popular determinants of user acceptance theories.

6.6 Suggestions for future research

6.6.1 The Proposed Theoretical Model

The proposed theoretical model that was developed based on the literature review that was conducted and later revised based on the statistical findings, lends itself to testing in similar environments (rural communities) and is open to further advancements. Further analysis of relationships between the measured variables could improve the model and provide insights

to the relationships that exist. A suggestion would be to test specific ICTs individually as this may provide a better focus in the survey instrument and the results that follow.



Revised Model for ICT Adoption in Food Security

6.6.2 Communication Channels of Smallholder Farmers in the Diffusion of Technology

Although this study to an extent provided insight into the influence of agricultural extension officers on smallholder farmers, there is a need to investigate the interpersonal networks that exist for the smallholder farmer in the diffusion of technology process within the smallholder farmers social system and there is a need for the collection of more sociometric data from the smallholder farmers in an attempt to further understand individual farmers behavior and how it influences the relationship or behavior of other smallholder farmers (Ryan & Gross, 1943). Everett M Rogers and Kincaid (1981) identified mass media exposure as an important factor in increasing adoption of an innovation and therefore, is an avenue worth conducting a further study on from a smallholder farmer perspective.

6.6.3 Role of Information Communication Technology Adoption on Smallholder Farming Practices

An area that is of importance is the understanding of the role that ICT adoption has on smallholder farmer social systems and how this adoption affects farming practices. To what extent do ICTs change the way of life of the smallholder farmer and do these ICTs have a

negative consequence on farming practices in the long run creating an unsustainable dependency?

The adoption of ICTs for improving food security by smallholder farmers does inevitably change their farming practices. With the fast moving changes in technologies themselves, future research can assist in providing formalised standards for smallholder technological requirements such that ICTs are matched with smallholder farmer needs and avoid technological changes for the sake of keeping up with what is the latest on the market.

6.7 Conclusion

Food Security is clearly a global concern and the eradication of insecurity is a top priority on world agendas; so much so that the United Nations has included this issue as one of its millennium development goals as well as in its newly adopted sustainable development goals. In most cases food insecurity exists in rural communities where resources and opportunities for employment are scarce and therefore, smallholder farming is seen as a huge potential to provide much needed resources in these communities.

One has to take into account that most of the smallholder farmers in this survey have no formal education whilst a few of them have degrees and certificates. As a result, it has to be stressed that GIS and KMS need to be taught to the smallholder farmers in the form of workshops, short courses and training exercises. Only then can the barrier of ignorance and computer illiteracy be broken, and GIS and KMS can then be used to improve food security in KZN. There has to be consistent communication between the relevant people such as the Department of Agriculture and the KZN farmers so they can initiate the GIS and KMS education. It makes sense that smallholder farmer's do not use websites, GIS or KMS technology as much as they use more established ICTs because they do not know how to utilize the technology. There must be a move to bring in mobile computer LANS and satellite computer labs so that the smallholder farmers can embark on their training and utilize the ICTs in order to create improvements in food security within the KwaZulu-Natal province. This research revealed that there is clearly a poor understanding and use of knowledge management systems amongst extension officers. This can be resolved through increased training workshops or user specific short courses.

In order to fully maximise the potential of smallholder farming, it is crucial to incorporate the utilization of ICTs (Anoop et al., 2015) whose benefits can increase farmer productivity and hence much needed income. It is clear that ICTs have a positive role on food security and smallholder farmers prefer certain technologies to others, this preference though is mostly as a result of limited knowledge of the tools available, and the lack of opportunity to try the alternative technologies and an appreciation of their usefulness in farming practices. The ease

of use of a technology is seen to be of crucial importance in the adoption of a technology and a need is seen for training on the various technological tools that can improve smallholder productivity. Going forward the question worth asking is what are the consequences of introducing ICTs as a farming innovation? Sharp (1952) provides a reminder that it is important that the introduction of an innovation should be based on an understanding of the needs of inhabitants of a social system and not by those set by the innovators. Innovations should seek to complement existing practices and not radically interrupt everyday practices and processes. The study shows that ICTs play a positive role in at least maintaining food security and in improving the food security status of smallholder farmer households in KwaZulu-Natal. The implementation of the recommendations provided would therefore go a long way in contributing towards the increase in the food security status of smallholder farmer households.

Food insecurity is a growing global concern that requires effective solutions supported by policy. A food secure population contributes significantly to a healthy population which has a positive economic impact both at household level and at national level. On the other hand, the prevalence of food insecurity can lead to poor health in communities and can negatively impact on the management and control of chronic diseases. Food insecurity therefore has a negative impact on healthcare systems of nations and their overall productivity. Food insecurity affects everyone although it has an even more destructive effect on children. This situation affects children's mental and physical development and in turns their academic potential. Eliminating food insecurity is in support of the World Summit for Children which is a human rights treaty for children and aims to improve child health. This study makes a contribution to providing solutions to this growing problem of household food insecurity though the use of ICTs.

References

Achebe, Chinua, & Bacon, By Katie. (2000). An African Voice. *The Atlantic Online*.

Adams, Garry L, & Lamont, Bruce T. (2003). Knowledge management systems and developing sustainable competitive advantage. *Journal of Knowledge Management, 7*(2), 142-154.

Agarwal, Ritu, & Prasad, Jayesh. (1997). The role of innovation characteristics and perceived voluntariness in the acceptance of information technologies. *Decision sciences, 28*(3), 557-582.

Ainembabazi, John Herbert, & Mugisha, Johnny. (2014). The Role of Farming Experience on the Adoption of Agricultural Technologies: Evidence from Smallholder Farmers in Uganda. *Journal of Development Studies, 50*(5), 666-679.

Aitchison, John, & Harley, Anne. (2004). South African illiteracy statistics and the case of the magically growing number of literacy and ABET learners. *Centre for Adult Education. University of KwaZulu-Nata*.

Ajani, EN. (2014). Promoting the Use of Information and Communication Technologies (ICTs) for Agricultural Transformation in Sub-Saharan Africa: Implications for Policy. *Journal of Agricultural & Food Information, 15*(1), 42-53.

Ajibade, Lanre Tajudeen. (2003). In search for methodology for the collection and evaluation of farmers' indigenous environmental knowledge. *Indilinga African Journal of Indigenous Knowledge Systems, 2*(1), p. 99-105.

Aker, Jenny C. (2011). Dial "A" for agriculture: A review of information and communication technologies for agricultural extension in developing countries. *Agricultural economics, 42*(6), 631-647.

Alam, Quamrul, Yusuf, Mohammad Abu, & Coghill, Ken. (2010). Village phone program, commodification of mobile phone set and empowerment of women. *The Journal of Community Informatics, 5*(3-4).

Alavi, Maryam, & Leidner, Dorothy E. (2001). Review: Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS quarterly*, 107-136.

Aleke, Bartholomew, Ojiako, Udechukwu, & Wainwright, David W. (2011). ICT adoption in developing countries: perspectives from small-scale agribusinesses. *Journal of Enterprise Information Management, 24*(1), 68-84.

Aliber, Michael, & Cousins, Ben. (2013). Livelihoods after land reform in South Africa. *Journal of Agrarian Change, 13*(1), 140-165.

Aliber, Michael, Kirsten, Marié, Maharajh, Rasigan, Nhlapo-Hlope, Josephilda, & Nkoane, Oupa. (2006). Overcoming underdevelopment in South Africa's second economy. *Development Southern Africa, 23*(01), 45-61.

Allison, P. D. . (2005). *Logistic Regression using SAS: Theory and Application*: Cary, NC:SAS Institute Inc.

Amin, Md, & Li, Jinghua. (2014). Applying Farmer Technology Acceptance Model to Understand Farmer's Behavior Intention to use ICT Based Microfinance Platform: A Comparative analysis between Bangladesh and China.

Anoop, M, Ajjan, N, & Ashok, KR. (2015). ICT based market information services in Kerala–determinants and barriers of adoption. *Economic Affairs, 60*(1), 117-121.

Appel-Meulenbroek, Rianne, de Vries, Bauke, & Weggeman, Mathieu. (2014). Layout mechanisms that stimulate innovative behaviour of employees. *ING IN*, 5.

Archie, Kelli M., Dilling, Lisa, Milford, Jana B., & Pampel, Fred C. (2014). Unpacking the 'information barrier': Comparing perspectives on information as a barrier to climate change adaptation in the interior mountain West. *Journal of Environmental Management, 133*(0), 397-410. doi: http://dx.doi.org/10.1016/j.jenvman.2013.12.015

as cited in Nuzzo, Regina. (2014). Statistical errors. *Nature, 506*(7487), 150-152.

Asendorpf, Jens B., Conner, Mark, De Fruyt, Filip, De Houwer, Jan, Denissen, Jaap J. A., Fiedler, Klaus, . . . Wicherts, Jelte M. (2013). Recommendations for Increasing

Replicability in Psychology. *European Journal of Personality, 27*(2), 108-119. doi: 10.1002/per.1919
Asiedu, Christobel. (2012). Information communication technologies for gender and development in Africa The case for radio and technological blending. *International Communication Gazette, 74*(3), 240-257.
Attuquayefio, Samuel, & Addo, Hilla. (2014). REVIEW OF STUDIES WITH UTAUT AS CONCEPTUAL FRAMEWORK. *European Scientific Journal, 10*(8).
Aubert, Benoit A, Schroeder, Andreas, & Grimaudo, Jonathan. (2012). IT as enabler of sustainable farming: An empirical analysis of farmers' adoption decision of precision agriculture technology. *Decision Support Systems, 54*(1), 510-520.
Axinn, George H, & Thorat, Sudhakar. (1972). *Modernizing world agriculture: a comparative study of agricultural extension education systems*: Praeger New York.
Bagchi. (2001). *The impact of national culture and other national-level indicators on information technology (IT) diffusion.* (Unpublished PhD dissertation), Florida Atlantic University, Boca Raton, FL.
Bagchi, Kallol, & Udo, Godwin. (2007). Empirically testing factors that drive ICT adoption in Africa and OECD set of nations. *Issues in information systems, 8*(2), 45-52.
Bagozzi, Richard P. (2007). The Legacy of the Technology Acceptance Model and a Proposal for a Paradigm Shift. *Journal of the association for information systems, 8*(4), 3.
Baiyegunhi, LJS, & Fraser, GCG. (2014). Poverty Incidence among Smallholder Farmers in the Amathole District Municipality, Eastern Cape Province, South Africa. *J Hum Ecol, 46*(3), 261-273.
Bakkabulindi, FEK, Nkata, JL, & Amin, Martin E. (2008). Organizational characteristics as correlates of ICT adoption in Makerere University. *Kampala International University Research Digest, 1*(2), 124-137.
Ballantyne, P. . (2009). Accessing, sharing and communicating agricultural information for development: Emerging trends and issues. *Information Development, 25*(4), 260-271.
Barlett, Peggy F. (2013). *Agricultural decision making: Anthropological contributions to rural development*: Academic Press.
Beaudry, Anne, & Pinsonneault, Alain. (2010). The Other Side of Acceptance: Studying the Direct and Indirect Effects of Emotions on Information Technology Use. *MIS quarterly, 34*(4), 689-710.
Benson, Carol. (2004). The importance of mother tongue-based schooling for educational quality. Commissioned study for EFA Global Monitoring Report 2005: Paris: UNESCO.
Berends, Hans, Bij, Hans, Debackere, Koenraad, & Weggeman, Mathieu. (2006). Knowledge sharing mechanisms in industrial research. *R&D Management, 36*(1), 85-95.
Bhatnagar, Subhash. (2015). 12. Using ICT to improve governance and service delivery to the poor. *Governance in Developing Asia: Public Service Delivery and Empowerment*, 296.
Biswas, Asit K, Tortajada, Cecilia, Biswas-Tortajada, Andrea, Joshi, Yugal K, & Gupta, Aishvarya. (2014). The Key to Success: Agricultural Extension Services *Creating Shared Value* (pp. 31-39): Springer.
BiztechAfrica. (2014). Kenya rolls out e-extension to improve agriculture from http://www.biztechafrica.com/article/kenya-rolls-out-e-extension-improve-agriculture/8384/ - .VYHQ7RftIkA
Bleie, Tone, & Lillevoll, Tor Arne. (2010). Shepherds of the Mountains: Sheep Farming in a North Norwegian Alpine Landscape as a Community of Practice. *Journal of Northern Studies*(2), 11-32.
Boithi, Frederick N, Muchiri, Edward, Birech, Rhodah, & Mulu-Mutuku, Milcah. (2014). Factors Influencing Smallholder Farmers' Adoption of Agricultural Water

Technologies and Innovations in Lare and Elementaita Divisions of Nakuru County, Kenya.
Bollen, Kenneth A. (2014). *Structural equations with latent variables*: John Wiley & Sons.
Bornstein, David. (2007). *How to change the world: Social entrepreneurs and the power of new ideas*: Oxford University Press.
Bowman, Warigia, Mensah, Marianne, & Urama, Kevin. (2014). Information and telecommunication technologies in Africa: a potential Revolution? *Innovation for Sustainable Development*, 45.
Boyd, Emily, Cornforth, Rosalind J, Lamb, Peter J, Tarhule, Aondover, Lélé, M Issa, & Brouder, Alan. (2013). Building resilience to face recurring environmental crisis in African Sahel. *Nature climate change, 3*(7), 631-637.
Brandon Croke. (2011). Admissions Marketing – What's Here vs. What's Next. Retrieved 10/12/14, from http://www.uversity.com/blog/whats-here-vs-whats-next-in-admissions-marketing/ - contact_us
Browne, Stephen. (2012). *Aid and influence: do donors help or hinder?* : Taylor & Francis.
Bruce, JA, & Pickett, John A. (2014). Achieving food security for one million sub-Saharan African.
Brunori, Gianluca, Malandrin, Vanessa, & Rossi, Adanella. (2013). Trade-off or convergence? The role of food security in the evolution of food discourse in Italy. *Journal of Rural Studies, 29*, 19-29.
Bryan, S. (2014). *Institutional defi ciencies and adoption of farm innovations: Implications and options for agricultural research centers*: International Potato Center.
Bryceson, Deborah Fahy, & Jønsson, Jesper Bosse. (2010). Gold digging careers in rural East Africa: Small-scale miners' livelihood choices. *World Development, 38*(3), 379-392.
Buthelezi, NN, & Hughes, JC. (2014). Indigenous knowledge systems and agricultural rural development in South Africa: past and present perspectives. *Indilinga African Journal of Indigenous Knowledge Systems, 13*(2), 231-250.
Byrne, Barbara M. (2013). *Structural equation modeling with AMOS: Basic concepts, applications, and programming*: Routledge.
Campbell, Bruce. (2014). Climate change: Call for UN to act on food security. *Nature, 509*(7500), 288-288.
Carter, Megan Ann, Dubois, Lise, & Tremblay, Mark S. (2014). Place and food insecurity: a critical review and synthesis of the literature. *Public health nutrition, 17*(01), 94-112.
Carty, Victoria. (2010). New information communication technologies and grassroots mobilization. *Information, Communication & Society, 13*(2), 155-173.
Cawthorn, Donna-Mareè, Steinman, Harris A, & Hoffman, Louwrens C. (2013). A high incidence of species substitution and mislabelling detected in meat products sold in South Africa. *Food Control, 32*(2), 440-449.
Chen, Lei-da, Gillenson, Mark L, & Sherrell, Daniel L. (2002). Enticing online consumers: an extended technology acceptance perspective. *Information & management, 39*(8), 705-719.
Cheripelly, Naveen Kumar, & Chandri, Raghava Reddy. (2015). Role of ICTs in Sustainable Agriculture: A Study of e-Sagu in Andhra Pradesh *Climate Change Modelling, Planning and Policy for Agriculture* (pp. 109-118): Springer.
Cherotich, V KIRUI, Saidu, OSENI, & Bebe, B OMEDO. (2012). Access to climate change information and support services by the vulnerable groups in semi-arid Kenya for adaptive capacity development. *African Crop Science Journal, 20*(2), 169-180.
Chhachhar, Abdul Razaque, Osman, Mohd Nizam, & Omar, Siti Zobidah. (2012). Role of television in agriculture development of Sindh, Pakistan. *A publication of the pacific and asian communication association, 15*(1), 1-11.

Chong, Sandy. (2004). An empirical study of factors that influence the extent of deployment of electronic commerce for small-and medium-sized enterprises in Australia.
Christie, Agatha. (1935). *The mysterious affair at Styles : a detective story / Agatha Christie*. London: Penguin.
Chung, Youjin B. (2012). Climate Resilient Sustainable Agriculture: A real alternative to false solutions. *Development, 9478*, 9489.
Cisco. (2015). Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update 2014–2019 White Paper - Cisco. Retrieved 10/060/15, 2015, from http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.html
Coates, Jennifer, Swindale, Anne, & Bilinsky, Paula. (2007). Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide. In v. 3 (Ed.). Washington: Academy for Educational Development.
Coffey, Kevin, Haile, Menghestab, Halperin, Mea, Wamukoya, Geogre, Hansen, James, Kinyangi, James, . . . Dinesh, Dhanush. (2015). Improving early warning systems for agricultural resilience in Africa.
Coleman, James S. (1986). Social theory, social research, and a theory of action. *American journal of Sociology, 91*(6), 1309.
Collier, Paul, & Dercon, Stefan. (2013). African Agriculture in 50Years: Smallholders in a Rapidly Changing World? *World Development*.
Collinson, Mark A. (2010). Striving against adversity: the dynamics of migration, health and poverty in rural South Africa. *Global health action, 3*.
Comte, Auguste. (1998). *Auguste Comte and positivism: The essential writings*: Transaction Publishers.
Costa, Corrado, Antonucci, Francesca, Pallottino, Federico, Aguzzi, Jacopo, Sarriá, David, & Menesatti, Paolo. (2013). A review on agri-food supply chain traceability by means of RFID technology. *Food and Bioprocess Technology, 6*(2), 353-366.
Cousins, Ben. (2009). Second Economy Strategy: Addressing Inequality and Economic Marginalisation: Presidency.
Cousins, Ben. (2010). What is a 'smallholder'? *PLAAS, University of the Western Cape, Working Paper, 16*.
Cromley, Ellen K, & McLafferty, Sara L. (2011). *GIS and public health*: Guilford Press.
Crowther, David, & Lancaster, Geoff. (2012). *Research methods*: Routledge.
Crystal, David. (2012). *English as a global language*: Cambridge University Press.
Czaja, Sara J, Charness, Neil, Fisk, Arthur D, Hertzog, Christopher, Nair, Sankaran N, Rogers, Wendy A, & Sharit, Joseph. (2006). Factors predicting the use of technology: findings from the Center for Research and Education on Aging and Technology Enhancement (CREATE). *Psychology and aging, 21*(2), 333.
Dalkir, Kimiz. (2013). *Knowledge management in theory and practice*: Routledge.
Damanpour, Fariborz, & Schneider, Marguerite. (2009). Characteristics of innovation and innovation adoption in public organizations: assessing the role of managers. *Journal of public administration research and theory, 19*(3), 495-522.
Davenport, Thomas H. (2013). *Process innovation: reengineering work through information technology*: Harvard Business Press.
Davis. (1989). Perceived usefulness, perceived ease of use and acceptance of information technology. *MIS Quarterly, 13, 319-340*(13), 319-340.
Davis. (1993). User acceptance of information technology: system characteristics, user perceptions and behavioral impacts. *International journal of man-machine studies, 38*(3), 475-487.
Davis, Bagozzi, Richard P, & Warshaw, Paul R. (1989). User acceptance of computer technology: a comparison of two theoretical models. *Management science, 35*(8), 982-1003.

Davis, Tall, & Guntuku. (2014). Reaching the last mile: best practices in leveraging the power of ICTs to communicate climate services to farmers at scale.
Davis, Alicia, Tall, Arame, & Guntuku, Dileepkumar. (2014). Reaching the last mile: best practices in leveraging the power of ICTs to communicate climate services to farmers at scale.
Denzin, Norman K (Ed.). (1970). *The research act: A theoretical introduction to sociological methods* (1st ed.): Transaction publishers.
Denzin, Norman K (Ed.). (1978). *The Research Act: A Theoretical Introduction to Sociological Methods.* : New York, USA: McGraw Hill.
Denzin, Norman K (Ed.). (1989). *The research act : a theoretical introduction to sociological methods* (3rd ed.). Englewood Cliffs, N.J: Prentice Hall.
Department of Communications. (2014). *NATION AL INTEGRATED ICT POLICY GREEN PAPER*. Retrieved from http://www.gpwonline.co.za.
Department of Education. (2011). Adult Education and Trainning 2011 Report: Department of Education KwaZulu-Natal Provine.
Dileepkumar, Guntuku, Holz-Clause, Mary, & Aruna Sai, K. (2011). A Theoretical Framework for Rural Knowledge Centers. *US-China Education Review*, 1-9.
Dinkelman, Taryn. (2011). The effects of rural electrification on employment: New evidence from South Africa. *The American Economic Review*, 3078-3108.
Disley, Y Phil. (2013). Sustainable development goals for people and planet. *Nature, 495*, 21.
Doss, Cheryl R. (2006). Analyzing technology adoption using microstudies: limitations, challenges, and opportunities for improvement. *Agricultural economics, 34*(3), 207-219.
Doss, Cheryl R, & Morris, Michael L. (2000). How does gender affect the adoption of agricultural innovations? *Agricultural economics, 25*(1), 27-39.
Doucouliagos, Hristos, & Paldam, Martin. (2011). The ineffectiveness of development aid on growth: An update. *European journal of political economy, 27*(2), 399-404.
Duncombe, Richard. (2015). Mobile Phones for Agricultural and Rural Development: A Literature Review and Suggestions for Future Research. *European Journal of Development Research*.
Dupas, Pascaline, Green, Sarah, Keats, Anthony, & Robinson, Jonathan. (2014). Challenges in banking the rural poor: Evidence from Kenya's western province *African Successes: Modernization and Development*: University of Chicago Press.
Duveskog, Deborah, Friis-Hansen, Esbern, & Taylor, Edward W. (2011). Farmer Field Schools in Rural Kenya: A Transformative Learning Experience. *The Journal of Development Studies, 47*(10), 1529-1544. doi: 10.1080/00220388.2011.561328
Dzansi, Dennis Yao, & Amedzo, Kofi. (2014). Integrating ICT into Rural South African Schools: Possible Solutions for Challenges.
Economist. (2009, September 26–October 2). "Eureka Moments: How a Luxury Became a Tool of Global Development." 4–8.
EIU. (2010). Digital economy rankings 2010 beyond e-readiness. *The Economist*.
Elder, Laurent, Emdon, Heloise, Fuchs, Richard, & Petrazzini, Ben. (2013). *Connecting ICTs to development: The IDRC experience*: Anthem Press.
FAO. (2014). The State of Food and Agriculture. Rome: FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS.
Fawole, OP, & Olajide, BR. (2012). Awareness and Use of Information Communication Technologies by Farmers in Oyo State, Nigeria. *Journal of Agricultural & Food Information, 13*(4), 326-337.
Feizizadeh, Bakhtiar, & Blaschke, Thomas. (2013). Land suitability analysis for Tabriz County, Iran: a multi-criteria evaluation approach using GIS. *Journal of Environmental Planning and Management, 56*(1), 1-23.

Fischer, Elisabeth, & Qaim, Matin. (2012). Linking smallholders to markets: determinants and impacts of farmer collective action in Kenya. *World Development, 40*(6), 1255-1268.
Fischer, Elisabeth, & Qaim, Matin. (2014). Smallholder Farmers and Collective Action: What Determines the Intensity of Participation? *Journal of Agricultural Economics, 65*(3), 683-702.
Fish, Rob, Lobley, Matt, & Winter, Michael. (2013). A license to produce? Farmer interpretations of the new food security agenda. *Journal of Rural Studies, 29*, 40-49.
Flor, Alexander G, & Cisneros, Andrea Jimenez. (2015). e-Agriculture. *The International Encyclopedia of Digital Communication and Society*.
Foley, Jonathan A, Ramankutty, Navin, Brauman, Kate A, Cassidy, Emily S, Gerber, James S, Johnston, Matt, . . . West, Paul C. (2011). Solutions for a cultivated planet. *Nature, 478*(7369), 337-342.
Food, UN, & Organization, Agriculture. (2011). The State of Food and Agriculture 2010–2011: Women in Agriculture: Closing the Gender Gap for Development. *FAO Home,* http://www*. fao. org/docrep/013/i2050e/i2050e00. htm (accessed 1 November 2011)*.
Forestier, Emmanuel, Grace, Jeremy, & Kenny, Charles. (2002). Can information and communication technologies be pro-poor? *Telecommunications policy, 26*(11), 623-646.
Fosu-Mensah, B. Y., Vlek, P. L. G., & MacCarthy, D. S. (2012). Farmers' perception and adaptation to climate change: a case study of Sekyedumase district in Ghana. *Environment, Development and Sustainability, 14*(4), 495-505. doi: 10.1007/s10668-012-9339-7
Fu, Xiaolan, Pietrobelli, Carlo, & Soete, Luc. (2011). The role of foreign technology and indigenous innovation in the emerging economies: technological change and catching-up. *World Development, 39*(7), 1204-1212.
Fukuda-Parr, Sakiko, & Lopes, Carlos. (2013). *Capacity for development: new solutions to old problems*: Routledge.
Gagliardone, Iginio. (2015). 'Can you hear me?'Mobile–radio interactions and governance in Africa. *New Media & Society*, 1461444815581148.
Gakuru, M, Winters, K, & Stepman, F. (2009). Inventory of innovative farmer advisory services using ICTs: the forum for agricultural research in Africa.
Galagedara, GT Madhubhashini, Salman, Ali, Mahmud, Wan Amizah Wan, & Ahmad, Fauziah. (2014). A CASE STUDY ON INTERNET ADOPTION AMONG RURAL COMMUNITIES IN SRI LANKA. *e-BANGI, 9*(2), 172.
Gay, & Lorrie, R. (2006). *Educational research : competencies for analysis and applications* Pearson Merrill Prentice Hall.
Genius, Margarita, Koundouri, Phoebe, Nauges, Céline, & Tzouvelekas, Vangelis. (2014). Information Transmission in Irrigation Technology Adoption and Diffusion: Social Learning, Extension Services, and Spatial Effects. *American Journal of Agricultural Economics, 96*(1), 328-344.
Gerbner, George, & Gross, Larry. (1976). Living with television: The violence profile. *Journal of communication, 26*(2), 172-194.
Gereffi, Gary, & Wyman, Donald L. (2014). *Manufacturing miracles: paths of industrialization in Latin America and East Asia*: Princeton University Press.
Ghattas, Hala, Sassine, AnnieBelle J, Seyfert, Karin, Nord, Mark, & Sahyoun, Nadine R. (2014). Food insecurity among Iraqi refugees living in Lebanon, 10 years after the invasion of Iraq: data from a household survey. *British Journal of Nutrition*, 1-10.
Girard, Bruce. (2003). Radio and the internet: mixing media to bridge the divide. *The One to Watch: Radio, New ICTs and Interactivity. Food and Agriculture Organization of the United Nations, Rome*, 2-20.

Glendenning, Claire J, & Ficarelli, Pier Paolo. (2012). The relevance of content in ICT initiatives in Indian agriculture. *International Food Policy Research Institute Discussion Paper, 1180*, 1-40.
Gloet, Marianne, & Terziovski, Milé. (2004). Exploring the relationship between knowledge management practices and innovation performance. *Journal of Manufacturing Technology Management, 15*(5), 402-409.
Godfray, H Charles J, Beddington, John R, Crute, Ian R, Haddad, Lawrence, Lawrence, David, Muir, James F, . . . Toulmin, Camilla. (2010). Food security: the challenge of feeding 9 billion people. *science, 327*(5967), 812-818.
Gray, Peter H, & Meister, Darren B. (2004). Knowledge sourcing effectiveness. *Management science, 50*(6), 821-834.
Greene, Catherine R, & Kremen, Amy. (2003). US organic farming in 2000-2001: Adoption of certified systems: United States Department of Agriculture, Economic Research Service.
Groves, Robert M, Fowler Jr, Floyd J, Couper, Mick P, Lepkowski, James M, Singer, Eleanor, & Tourangeau, Roger. (2013). *Survey methodology*: John Wiley & Sons.
Grunfeld, Helena, & Houghton, John. (2013). Using ICT for Climate Change Adaptation and Mitigation through Agro-ecology in the Developing World. *on Information and Communication Technologies*, 128.
Gumede, NomPumelelo P, Bob, Urmilla, & Okech, Roselyne N. (2009). Women and Technology in South Africa A Case of Four Communities in Kwazulu-Natal. *Gender, Technology and Development, 13*(1), 103-125.
Hardy, Andrew P. (1980). The role of the telephone in economic development. *Telecommunications policy, 4*(4), 278-286.
Hargadon, Andrew, & Sutton, Robert I. (1997). Technology brokering and innovation in a product development firm. *Administrative science quarterly*, 716-749.
Hassen, Yasin Ali, & Svensson, Ann. (2014). The Role of ICT for the Growth of Small Enterprises in Ethiopia. *The Electronic Journal of Information Systems in Developing Countries*.
Heeks, Richard. (2010). Do information and communication technologies (ICTs) contribute to development? *Journal of International Development, 22*(5), 625-640.
Hellin, Jon, & Higman, Sophie. (2002). *Smallholders and niche markets: Lessons from the Andes*: Overseas Development Institute.
Hendriks, SL, & Msaki, MM. (2014). Small holder commercialisation: The impact on dietary diversity and Nutrients adequacy at Umbumbulu.
Hillier, Debbie, & Dempsey, Benedict. (2012). A dangerous delay: the cost of late response to early warnings in the 2011 drought in the Horn of Africa. *Oxfam Policy and Practice: Agriculture, Food and Land, 12*(1), 1-34.
Hoffman, D. (2000). The Revolotion will not be Televised: Introduction to the Special Issue on Marketing Science and Technology. *Marketing Science, 19*, 1-3.
Hofstede, G. (1980a). Culture and organizations. *International Studies of Management & Organization*, 15-41.
Hofstede, G. (1984). *Culture's consequences: International differences in work-related values* (Vol. 5): sage.
Hofstede, G. (2001). Identifying organizational subcultures: An empirical approach. *Journal of Management Studies* (35(1)), 1-12.
Hofstede, G. (2013). Dimensions of national cultures.
Hofstede, G (Ed.). (1980b). *Culture's Consequences*. Newbury Park, CA: Sage Publications.
Hofstede, G (Ed.). (1991). *Cultures and organizations*: London: McGraw-Hill.
Hofstede, G, & Bond, M. (1988). The Confucius connection: From cultural roots to economic growth. *Organizational dynamics, 16*(4), 5-21.

Hou, Chung–Kuang. (2014). Exploring the user acceptance of business intelligence systems in Taiwan's electronics industry: applying the UTAUT model. *International Journal of Internet and Enterprise Management, 8*(3), 195-226.
Hough, T, & Home, W. (2001). The language transferee: Evaluators and consultants, PO Box.
Howard, Peter, & Sterner, Thomas. (2014). *Raising the Temperature on Food Prices: Climate Change, Food Security, and the Social Cost of Carbon.* Paper presented at the presentation at the Agricultural & Applied Economics Association's 2014 Annual Meeting, Minneapolis, MN.
Hu, J., Chau Y., Liu Sheng R, & Yan Tam, K. (1999). Examining the technology acceptance model using physician acceptance of telemedicine technology. *Management Information Systems, 16*(2), 91–112.
Huat, J, Aubry, C, & Dore, T. (2014). Understanding Crop Management Decisions for Sustainable Vegetable Crop Protection: A Case Study of Small Tomato Growers in Mayotte Island. *Agroecology and Sustainable Food Systems*(just-accepted).
Huber, George P. (1991). Organizational learning: The contributing processes and the literatures. *Organization science, 2*(1), 88-115.
Hudson, Heather E. (2013). *From rural village to global village: Telecommunications for development in the information age*: Routledge.
Hyde-Clarke, Nathalie, & Van Tonder, Tamsin. (2011). Revisiting the'Leapfrog'debate in light of current trends of mobile phone Internet usage in the Greater Johannesburg area, South Africa. *Journal of African Media Studies, 3*(2), 263-276.
Ibitoye, Stephen J, & Onje, SO. (2013). Economic Analysis of Oil Palm Fruit Processing in Dekina Local Government Area of kogi State, Nigeria.
Igari, Noriko. (2014). How to successfully promote ICT usage: A comparative analysis of Denmark and Japan. *Telematics and Informatics, 31*(1), 115-125.
Isaya, Elizabeth Lucas. (2015). *Sources of Agricultural Information for Women Farmers in Hai and Kilosa Districts, Tanzania.* The Ohio State University.
ITU. (2015). Statistics

. Retrieved 09/06/15, 2015, from http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx
Jack, William, & Suri, Tavneet. (2011). Mobile money: the economics of M-PESA: National Bureau of Economic Research.
Jacobs, Peter. (2010). Household food insecurity, rapid food price inflation and the economic downturn in South Africa. *Agenda, 24*(86), 38-51.
Jain, Lokesh, Kumar, Harish, & Singla, RK. (2014). Assessing Mobile Technology Usage for Knowledge Dissemination among Farmers in Punjab. *Information Technology for Development*(ahead-of-print), 1-9.
James, Jeffrey. (2005). Technological blending in the age of the Internet: A developing country perspective. *Telecommunications policy, 29*(4), 285-296.
James, Jeffrey. (2014). Relative and absolute components of leapfrogging in mobile phones by developing countries. *Telematics and Informatics, 31*(1), 52-61.
Jarosz, Lucy. (2014). Comparing food security and food sovereignty discourses. *Dialogues in Human Geography, 4*(2), 168-181.
Jiyane, Glenrose Velile, & Fairer-Wessels, Felicité. (2012). Dissemination of information on climate change: a case study of women mussel harvesters at KwaNgwanase in KwaZulu-Natal. *Mousaion, 30*(1), 19-38.
Jovanović, Verka, & Njeguš, Angelina. (2013). The application of GIS and its components in tourism. *Yugoslav Journal of Operations Research ISSN: 0354-0243 EISSN: 2334-6043, 18*(2).
Kabunga, Nassul Ssentamu, Dubois, Thomas, & Qaim, Matin. (2012). Heterogeneous information exposure and technology adoption: The case of tissue culture bananas in Kenya. *Agricultural economics, 43*(5), 473-486.

Kadigi, Ibrahim L, Muhiche, Lupyana, Kadigi, Reuben MJ, Makindara, Jeremiah, Laswai, Germana, & Kashaigili, Japhet J. (2013). E-Ng'ombe: A Mobile Phone ICT to Tackle the Pitfall of Information Asymmetry in the Value Chain of Indigenous Beef Cattle in Mwanza Region, Tanzania. *Journal of Agriculture Economics and Rural Development, 1*, 7.

Kani, Aliakbar Najafi. (2014). Investigating sustainable development obstacles in front of mountainous village settlements (Case study: Mountainous Villages, Bandpey District, Babol Township).

Kapoor, Kawaljeet Kaur, Dwivedi, Yogesh K, & Williams, Michael D. (2014). Rogers' Innovation Adoption Attributes: A Systematic Review and Synthesis of Existing Research. *Information Systems Management*(just-accepted).

Karamchandani, Ashish, Kubzansky, Mike, & Lalwani, Nishant. (2011). Is the bottom of the pyramid really for you. *Harvard Business Review, 89*(3), 107-111.

Kashorda, M, & Waema, T. (2014). E-Readiness survey of Kenyan Universities (2013) report. *Nairobi: Kenya Education Network*.

Katengeza, Samson P, Okello, Julius J, Mensah, Edouard R, & Jambo, Noel. (2014). Effect of Participation in ICT-Based Market Information Services on Transaction Costs and Household Income Among Smallholder Farmers in Malawi *Technologies for Sustainable Development* (pp. 197-207): Springer.

Katengeza, Samson P, Okello, Julius Juma, & Jambo, Noel. (2011). Use of mobile phone technology in agricultural marketing: The case of smallholder farmers in Malawi. *International Journal of ICT Research and Development in Africa (IJICTRDA), 2*(2), 14-25.

Khan, Hossain, Shahadat, Hasan, Mahbub, & Clement, Che Kum. (2012). Barriers to the Introduction of ICT into Education in Developing Countries: The Example of Bangladesh. *Online Submission, 5*(2), 61-80.

Khan, Midega, Charles , Pittchar, Jimmy , Murage, Alice , Birkett, Michael , Bruce, Toby , & Pickett, John (2014). Achieving food security for one million sub-Saharan African poor through push–pull innovation by 2020. *Philosophical Transactions of the Royal Society B: Biological Sciences, 369*(1639), 20120284.

Kiiza, Barnabas, & Pederson, Glenn. (2012). ICT-based market information and adoption of agricultural seed technologies: Insights from Uganda. *Telecommunications policy, 36*(4), 253-259.

Kim, Yongsoo, Kelly, Tim, & Raja, Siddhartha. (2010). *Building broadband: Strategies and policies for the developing world*: World Bank Publications.

Kleine, Dorothea. (2013). *Technologies of choice?: ICTs, development, and the capabilities approach*: MIT Press.

Kolawole, Oluwatoyin D. (2014). Whither sustainable rural development?: A critical exploration of remote communities in and around the Okavango Delta, Botswana.

Krämer, Ing Markus, & Peris, M Sc Benjamin. (2014). Usage of Geographic Information Systems (GIS) and Building Information Models (BIM) in Facility Management at Botanic Garden Berlin. *ING IN*, 224.

Kunene, NW, & Fossey, A. (2010). A survey on livestock production in some traditional areas of Northern Kwazulu Natal in South Africa. *Work, 23*, 30.33.

Labadarios, Demetre, Mchiza, Zandile June-Rose, Steyn, Nelia Patricia, Gericke, Gerda, Maunder, Eleni Maria Winifred, Davids, Yul Derek, & Parker, Whadi-ah. (2011). Food security in South Africa: a review of national surveys. *Bulletin of the World Health Organization, 89*(12), 891-899.

Lal, Rattan. (2015). Sustainable intensification for adaptation and mitigation of climate change and advancement of food security in Africa *Sustainable Intensification to Advance Food Security and Enhance Climate Resilience in Africa* (pp. 3-17): Springer.

Larsen, K. R., Allen, G., Vance, A., & Eargle, D. . (2014). Theories Used in IS Research Retrieved 24-04-14, 2014, from http://istheory.byu.edu/wiki/Main_Page

Lashgarara, Farhad, Mirdamadi, S Mehdi, & Hosseini, S Jamal Farajollah. (2013). Identification of appropriate tools of information and communication technologies (ICT) in the improvement of food security of Iran's rural households. *African Journal of Biotechnology, 10*(45), 9082-9088.

Lee, S, & Cheung, C. (2004). Internet retailing adoption by small-to-medium sized enterprises (SMEs): A multiple-case study. *Information Systems Frontiers, 6*(4), 385-397.

Lee, S, Levendis, J, & Gutierrez, L. (2012). Telecommunications and economic growth: an empirical analysis of sub-Saharan Africa. *Applied Economics, 44*(4), 461-469.

Legris, Paul, Ingham, John, & Collerette, Pierre. (2003). Why do people use information technology? A critical review of the technology acceptance model. *Information & management, 40*(3), 191-204.

Levy, Judith A. (1988). Intersections of gender and aging. *The Sociological Quarterly, 29*(4), 479-486.

Liao, Zonghu, Hong, Yang, Wang, Jun, Fukuoka, Hiroshi, Sassa, Kyoji, Karnawati, Dwikorita, & Fathani, Faisal. (2010). Prototyping an experimental early warning system for rainfall-induced landslides in Indonesia using satellite remote sensing and geospatial datasets. *Landslides, 7*(3), 317-324.

Lloyd, Annemaree, Anne, Mary, Thompson, Kim M, & Qayyum, Asim. (2013). Connecting with new information landscapes: information literacy practices of refugees. *Journal of Documentation, 69*(1), 121-144.

Lwoga, Edda Tandi, Stilwell, Christine, & Ngulube, Patrick. (2011). Access and use of agricultural information and knowledge in Tanzania. *Library review, 60*(5), 383-395.

Magdalena, L, & Rome, FAO. (2007). *Trends and Challenges in Agricultural Extension–Policies and Strategies for Reform.* Paper presented at the Workshop, Skopje.

Magesa, Mawazo Mwita, Michael, Kisangiri, & Ko, Jesuk. (2014). Towards a Framework for Accessing Agricultural Market Information. *The Electronic Journal of Information Systems in Developing Countries, 66*.

Maitra, Anjana. (2014). Safe motherhood and ICT tools in BCC.

Manfre, Cristina, & Nordehn, Caitlin. (2013). Exploring the promise of information and communication technologies for women farmers in Kenya. *Cultural practice, LLC, MEAS Case Study, 4*.

Manfre, Cristina, Rubin, Deborah, Allen, Andrea, Summerfield, Gale, Colverson, Kathleen, & Akeredolu, Mercy. (2013). Reducing the gender gap in agricultural extension and advisory services: How to find the best fit for men and women farmers. *Modernizing Extension and Advisory Services*.

Mann, W, Lipper, L, Tennigkeit, T, McCarthy, N, Branca, G, & Paustian, K. (2009). Food Security and Agricultural Mitigation in Developing Countries: Options for Capturing Synergies. *Rome: FAO*.

Mashavave, T, Mapfumo, P, Mtambanengwe, F, Chikowo, R, Gwandu, T, Nezomba, H, & Siziba, S. (2013). Interaction patterns determining improved information and knowledge sharing among smallholder farmers participating in field-based learning alliances in eastern Zimbabwe.

Masset, E. . (2011). A review of hunger indices and methods to monitor country commitment to fighting hunger. *Food policy, 36*, S102-S108. doi: doi:10.1016/j.foodpol.2010.11.007

Mathews, John A. (2011). Naturalizing capitalism: the next great transformation. *Futures, 43*(8), 868-879.

Matungul, Pierre M, Lyne, Michael C, & Ortmann, Gerald F. (2001). Transaction costs and crop marketing in the communal areas of Impendle and Swayimana, KwaZulu-Natal. *Development Southern Africa, 18*(3), 347-363.

Maumbe, Blessing M, & Okello, Julius. (2013). *Technology, Sustainability, and Rural Development in Africa*: IGI Global.
May, Sumiko, & Tall, Arame. (2013). Developing a methodology for the communication of climate services at scale through intermediaries for farmer communities in Africa and South Asia.
McMichael, Philip. (2011). *Development and social change: A global perspective*: Sage Publications.
McNabb, David E. (2013). *Research methods in public administration and nonprofit management: Quantitative and qualitative approaches*: ME Sharpe.
Merem, Edmund C, Yerramilli, Sudha, Twumasi, Yaw A, Wesley, Joan M, Robinson, Bennetta, & Richardson, Chandra. (2011). The applications of GIS in the analysis of the impacts of human activities on South Texas Watersheds. *International journal of environmental research and public health, 8*(6), 2418-2446.
Minges, Michael. (2006). Tracking ICTs: world summit on the information society targets. *Information and Communications for Development: Global Trends and Policies*, 125-146.
Mishra, KN. (1989). Growing Up With Indigenous Knowledge in North India. *CIKARD News, 2*(2), 4-5.
Mistilis, Nina, & Gretzel, Ulrike. (2014). Visitor at-destination information search: A preliminary study.
Mittal, Surabhi, Gandhi, Sanjay, & Tripathi, Gaurav. (2010). *Socio-economic impact of mobile phones on Indian agriculture*: Indian Council for Research on International Economic Relations New Delhi.
Moghaddam, Golnessa Galyani. (2010). Information technology and gender gap: toward a global view. *Electronic Library, The, 28*(5), 722-733.
Mohrman, Susan A, Finegold, David, & Klein, Janice A. (2002). Designing the knowledge enterprise: beyond programs and tools. *Organizational dynamics, 31*(2), 134-150.
Moon, Junghoon, Hossain, Md Dulal, Kang, Hyoung Goo, & Shin, Jungsoon. (2012). An analysis of agricultural informatization in Korea: the government's role in bridging the digital gap. *Information Development, 28*(2), 102-116.
Moore, Gordon E. (1995). *Lithography and the future of Moore's law.* Paper presented at the SPIE's 1995 Symposium on Microlithography.
Morris, M, & Venkatesh, V. (2000). Age differences in technology adoption decisions: Implications for a changing work force. *Personnel psychology, 53*(2), 375-403.
Moyo, Dambisa. (2009). *Dead aid: Why aid is not working and how there is a better way for Africa*: Macmillan.
Mponela, Powell, Jumbe, Charles BL, & Mwase, Weston F. (2011). Determinants and extent of land allocation for< i> Jatropha curcas</i> L. cultivation among smallholder farmers in Malawi. *Biomass and Bioenergy, 35*(7), 2499-2505.
Muinde, Florence Nzisa Nzwilli. (2009). Investigation of factors affecting the adoption of information and communication technologies for communication of research output in research institutions in Kenya.
Munshi, Jamal. (2014). A method for constructing Likert scales. *Available at SSRN 2419366*.
Munyua, Hilda, & Adera, Edith. (2009). Emerging ICTs and Their Potential in Revitalzing Small-Scale Agriculture. *Agricultural information worldwide, 2*(1), 3-9.
Murphy, Gardner, & Likert, Rensis. (1938). *Public opinion and the individual*: Harper & brothers.
Musemwa, L, Zhou, L, & Aghdasi, F. (2013). Factors affecting household access to enough food in the Eastern Cape Province of South Africa. *Journal of Development and Agricultural Economics, 5*(3), 84-91.
Mwombe, Simon OL, Mugivane, Fred I, Adolwa, Ivan S, & Nderitu, John H. (2014). Evaluation of information and communication technology utilization by small

holder banana farmers in Gatanga district, Kenya. *The Journal of Agricultural Education and Extension, 20*(2), 247-261.
Napoli, Philip M, & Obar, Jonathan A. (2013). Mobile Leapfrogging and Digital Divide Policy: assessing the limitations of mobile Internet access. *Fordham University Schools of Business Research Paper*(2263800).
Narrod, Clare, Roy, Devesh, Okello, Julius, Avendaño, Belem, Rich, Karl, & Thorat, Amit. (2009). Public–private partnerships and collective action in high value fruit and vegetable supply chains. *Food policy, 34*(1), 8-15.
Nassanga, Goretti Linda, Manyozo, Linje, & Lopes, Claudia. (2013). ICTs and radio in Africa: How the uptake of ICT has influenced the newsroom culture among community radio journalists. *Telematics and Informatics, 30*(3), 258-266.
Nazari, Mohammad Reza, & Hassan, MSBH. (2011). The role of television in the enhancement of farmers' agricultural knowledge. *African Journal of Agricultural Research, 6*(4), 931-936.
Nchise, Abinwi C, Boateng, Richard, Shu, Ignatius, & Mbarika, Victor. (2012). Mobile phones in health care in Uganda: The Applab study. *The Electronic Journal of Information Systems in Developing Countries, 52*.
Ncube, Mthuli. (2013). Infrastructure Deficit, Financing Needs and the Post-2015 MDG Framework in Africa. *IDS Bulletin, 44*(5-6), 72-80.
Newton. (1676). *The Correspondence of Isaac Newton*. On the Shoulders of Giants, (1). New York.
Ngwira, Amos Robert, Thierfelder, Christian, & Lambert, Dayton M. (2013). Conservation agriculture systems for Malawian smallholder farmers: long-term effects on crop productivity, profitability and soil quality. *Renewable Agriculture and Food Systems, 28*(04), 350-363.
Nkosi, Daniel, & Chikumba, Patrick Albert. (2014). Implications of Institutional Client-Server Geographic Information System: A Case of Mzuzu Agriculture Development Division *e-Infrastructure and e-Services for Developing Countries* (pp. 189-197): Springer.
Obidike, Nnenna A. (2011). Rural farmers' problems accessing agricultural information: A case study of Nsukka local government area of Enugu State, Nigeria.
Odhiambo, Thomas. (1990). You cannot fix indigenous knowledge. *ILEIA Newsletter, 6*(1), 3-5.
OECD. (2000). Indicators for the international development goals: a suggestion for some qualitative indicators.
Oh, Jong-Chul, & Yoon, Sung-Joon. (2014). Predicting the use of online information services based on a modified UTAUT model.
Okello, Julius J. (2013). Awareness of ICT—Based Projects and the Intensity of Use of Mobile Phones Among. *Technology, Sustainability, and Rural Development in Africa*, 89.
Okello, Julius J, Al-Hassan, Ramatu, & Okello, Ruth M. (2010). A framework for analyzing the role of ICT on agricultural commercialization and household food security. *International Journal of ICT Research and Development in Africa (IJICTRDA), 1*(1), 38-50.
Perkins, Richard. (2003). Technological "lock-in". *Online Encyclopaedia of Ecological Economics*.
Peterman, Amber, Behrman, Julia A, & Quisumbing, Agnes R. (2014). *A review of empirical evidence on gender differences in nonland agricultural inputs, technology, and services in developing countries*: Springer.
Phillipson, Robert. (1996). Linguistic imperialism: African perspectives. *ELT Journal, 50*(2), 160-167.
Piburn, Sidney. (1990). *The Dalai Lama, a policy of kindness : an anthology of writings by and about the Dalai Lama*. Ithaca, N.Y., USA: Snow Lion Publications.

Pillay, Kiru. (2012). *DO WEB 2.0 SOCIAL MEDIA IMPACT TRANSNATIONAL SOCIAL ADVOCACY? A STUDY OF*

SOUTH AFRICAN CIVIL SOCIETY AND GREENPEACE.

Pillay, Kiru, & Maharaj, Manoj. (2010). An Overview of Web 2.0 Social Media as a tool for advocacy. *University of KwaZulu Nata. South Africa*.

Podsakoff, Philip M, MacKenzie, Scott B, Lee, Jeong-Yeon, & Podsakoff, Nathan P. (2003). Common method biases in behavioral research: a critical review of the literature and recommended remedies. *Journal of applied psychology, 88*(5), 879.

Poppy, GM, Chiotha, S, Eigenbrod, F, Harvey, CA, Honzák, M, Hudson, MD, . . . Shackleton, CM. (2014). Food security in a perfect storm: using the ecosystem services framework to increase understanding. *Philosophical Transactions of the Royal Society B: Biological Sciences, 369*(1639), 20120288.

Pretorius, Elizabeth J. (2002). Reading ability and academic performance in South Africa: Are we fiddling while Rome is burning?

Qiang, Christine Zhen-Wei, Rossotto, Carlo M, & Kimura, Kaoru. (2009). Economic impacts of broadband. *Information and Communications for Development 2009: Extending Reach and Increasing Impact*, 35-50.

Quadir, Iqbal. (1999). Connectivity Is Productivity: Found at http://www. grambangla. com/grameen/GramPhone_IK. php.

Quadir, Iqbal (2000). Connecting Bangladeshi Villages: Unpublished.

Quisumbing, Agnes R, & Pandolfelli, Lauren. (2010). Promising approaches to address the needs of poor female farmers: Resources, constraints, and interventions. *World Development, 38*(4), 581-592.

Rai, Arun, Ravichandran, Thiagarajan, & Samaddar, Subhashish. (1998). How to anticipate the Internet's global diffusion. *Communications of the ACM, 41*(10), 97-106.

Rezai-Rad, M, Vaezi, R, & Nattagh, F. (2012). E-health readiness assessment framework in iran. *Iranian journal of public health, 41*(10), 43.

Rivera, William M, Alex, Gary, Hanson, James, & Birner, Regina. (2006). *Enabling agriculture: The evolution and promise of agricultural knowledge frameworks.* Paper presented at the Proceedings of the Association for International Agricultural and Extension Education.

Robertson, Maxine, Scarbrough, Harry, & Swan, Jacky. (2003). Knowledge creation in professional service firms: Institutional effects. *Organization Studies, 24*(6), 831-857.

Rogers. (1995). *Diffusion of innovations* (3rd ed.). New York: Collier Macmillan.

Rogers. (2003). *Diffusion of Innovations* (5th ed.): New York: Free Press.

Rogers (Ed.). (2010). *Diffusion of innovations*: Simon and Schuster.

Rogers, E. M (Ed.). (2010). *Diffusion of innovations*: Simon and Schuster.

Rogers, E. M. (1961). Characteristics of agricultural innovators and other adopter categories. *DOCUMENT RESUME EM 008 224 Katz, Elihu; And Others Studies of Innovation and of Communication to the Public. Studies in the Utilization of Behavioral*, 62.

Rogers, Everett M, & Kincaid, D Lawrence. (1981). Communication networks: Toward a new paradigm for research.

Rogers, Everette M. (1963). The adoption process: Part I. *Journal of Cooperative Extension, 1*(1), 16-22.

Rohman, Ibrahim Kholilul. (2013). The globalization and stagnation of the ICT sectors in European countries: An input-output analysis. *Telecommunications policy, 37*(4), 387-399.

Rose, Andrew K, & Spiegel, Mark M. (2012). Cross-country causes and consequences of the 2008 crisis: early warning. *Japan and the World Economy, 24*(1), 1-16.

Ruiz-Garcia, Luis, & Lunadei, Loredana. (2011). The role of RFID in agriculture: Applications, limitations and challenges. *Computers and Electronics in Agriculture, 79*(1), 42-50.
Ryan, Bryce, & Gross, Neal C. (1943). The diffusion of hybrid seed corn in two Iowa communities. *Rural sociology, 8*(1), 15-24.
Saghir, A, Chaudhary, KM, Muhammad, S, & Maan, AA. (2013). ROLE OF ICTS IN BRIDGING THE GENDER GAP OF INFORMATION REGARDING LIVESTOCK PRODUCTION TECHNOLOGIES. *JAPS, Journal of Animal and Plant Sciences, 23*(3), 929-933.
Sahin, Ismail. (2006). Detailed Review of Rogers' Diffusion of Innovations Theory and Educational Technology-Related Studies Based on Rogers' Theory. *Online Submission, 5*.
Sahyoun, Nadine R, Nord, Mark, Sassine, Anniebelle J, Seyfert, Karin, Hwalla, Nahla, & Ghattas, Hala. (2014). Development and Validation of an Arab Family Food Security Scale. *The Journal of nutrition, 144*(5), 751-757.
Samanta, R. K. (2010). *Revamping agricultural education in the context of globalization*. Delhi: B.R. Pub. Corp.
Sartorius, Kurt, & Sartorius, Benn. (2013). The comparative performance of chartered accountancy students in South Africa: The impact of historical legacies. *Development Southern Africa, 30*(3), 401-416.
Satyanarayana, P, & Yogendran, S. (2013). Military applications of GIS.
Saunders, M., Lewis, P. , & Thornhill, A. (2009). *Research Methods for Business Students* (5 ed.). London: Harlow: FT/Prentice Hall.
Schiffman, L. G. , & Kanuk, L. L. (1997). *Consumer Behaviour*. London: Prentice Hall.
Schirmacher, Wolfgang. (2002). *German 20th century philosophical writings*. New York; London: Continuum.
Schreiber, James B, Nora, Amaury, Stage, Frances K, Barlow, Elizabeth A, & King, Jamie. (2006). Reporting structural equation modeling and confirmatory factor analysis results: A review. *The Journal of Educational Research, 99*(6), 323-338.
Schumacker, Randall E, & Lomax, Richard G. (2004). *A beginner's guide to structural equation modeling*: Psychology Press.
Schwartz, P., & Leyden, P. . (2003). The Long Boom: A History of the Future, 1980 - 2020. from http://archive.wired.com/wired/archive/5.07/longboom_pr.html
Sekaran, U, & Bougie, R. (2010). Research methods for business: A skill building approach. Wiley: London.
Sharif, Mohd Hisham Mohd, Troshani, Indrit, & Davidson, Robyn. (2014). Adoption of Social Media Services: The Case of Local Government. *Demand-Driven Web Services: Theory, Technologies, and Applications*, 287.
Sharp, Lauriston. (1952). Steel axes for stone-age Australians. *Human organization, 11*(2), 17-22.
Shiferaw, Bekele, Kebede, Tewodros, Kassie, Menale, & Fisher, Monica. (2015). Market imperfections, access to information and technology adoption in Uganda: challenges of overcoming multiple constraints. *Agricultural economics*.
Simba, Daudi O. (2004). PRACTICE POINTS Application of ICT in strengthening health information systems in developing countries in the wake of globalisation. *African health sciences, 4*(3), 194-198.
Singh, Virendra, Sankhwar, Shweta, & Pandey, Dhirendra. (2015). THE ROLE OF INFORMATION COMMUNICATION TECHNOLOGY (ICT) IN AGRICULTURE. *GLOBAL JOURNAL OF MULTIDISCIPLINARY STUDIES, 3*(4).
Sinton, Diana Stuart, & Lund, Jennifer J. (2007). *Understanding place: GIS and mapping across the curriculum*: ESRI, Inc.
Spaull, Nicholas. (2013). Poverty & privilege: Primary school inequality in South Africa. *International Journal of Educational Development, 33*(5), 436-447.

Ssekakubo, Grace, Suleman, Hussein, & Marsden, Gary. (2011). *Issues of adoption: have e-learning management systems fulfilled their potential in developing countries?* Paper presented at the Proceedings of the South African Institute of Computer Scientists and Information Technologists Conference on Knowledge, Innovation and Leadership in a Diverse, Multidisciplinary Environment.

StatsSA. (2012). Census 2011 Municipal report KwaZulu-Natal Pretoria: Statistics South Africa.

Strong, Robert, Ganpat, Wayne, Harder, Amy, Irby, Travis L, & Lindner, James R. (2014). Exploring the Use of Information Communication Technologies by Selected Caribbean Extension Officers. *The Journal of Agricultural Education and Extension, 20*(5), 485-495.

Tacoli, Cecilia, & Mabala, Richard. (2010). Exploring mobility and migration in the context of rural—urban linkages: why gender and generation matter. *Environment and Urbanization, 22*(2), 389-395.

Tamrat, Tigest, & Kachnowski, Stan. (2012). Special delivery: an analysis of mHealth in maternal and newborn health programs and their outcomes around the world. *Maternal and child health journal, 16*(5), 1092-1101.

Teo, Timothy, & Noyes, Jan. (2011). An assessment of the influence of perceived enjoyment and attitude on the intention to use technology among pre-service teachers: A structural equation modeling approach. *Computers & Education, 57*(2), 1645-1653.

The Guardian. (2013). How the horsemeat scandal unfolded – timeline. *Food Safety.* Retrieved 11/12/2014, 2014, from http://www.theguardian.com/world/2013/feb/08/how-horsemeat-scandal-unfolded-timeline

The Presidency. (2011). *Department of Performance Monitoring and Evaluation: Strategic Plan (2011/12 - 2015)*. Pretoria: The Presidency.

Tittonell, Pablo, Muriuki, A, Shepherd, Keith D, Mugendi, D, Kaizzi, KC, Okeyo, J, . . . Vanlauwe, Bernard. (2010). The diversity of rural livelihoods and their influence on soil fertility in agricultural systems of East Africa–A typology of smallholder farms. *Agricultural systems, 103*(2), 83-97.

Tong, Canon, Tak, Walder Ip Wah, & Wong, Anthony. (2013). The impact of knowledge sharing on the relationship between organizational culture and job satisfaction: the perception of information communication and technology (ICT) practitioners in Hong Kong. *International Journal of Human Resource Studies, 3*(1), Pages 9-37.

Touray, Almamy, Salminen, Airi, & Mursu, Anja. (2013). ICT barriers and critical success factors in developing countries. *The Electronic Journal of Information Systems in Developing Countries, 56*.

Tsai, Hsien-Tang, Hong, Jai-Tsung, Yeh, Shang-Pao, & Wu, Tung-Ju. (2014). Consumers' Acceptance Model for Taiwan Agriculture and Food Traceability System. *Anthropologist, 17*(3), 845-856.

Tscharntke, Teja, Clough, Yann, Wanger, Thomas C, Jackson, Louise, Motzke, Iris, Perfecto, Ivette, . . . Whitbread, Anthony. (2012). Global food security, biodiversity conservation and the future of agricultural intensification. *Biological conservation, 151*(1), 53-59.

Uimonen, Paula, & Hellström, Johan. (2015). ICT4D Donor Agencies and Networks. *The International Encyclopedia of Digital Communication and Society*.

UN News Centre. (2010). Rural women key to economic growth, says UN official. 21/10/14, from http://www.un.org/apps/news/story.asp?NewsID=34165&Cr=agriculture&Cr1

United Nations. (2007). United nations declaration on the rights of indigenous peoples. *UN Wash, 12*, 1-18.

United Nations. (2010). WE CAN END POVERTY 2015 MILLENIUM DEVELOPMENT GOALS. from hhtp://http://www.un.org/millenniumgoals/
United Nations. (2011). World Population Prospects: The 2010 Revision.
United Nations. (2012). World Agriculture Towards 2030/2050: The 2012 Revision.
United Nations. (2013). Millennium Development Goals and Beyond 2015. Retrieved 22/05/15, 2015, from http://www.un.org/millenniumgoals/pdf/Goal_1_fs.pdf
United Nations. (2015a). Goal 17: Revitalize the global partnership for sustainable development. Retrieved 27/09/15, 2015, from http://www.un.org/sustainabledevelopment/globalpartnerships/
United Nations. (2015b). Millennium development goals and beyond 2015. Retrieved 23/08/15, 2015, from http://www.un.org/millenniumgoals/
United Nations. (2015c). Sustainable Development Goals Fact Sheet. Retrieved 28/09/15, 2015, from http://www.un.org/sustainabledevelopment/wp-content/uploads/2015/08/Factsheet_Summit.pdf
USDA. (2014). Current Recalls and Alerts. Retrieved 30-05-14, 2014, from http://www.fsis.usda.gov/wps/portal/fsis/topics/recalls-and-public-health-alerts/current-recalls-and-alerts
Van Audenhove, Leo. (2003). Towards an integrated information society policy in South Africa: an overview of political rhetoric and policy initiatives 1994–2000.
Van der Vorst, JGAJ, van Beurden, Jan, & Folkerts, Henk. (2003). Tracking and tracing of food products–An international benchmark study in food supply chains. *Management summary, Rinjnconsult, The Netherlands*.
van Vark, Caspar, Humphrey, John, Sampathkumar, Raghavan, Nicolaides, Linda, Robinson, Pamela, Ducharme, Heather, & Longfield, Jeanette. (2013). What do food traceability crises in the North mean for people working in food chains in the global South? *Food Chain, 3*(1), 5-17.
Veltri, Natasha F, & Elgarah, Wafa. (2009). The Role of National Culture Differences in User Adoption of Social Netowrking.
Venkatesh, V, & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. *Decision sciences, 39*(2), 273-315.
Venkatesh, V, Morris, M, Davis, G, & Davis, F. (2003). USER ACCEPTANCE OF INFORMATION TECHNOLOGY: TOWARD A UNIFIED VIEW. *MIS quarterly, 27*(3), 425-478.
Venkatesh, V, Sykes, T, & Venkatraman, S. (2014). Understanding e-Government portal use in rural India: role of demographic and personality characteristics. *Information Systems Journal, 24*(3), 249-269.
Venkatesh, V, & Zhang, X. (2010). Unified Theory of Acceptance and Use of Technology: US Vs. China. *Journal of Global Information Technology Management, 13*(1).
Venton, Courtenay Cabot, Fitzgibbon, Catherine, Shitarek, Tenna, Coulter, Lorraine, & Dooley, Olivia. (2012). The economics of early response and disaster resilience: lessons from Kenya and Ethiopia. *London: DFID*.
Wakabi, Wairagala, Gagliardone, Iginio, Kalemera, Ashnah, Kogen, Lauren, Stremlau, Nicole, & Nalwoga, Lillian. (2015). In Search of Local Knowledge on ICTs in Africa. *University of Pennsylvania*.
Warburton, J, Blake, R, Coupe, S, Pasteur, K, & Phillips, E. (2012). BRIDGING THE GAP BETWEEN RESOURCE-POOR FARMERS AND EXTENSION SERVICES: THE ROLE OF COMMUNITY-BASED EXTENSION SYSTEMS.
Warburton, J, Cowan, S, & Bathgate, T. (2013). Building social capital among rural, older Australians through information and communication technologies: A review article. *Australasian Journal on Ageing, 32*(1), 8-14. doi: 10.1111/j.1741-6612.2012.00634.x
Warren, D Michael. (1992). A preliminary analysis of indigenous soil classification and management systems in four ecozones of Nigeria. *The African Resource Centre for Indigenous Knowledge, NISER, Ibadan*.

Webb, EJ, & Campbell, DT. (1966). RD Schwartz en L. Sechrest, Unobtrusive measures: Nonreactive research in the social sciences: Chicago: Rand McNally.
Wheeler, Tim, & von Braun, Joachim. (2013). Climate Change Impacts on Global Food Security. *science, 341*(6145), 508-513. doi: 10.1126/science.1239402
White, Ben. (2012). Agriculture and the generation problem: rural youth, employment and the future of farming. *IDS Bulletin, 43*(6), 9-19.
Williamson, Oliver E. (2000). The new institutional economics: taking stock, looking ahead. *Journal of economic literature*, 595-613.
Wognum, PM Nel, Bremmers, Harry, Trienekens, Jacques H, van der Vorst, Jack GAJ, & Bloemhof, Jacqueline M. (2011). Systems for sustainability and transparency of food supply chains–Current status and challenges. *Advanced Engineering Informatics, 25*(1), 65-76.
World Bank. (2008a). High Food Prices - A Harsh New Reality. from http://go.worldbank.org/EROSXNAG0
World Bank. (2008b). World development report 2008: Agriculture for development. Washington, DC The World Bank.
World Bank. (2010). *Gender and Governance in Rural Services: Insights from India, Ghana and Ethiopia*: The World Bank.
World Bank. (2013). Media (R)evolutions: Global Mobile Phone Penetration. 08/06/15, from http://blogs.worldbank.org/publicsphere/media-revolutions-global-mobile-phone-penetration
Worth, Steve. (2012). Agricultural extension in South Africa: status quo report: Pretoria, South Africa: Department of Agriculture, Forestry and Fisheries.[Links].
Wu, Jen-Her, & Wang, Shu-Ching. (2005). What drives mobile commerce?: An empirical evaluation of the revised technology acceptance model. *Information & management, 42*(5), 719-729.
Xia, Jun. (2010). Linking ICTs to rural development: China's rural information policy. *Government Information Quarterly, 27*(2), 187-195.
Yin, R. K. . (1989). *Case study research: design and methods*. Newbury Park: Sage.
Yuliasari, Ika, Saleh, Amiruddin, Hubeis, Musa, & Sarwoprasodjo, Sarwititi. (2014). Discourse of Rural Development in Indonesia Local Media. *Jurnal Komunikasi Pembangunan, 12*(1).
Zabihi, Hossein, Habib, Farah, & Mirsaeedie, Leila. (2013). Towards Green Building: Sustainability Approach in Building Industrialization. *International Journal of Architecture and Urban Development, 3*(3), 49-56.
Zikmund, William, Babin, Barry, Carr, Jon, & Griffin, Mitch. (2012). *Business research methods*: Cengage Learning.

Appendix A: Smallholder Farmer Questionnaire (English Version)

THE ROLE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY IN IMPROVING FOOD SECURITY IN KWAZULU-NATAL

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Ethical Clearance Number:

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How to complete this questionnaire

- Please answer the questions as truthfully as you can. Be sure to read and follow the instructions of each section.
- All responses in this questionnaire will be treated with confidentiality and consent will be sort from the respondents before making any the findings public if need be. If you do not feel comfortable answering a question you can indicate that you do not want to answer it. It would be highly appreciated if you could answer as many questions as possible.
- You can indicate each response by making a tick or a cross, or encircling each appropriate response with a PEN (not a pencil), or by filling in the required words or number.

Participant Code _____

Section 1: Your Personal Information (Farmer)

1. My gender is:

- ❑ Female
- ❑ Male

2. I grew up in:
   - ❑ A rural area
   - ❑ A semi urban area
   - ❑ An urban area

3. I belong to the following ethnic group:
   - ❑ An African / Black
   - ❑ Indian / Asian
   - ❑ White
   - ❑ Coloured
   - ❑ A member of another ethnic group

4. My age falls within the range:
   - ❑ 20 to 29
   - ❑ 30 to 39
   - ❑ 40 to 49
   - ❑ 50 to 59
   - ❑ 60 or older

Section 2: General farmer Information

5. I have the following number of years of experience in farming:
   - ❑ 3 or less
   - ❑ 4 to 9
   - ❑ 10 to 19
   - ❑ 20 or more

6. Do you have formal education:
   - ❑ Yes (certificate)
   - ❑ Yes (Degree)
   - ❑ Yes (Higher than degree)
   - ❑ No

7. What is the size of farms you own/manage:
   - ❑ Subsistent farm (small scale)
   - ❑ Commercial farm

8. By estimation, how often do you travel to big towns/cities:
   - ❑ Once a month
   - ❑ Twice a month
   - ❑ 3 – 5 times a month
   - ❑ 6 – 10 times a month
   - ❑ Rarely

9. By estimation, how often do you visit the agricultural extension officer responsible for your ward:
   - ❑ Once a month

- ❑ Twice a month
- ❑ 3 – 5 times a month
- ❑ 6 – 10 times a month
- ❑ rarely

10.

	Never	Daily	Weekly	Monthly	Randomly
How often do you receive reading materials from the extension officer responsible for your ward (e.g. magazines, newsletters)?					

11.

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
Information provided to you in English is more effective than information provided in indigenous language.					

12.

	Very small extent	Small extent	Never	large extent	Very large extent
To what extent do you depend on the extension officer responsible for your ward for farming information?					

13.

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
13.1 As a farmer I work closely with					

the extension officer responsible for my ward for the day-to-day running of my farm					
13.2 As a farmer I am on first name basis with the extension officer responsible for my ward					
13.3 As a farmer I feel the extension officer helps remove unease in situations in which there are no clear guidelines					
13.4 In my opinion farming innovations lead by females are usually not adopted by farmers					
13.4 The extension officer encourage planning only on a seasonal basis					

Section 3: Information & Communication Technology (ICT)

ICT refers to technologies that provide access to information through telecommunications. This includes the Internet, wireless networks, cell phones, radio, television and other communication mediums.

14.

	Very small extent	Small extent	Never	large extent	Very large extent
14.1 To what extent do you use ICTs on your farm?					

15.

	Extremely hard	Quite hard	Neither	Quite easy	Extremely easy
15.1 How easy do you find ICTs are to use in your work?					

16.

	Extremely useless	Quite useless	Neither	Quite useful	Extremely useful
16.1 How useful do you find ICTs are in relation to your work?					

17. When did you decide to start using ICTs?
    - ❑ Do not use ICTs
    - ❑ 0-2 year ago
    - ❑ 2-4 years ago
    - ❑ 4-6 years ago
    - ❑ More than 6 years ago

18.

	Very small extent	Small extent	Never	large extent	Very large extent
18.1 To what extent do you share information with fellow farmers?					

19. What means do you use to share information with fellow farmers?

- ❑ Face-to-face
- ❑ Local radio
- ❑ Agricultural extension workers
- ❑ Gatherings/workshops
- ❑ Don't share information
- ❑ Telephone
- ❑ Newspapers
- ❑ Internet-mail
- ❑ Posters/brochures

20. What means do you use to share information with your extension officer?

- ❑ Face-to-face
- ❑ Local radio
- ❑ Agricultural extension workers
- ❑ Gatherings/workshops
- ❑ Don't share information
- ❑ Telephone
- ❑ Newspapers
- ❑ Internet-mail
- ❑ Posters/brochures

21.

	More than once per day	Once a day	2-3 times per week	Seldom	Never
21.1 To what extent do you use ICTs to share information with fellow farmers					
21.2 To what extent do you use ICTs to share information with the extension officer					

22. What influenced you to adopt ICTs?
    - ❑ Desire to be innovative
    - ❑ Avoid being left behind by others
    - ❑ To solve a problem
    - ❑ Desire to use new technology
    - ❑ Institutional pressure

23. Please rank the following media in order of your preference of media you use (Place the number on the box besides the media type) 1 – Most preferred to 10 – Least preferred

Add ranking below	Media Type	Add ranking below	Media Type
	Mobile phone(voice calls & sms)		Telephone (landline)
	Smart phone(internet access)		Websites
	Local radio		Newspapers
	Agricultural extension workers		Internet-mail
	Gatherings/workshops		Posters/brochures

24. How often do you use the following:

	More than once per day	Once a day	2-3 times per week	Seldom	Never
24.1 Mobile phone (sms & voice calls only)					
24.2 Desktop Computer					
24.3 Laptop or tablet computer					
24.4 Smart phone (internet services)					
24.5 Satellite data					
24.6 Fixed line internet					
24.7 Television					
24.8 Landline					
24.9 Radio					

25.

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
25.1 I am willing to adopt new communication media to access information					
25.2 I am willing to adopt new communication media to share information					

26.

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
26.1 ICTs are compatible with the business needs of my work					
26.2 ICTs are compatible with the					

information needs of farming					
26.3 ICTs are compatible with the cultural norms of farming					
26.4 ICTs are compatible with the existing infrastructure at my farm					

27.

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
27.1 Being given a chance to physically experience the use and functions of ICTs over a prescribed test period allows me to adopt them easily					

28.

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
28.1 Being able to see ICTs in use encouraged me to adopt them					

Section 4: Geographic Information Systems (GIS)

A geographic information system (GIS) is a computer application used to store, view, and analyze geographical information, especially maps.

29.

	Very small extent	Small extent	Never	large extent	Very large extent
29.1 To what extent do you use GIS in your farming activities?					

30. I use GIS for:

	Tick where applicable
30.1 Determining suitable areas for growth of crops	
30.2 Assessing the health of crops using satellite imagery	
30.3 Detecting crop diseases	
30.4 Detecting vulnerable areas to natural disasters e.g. floods	
30.5 Conducting suitability analysis of farm land e.g. soil, rainfall etc.	
30.6 Plotting the farms in order to determine fertilizer and crop seed use	
30.7 Estimating crop yields	
30.8 Identifying needy areas in terms of food supply by mapping populations	
30.9 Identifying areas where consistent access to healthy food is limited	
30.10 Mapping resources on farms e.g. infrastructure, irrigation pipes etc.	
30.11 Determining easiest access routes to markets	

Section 5: knowledge management systems (KMS)

Knowledge management Systems (KMS) comprises a range of practices used in an organization to identify, create, represent, distribute, and enable adoption of insights and experiences.

31.

	Very small	small extent	Never	large extent	Very large

	extent				extent
31.1 To what extent do you use indigenous knowledge in your farming activities?					
31.2 To what extent do you use institutional knowledge in your farming activities?					
31.3 In your opinion, to what extent does indigenous knowledge influence your choice to use ICTs?					
31.4 In your opinion, to what extent does institutional knowledge influence your choice to use ICTs?					
31.5 To what extent are you involved in knowledge management practices (identifying, creating, representing, distributing, and enabling adoption of insights and experiences)?					

32. Do you use ICTs in your knowledge management practices?
    - ❑ Yes
    - ❑ No

33. Which of the following Knowledge Management System (KMS) do you use?

	Tick where applicable
33.1 Websites	
33.2 Spreadsheets	
33.3 Databases	
33.4 Notebooks	

33.5 Traditional stories	
33.6 Do not use any	

34. Which of the following areas do you to use Knowledge Management System (KMS)?

	Tick where applicable
34.1 Crop cultivation	
34.2 Fertilizer application	
34.3 Pest management	
34.4 Harvesting	
34.5 Post-harvest handling	
34.6 Transporting of food/products	
34.7 Packaging	
34.8 Food preservation	
34.9 Food processing	
34.10 Food quality management	
34.11 Food safety	
34.12 Food storage	
34.13 Food marketing	
34.14 Do not use in any area	

35.

	Very small extent	small extent	Never	large extent	Very large extent
35.1 To what extent do you use systems that will allow for the tracing of the					

movement of your farm products?					

36. Which of the following traceability tools do you use?

	Tick where applicable
36.1 RFID tags	
36.2 Smart packaging	
36.3 Branding	
36.4 Do not use any	

Section 6: early warning systems (EWS)

EWS are systems of data collection and analysis to monitor plant well-being (including food security), in order to provide timely notice when an emergency threatens, and thus to elicit an appropriate response. These systems provide information on occurring hazards that might evolve into disasters unless early response is undertaken. The objective of EWS therefore is to monitor the first signs of emerging hazards in order to be able to trigger early and appropriate responses to these first signs and thus reduce or mitigate disaster risk.

37.

	Very small extent	Small extent	Never	large extent	Very large extent
36.1 To what extent do you use early warning systems (EWS) in your farming activities?					

38.

37.1 What kind of EWS do you use?	Tick where applicable
37.1 Websites	

37.2 Phones	
37.3 Radio	
37.4 Two way radios	

Thank you again for completing this questionnaire.

Appendix B: Smallholder Farmer Questionnaire (iSiZulu Version)

INDIMA YOLWAZI LWEZOBUCHWEPHESHE KWEZOKUXHUMANA EKUTHUTHUKISENI UKWANELISEKA KOKUDLA OKUNOMSOCO KWAZULU-NATAL

Umdidiyeli: Ntabeni Jere 208529551 (083 976 1105)

Ethical Clearance Number:

Umhleli: Prof. Manoj Maharaj (031 260 7051)

School of Management, IT and Governance

Inyuvesi YaKwaZulu-Natal (South Africa)

Ungayiphendula kanjani lemibuzo

- Uyacelwa ukuba uphendule lemibuzo ngokwethembeka. Qinisekisa ukulandela imiyalelo yengxenye ngayinye.
- Zonke izimpendulo kulemibuzo zizogcinwa ngokuthembeka nangokufihleka kanti futhi imiphumela yazo ayizukuphumela esidlangalaleni ngaphambi kokuvumelana nabaphenduli.
- Ungatshengisa izimpendulo zakho ngokuthikha (tick) noma wenze isiphambano okanye wenze indilinga kuleyo naleyo mpendulo yakho usebenzise ipeni lika-inki (elomusizi ungalisebenzisi) noma ugcwalise ngamagama noma izinamba ezilindelekile.

I-khodi yomumbandakanyi _____

Isigaba soku-1: Imininingwane (umlimi)

39. Ubulili bami:
    - ❑ Owesifazane
    - ❑ Owesilisa

40. Ngakhulela:
    - ❑ Emakhaya

- ❑ Elokushini
- ❑ Edolobheni

41. Ubuzwe bami:
    - ❑ Ngingonsundu
    - ❑ Ngiyi-ndiya
    - ❑ Ngingomhlophe
    - ❑ Khaladi
    - ❑ Ngingowobunye ubuzwe

42. Ngineminyaka ephakathi kwa:
    - ❑ 20 kuya -ku 29
    - ❑ 30 kuya-ku 39
    - ❑ 40 kuya-ku 49
    - ❑ 50 kuya-ku 59
    - ❑ 60 nangaphezulu

Isigaba sesi-2: Imniningwane ejwayelekile (umlimi)

43. Nginolwazi olunzulu kwezama-pulazi leminyaka engu:
    - ❑ 3 noma ngaphansi
    - ❑ 4 kuya ku- 9
    - ❑ 10 kuya ku- 19
    - ❑ 20 noma ngaphezulu

44. Unayo imfundo esezingeni eliphezulu:
    - ❑ Yebo (isitifiketi)
    - ❑ Yebo (digri)
    - ❑ Yebo(okungaphezulu kwe-digri)
    - ❑ Cha

45. Lingakanani ipulazi lakho oliphethe:
    - ❑ Elincane
    - ❑ Elikhulu lokudayisa

46. Ngokucabanga kwakho uya kangaki endaweni yase-dolobheni:
    - ❑ Kanye enyangeni
    - ❑ Kabili enyangeni
    - ❑ Kathathu noma kahlanu enyangeni
    - ❑ Ezikhathini eziyisithupha kuya kweziyishumi enyangeni
    - ❑ Akuvamile

47. Ngokucabanga kwakho,umvakashela kangakanani umuntu ophethe kwezokulima ewadini yakho:
    - ❑ Kanye enyangeni
    - ❑ Kabili enyangeni
    - ❑ Kathathu noma kahlanu enyangeni

- ❑ Ezikhathini eziyisithupha kuya kweziyishumi enyangeni
- ❑ Akuvamile

48.

	Cha	Ngosuku	Ngeviki	Ngenyanga	Noma yinini
10.1 Ukutholakangaki okokufunda kophethe ewadini lakho(njenge bhuku lezindaba noma iphepha ndaba)					

49.

	Ngiyaphi kisana kakhulu	Ngiyaphi kisana	Anginaso isiqiniseko	Ngiyavu melana	Ngiyavu melana kakhulu
11.1.Imininingwano oyethulelwa ngolimi lwesingisi ingcono kunaleyo eyathulwa ngezinye izilimi					

50.

	Mbijane	Kancane	Nakanye	Kakhulu	Kakhud lwana
12.1Uncike kangakanani kumphathi wakho ophethe ewadini lakho kwezokulima					

51.

	Ngiyaphikisana kakhulu	Ngiyaphikisana	Anginaso isiqiniseko	Ngiyavumelana	Ngiyavumela kakhulu
13.1 Njengomlimi ngisebenzisana kakhulu					

nomphathi wami ewadini, zonke izinsuku					
13.2 Njengomlimi ngisondelene nomphathi wewadi yami					
13.3 Njengomlimi ngibona ukuthi umphathi uwusizo ezintweni engingaziqondi mayelana ne-pulazi					
13.4 Ngolwazi lwami izindlela ezintsha zokulima ezisungulwa abesimame azamukelwa abesilisa kalula					
13.4 Umphathi uyakugqugquzela ukutshala ngezikhathi ezahlukene(ihlobo noma ubusika)					

Isigaba sesi-3: ulwazi lwezobuchwepheshe kwezokuxhumana (ICT)

ICT ihambisana nobuchwepheshe obuzokunika ulwazi olutholakala kwi-telecommunication (ukuxhumana). Lokhu kuthinta intanethi, umakhalekhukhwini, intanethi, imisakazo, omabonakude kanye nokunye okuthinta okwezokuxhumana.

14.

	Mbijane	Kancane	Nakanye	Kakhulu	Kakhud lwana
14.1Uyisebenzisa kangakanani i-ICT epulazini lakho?					

.15.

	Kunzima kakhulu	Kunzima	Kukahle	Kulula	Kulula kakhulu
15.1 Ingabe kulula yini kuwe ukusebenzisa i-ICT epulazini lakho?					

16.

	Ayinamsebenzi	Ayidingeki	Ikahle	Iyadingeka	Iyadingeka kakhulu
16.1 Ikusiza kangakanani i-ICT emusebenzini wakho?					

17.Waqala nini ukusebenzisa i-ICT?

- ❑ Angiyisebenzisi
- ❑ Eminyakeni emibili edlule
- ❑ Eminyakeni emibili kuya kwemine edlule
- ❑ Eminyakeni eminei kuya kweyisithupha edlule
- ❑ Eminyakeni engaphezu kweziyisthupha edlule

18.

	Mbijane	kancane	Nakanye	Kakhulu	Kakhud lwana
18.1 Nicobelelana kangakanani ngolwazi nabanye osoma pulazi?					

19.Nicobelelana ngayiphi indlela nabanye osoma pulazi ulwazi

- ❑ Umlomo no-mlomo
- ❑ Ngomsakazo
- ❑ Ngabasebenzi bakwezolimo
- ❑ Ngokuhlanganyela
- ❑ Asilucobeleli ulwazi
- ❑ Ngocingo

- ❑ Ngephephandaba
- ❑ I-meyili
- ❑ Ngama-phosta

20.Yini oyisebenzisayo ukucobelelana ngolwazi nomphathi wakho?

- ❑ Umlomo no-mlomo
- ❑ Ngomsakazo
- ❑ Ngabasebenzi bakwezolimo
- ❑ Ngokuhlanganyela
- ❑ Asilucobeleli ulwazi
- ❑ Ngocingo
- ❑ Ngephephandaba
- ❑ I-meyili
- ❑ Ngama-phosta

21.

	Ngaphezu kokukodwa ngosuku	Kanye ngosuku	Ka-2 noma ka-3 ngeviki	Akujwayelekile	akwenzeki
21.1 Uyisebenzisa kangaki i-ICT ekucobelelaneni ulwazi nabanye osomaplulazi?					
21.2 Uyisebenzisa kangaki i-ICT ekucobelelaneni ulwazi nomphathi wakho?					

22.Yini eyakwenza ukuba Usebenzise i-ICT?

- ❑ Ukufuna ukuba phambili ngolwazi
- ❑ Ukugwema ukusalela emumva
- ❑ Ukufuna ukuxazulula izinkinga
- ❑ Ukufuna ukusebenzisa ubuchwepheshe obusha
- ❑ Ukuhlohlwa yinkampani

23.qondanisa izinhlobo zokuxhumana ukuze kuzotholakala oyincamelayo (faka inombolo ebhokisini eliseceleni kwenhlobo yokuxhumana oyicamelayo). 1- oyincamela kakhulu kuyaku-10 ongayincami nhlobo.

Gcwalisa ngenombol	Uhlobo lokuxhumana	Gcwalisa inombolo	Uhlobo lokuxhumana

o ngezansi		ngezansi	
	Umakhala ekhukhwini		Ucingo
	Umakhala ekhukhwini one-internet		Ama-Websites
	Umsakazo wangakini		Iphepha ndaba
	Abasebenzi ba-Hulumeni bomyango we-Agriculture		Intanethi
	imihlangano		amaphosta

24. ukusebenzisa kangaki lokhu okulandelayo

	Ngaphezu kokukodwa ngosuku	Kanye ngosuku	Kabili noma kathathu ngeviki	akujwa yelekile	akwenzeki
24.1 Umakhala ekhukhwini					
24.2 ikhompuyutha yasendlini					
24.3 iLaptop					
24.4 Umakhala ekhukhwini one-internet					
24.5 Ulwazi oluvela kuma-satellite					
24.6 i-internet yasendlini					
24.7 umabonakude					
24.8 ucingo lwasendlini					
24.9 umsakazo					

25.

	Angivumi nhlobo	angivumi	Anginaso isiqiniseko	ngiyavuma	Ngivuma kakhulu
25.1 ngizimisele ukusebenzisa indlela entsha yokuxhumana yokuthola ulwazi					
25.2 ngizimisele ukusebenzisa indlela entsha yokuxhumana nokucobelelana ngolwazi					

26.

	Angivumi nhlobo	angivumi	Anginaso isiqiniseko	ngiyavuma	Ngivuma kakhulu

26.1 Ama ICTs ayahambisana nezidingo zebhizinisi engilisebenzelayo					
26.2 Ama ICTs ayahambisana nolwazi oludingekayo emapulazini					
26.3 Ama ICTs ayahambiselana nendlela zezamapulazi					
26.4 Ama ICTs ayahambisana nobume beplazi lami					

27.

	Angivumi nhlobo	angivumi	Anginaso isiqiniseko	ngiyavuma	Ngivuma kakhulu
27.1 ukunikwa ithuba lokuzenzela mathupha imisebenzi yama ICTs esikhathini sesivivinyo esibekiwe kungenza ukuthi ngazi kalula					

28.

	Angivumi nhlobo	angivumi	Anginaso isiqiniseko	ngiyavuma	Ngivuma kakhulu
28.1 ukubona ama ICTs esetshenziswa kuyangigqugquzela ukubangiwasebenzise					

Isigaba sesi-4: i-Geographic Information Systems (GIS)

I-geographic information system (GIS) iyikhompyutha egcina, ihlole, iphinde ihlaziye ulwazi oluhambiselana nokomhlaba , kakhulukazi ama-mephu.

29.

	Mbijane	Kancane	Nakanye	kakhulu	Kakhud lwana
29.1 Uyisebenzisa kangakanani I-GIS emisebenzini yezamapulazi					

30.I- GIS ngiyisebenzisela:

	Thikha enzansi
30.1 Ekuboneni indawo ekahle yokukhulisa izitshalo	
30.2 Ukubona impilo yezitshalo ngisebenzisa i- satellite imagery	
30.3 ukuhlola izifo Zezitshalo	
30.4 ukuthola izindawo ezihlaseleka kalula izimo zezulu (izikhukhula)	
30.5 ukuhlaziya indawo evundile yokwenza ipulazi (inhlabathi enhle, nemvula)	
30.6 ukuhlola ipulazi ukuze kuzotholakala umanyolo ohambisana nepulazi.	
30.7 ukubona ukukhula kwezitshalo	
30.8 ukubona indawo ezidingakalayo zokucanana ukudla	
30.9 ukubona indawo	

evimbelekileukukhiqiza ukudla okunomsoco	
30.10 Ukudweba nokusetshenziswa kwezisetshenziso amapulazini njengama payipi nokunye okusetshenziswayo.	
30.11 indlela elula yokungena emakethe	

Isigaba sesi-5: i-Kknowledge Management System (KMS)

KMS imayelana nezinhlobonhlobo ezisetshenziswa ngabantu ukuchaza, ukwenza, ukwethula, ukukhipha, nokuvumela ukusetshenziswa kolwazi lweminyaka olunzulu

31.

	Mbijane	Kancane	Nakanye	Kakhulu	Khakhudlwana
31.1Uzisebenzisa kangakanani izingxoxo zamasiko epulazini lakho?					
31.2Ulisebenzisa kangakanani ulwazi olwaziwayo epulazini lakho?					
31.3 Ngombono wakho izingxoxo zamasiko zinamuthelela muni ekukhetheni kwakho ukusebenzisa i-ICT?					
31.4 Ngombono wakho Ulwazi olwaziwayo linamuthelela muni ekukhetheni kwakho					

ukusebenzisa i-ICT?					
31.5 uzinikele kangakanani ekuphatheni ngokusebenzisa ulwazi(ukuchaza, ukwenza, ukwethula, ukukhipha , nokuvumela ukusetshenziswa kolwazi lweminyaka olunzulu					

32.Uyayisebenzisa i-ICT olwazini lakho lokuphatha?

- ❑ Yebo
- ❑ Cha

33.ikuphi okulandelayo kolwazi okusebenzisayo(KMS)?

	Thikha ngenznsi
33.1 Ama-*Websites*	
33.2 Ama-spreadsheets	
33.3 Ama-database	
33.4 Izincwadi	
33.5 Izinxoxo zamasiko	
33.6 Angisebenzisi lutho	

34.Iziphi izindawo osebenzisa kuzo i-KMS?

	Thikha ngezansi
34.1 Ekukhuliseni izitshalo	

34.2 Ekevundiseni	
34.3 Ukulwa nezinambuzane	
34.4 Ekuvuneni	
34.5 Ekukhiqizeni ukudla	
34.6 Ekuthutheni ukudla	
34.7 Ekupakisheni	
34.8 Ekugcineni kokudla	
34.9 Ekukhipheni ukudla	
34.10 Ukuphatha kokudla	
34.11 ukuphepha kokudla	
34.12 Ukubekwa kokudla	
34.13 Ekudayiseni ukudla	
34.14 asisebenzisi lutho	

35.

	Mbijane	kancane	Nakanye	kakhulu	Kakhudlwana
35.1Uzisebenzisa kangakanani izindlela zokukwazi ukuthi izitshalo zakho zihamba zifinyelelephi? (amasayini)					

36. Imaphi kwamathuluzi angenzansi owasebenzisayo?

	Thikha ngezansi
36.1 Amalebuli e-RFID	
36.2 Ukupakisha okuhlelekile	
36.3 Ukumaka	

36.4 Angisebenzisi lutho	

Isigaba sesi-6: ama-Early Warning Systems (EWS)

Indlela yokuqoqa ulwazi, nokuhlaziya ukukhula kwezitshalo zakho,ukuze ukwazi ukusheshe ungenele umangabe kukhona ubungozi ezibhekene nabo. EWS iqukethe ulwazi mayelana nokukhulisa izitshalo nokugwema izinto ezingaphazamisa izitshalo zakho ukuba zingakhuli. Ingqikithi ye-EWS ukuqaphelisisa ukuthi izimpawu zokuqala zosizo olusheshayo zengozi ukuze sithole isixazululo kusanesikhathi ngendlela okuyiyo kulezimpawu zokuqala ukuze kwehliswe noma kuvikelwe ubungozi obungenzeka.

37.

	mbijane	kancane	nakanye	kakhulu	kakhudlwana
37.1 Uyisebenzisa kangakanani i-EWS ekutshaleni kwakho?					

38.

38.1Iziphi izinhlobo ze-EWS ozisebenzisayo?	Thikha ngezansi
38.2Ama- Websites	
38.3 Omakhala ekhukhwini	
38.4 Umusakazo	
38.5 o-ova (walkie talkie)	

Siyabonga ngokuzinikela kwakho ekuphenduleni lemibuzo

Appendix C: Household Food Insecurity Access Scale (HFIAS) for Smallholder Farmers (English Version)

Questionnaire to be completed by field worker for smallholder farmer households in the study of the role of information and communications technology in improving food security in KwaZulu-Natal

Participant code _____

Kindly complete the following questionnaire as honestly as possible. There are no right or wrong answers. Please note that the results of this research project will not be, in any way, linked or traced back to you in person.

No.	QUESTION	RESPONSE OPTIONS	CODE
1.	Do you worry that your household would not have enough food?	0 = No (skip to Q2) 1=Yes	
1.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	
2.	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	0 = No (skip to Q3) 1=Yes	
2.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	
3.	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a	0 = No (skip to Q4) 1 = Yes	

	lack of resources?		
3.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	
4.	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	0 = No (skip to Q5) 1 = Yes	
4.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	
5.	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	0 = No (skip to Q6) 1 = Yes	
5.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten	

		times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	
6.	In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	0 = No (skip to Q7) 1 = Yes	
6.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	
7.	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	0 = No (skip to Q8) 1 = Yes	
7.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	
8.	In the past four weeks, did you or any household member go to sleep at	0 = No (skip to Q9) 1 = Yes	

	night hungry because there was not enough food?		
8.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	
9.	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	0 = No (questionnaire is finished) 1 = Yes	
9.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	

Appendix D: Household Food Insecurity Access Scale (HFIAS) for Smallholder Farmers (iSiZulu Version)

Imibuzo izogcwaliswa ngumsebenzi wocwaningo lwendima yolwazi kwezobuchwepheshe kwezokuxhumana ekuthuthukiseni ukwaneliseka kokudla okunomsoco KwaZulu-Natal.

I-khodi yomumbandakanyi _____

Qedela lemibuzo elandelayo ngokuthembeka. Khululeka zonke izimpendulo zamukelekile. Wazi ukuthi lolucwaningo angeke lubhekiswe kuwe uma usuqedile.

No.	Umbuzo	Khetha kulezizimpendulo	iKhodi
1.	Uyakhathazeka yini ukuthi emzini wakho ungase ungabi nakho ukudla okwanele?	0 = Cha (makunjalo dlulela kumbuzo 2) 1=Yebo	
1.a	Kwenzeke kangaki lokho?	1 = Akuvamile (kanye noma kabili emavikini amane adlule) 2 = Ngesinye isikhathi (kathathu kuyela eshumini emavikini amane adlule) 3 = Kuvamile (kudlulile eshumini emavikini amane adlule)	
2.	Emavikini amane adlule, kukekwenzeka ukuthi wena noma abantu ohlalisana nabo ningakwazi ukudla enikuthandayo ngenxa yokweswela?	0 = Cha (makunjalo dlulela kumbuzo 3) 1=Yebo	
2.a	Kwenzeke kangaki lokho?	1 = Akuvamile (kanye noma kabili emavikini amane adlule) 2 = Ngesinye isikhathi (kathathu kuyela eshumini emavikini amane adlule) 3 = Kuvamile (kudlulile eshumini emavikini amane adlule)	
3.	Emavikini amane adlule, kukekwenzeka ukuthi wena noma abantu ohlalisana nabo nidle ukudla kwezinhlobo ezingandile ngenxa yokweswela?	0 = Cha (makunjalo dlulela kumbuzo 4) 1=Yebo	
3.a	Kwenzeke kangaki lokho?	1 = Akuvamile (kanye noma kabili emavikini amane adlule)	

		2 = Ngesinye isikhathi (kathathu kuyela eshumini emavikini amane adlule) 3 = Kuvamile (kudlulile eshumini emavikini amane adlule)	
4.	Emavikini amane adlule, kukekwenzeka ukuthi wena noma abantu ohlalisana nabo nidle ukudla eningakuthandi ngenxa yokuntuleka kwezinsiza kusebenza zokuthola okunye ukudla?	0 = Cha (makunjalo dlulela kumbuzo 5) 1=Yebo	
4.a	Kwenzeke kangaki lokho?	1 = Akuvamile (kanye noma kabili emavikini amane adlule) 2 = Ngesinye isikhathi (kathathu kuyela eshumini emavikini amane adlule) 3 = Kuvamile (kudlulile eshumini emavikini amane adlule)	
5.	Emavikini amane adlule, kukekwenzeka ukuthi wena noma abantu ohlalisana nabo nidle isikali sokudla esincane ngenxa yokuswela ukudla?	0 = Cha (makunjalo dlulela kumbuzo 6) 1=Yebo	
5.a	Kwenzeke kangaki lokho?	1 = Akuvamile (kanye noma kabili emavikini amane adlule) 2 = Ngesinye isikhathi (kathathu kuyela eshumini emavikini amane adlule) 3 = Kuvamile (kudlulile eshumini emavikini amane adlule)	
6.	Emavikini amane adlule,	0 = Cha (makunjalo dlulela	

	kukekwenzeka ukuthi wena noma abantu ohlalisana nabo nidle ukudla okungenele/okuncane osukwini ngenxa yokuba nokudla okunganele?	kumbuzo 7) 1=Yebo	
6.a	Kwenzeke kangaki lokho?	1 = Akuvamile (kanye noma kabili emavikini amane adlule) 2 = Ngesinye isikhathi (kathathu kuyela eshumini emavikini amane adlule) 3 = Kuvamile (kudlulile eshumini emavikini amane adlule)	
7.	Emavikini amane adlule kukekwenzeka yini ukuthi kungabikhona ukudla endlini ngenxa yokuswela?	0 = Cha (makunjalo dlulela kumbuzo 8) 1=Yebo	
7.a	Kwenzeke kangaki lokho?	1 = Akuvamile (kanye noma kabili emavikini amane adlule) 2 = Ngesinye isikhathi (kathathu kuyela eshumini emavikini amane adlule) 3 = Kuvamile (kudlulile eshumini emavikini amane adlule)	
8.	Emavikini amane adlule, kukekwenzeka ukuthi wena noma abantu ohlalisana nabo nike nilale nilambile ngenxa yokuswela?	0 = Cha (makunjalo dlulela kumbuzo 9) 1=Yebo	
8.a	Kwenzeke kangaki lokho?	1 = Akuvamile (kanye noma kabili emavikini amane adlule) 2 = Ngesinye isikhathi (kathathu kuyela eshumini emavikini amane adlule)	

		3 = Kuvamile (kudlulile eshumini emavikini amane adlule)	
9.	Emavikini amane adlule, kukekwenzeka ukuthi wena noma abantu ohlalisana nabo niqhube usuku nobusuku bonke ningadlanga ngenxa yokuswela?	0 = Cha 1 = Yebo	
9.a	Kwenzeke kangaki lokho?	1 = Akuvamile (kanye noma kabili emavikini amane adlule) 2 = Ngesinye isikhathi (kathathu kuyela eshumini emavikini amane adlule) 3 = Kuvamile (kudlulile eshumini emavikini amane adlule)	

Appendix E: Extension Officer Questionnaire

THE ROLE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY IN IMPROVING FOOD SECURITY IN KWAZULU-NATAL

Researcher: Ntabeni Jere 208529551 (083 976 1105)

Ethical Clearance Number:

Supervisor: Prof. Manoj Maharaj (031 260 7051)

School of Management, IT and Governance

University of KwaZulu-Natal (South Africa)

How to complete this questionnaire

- Please answer the questions as truthfully as you can. Be sure to read and follow the instructions of each section.
- All responses in this questionnaire will be treated with confidentiality and consent will be sort from the respondents before making any the findings public if need be. If you do not feel comfortable answering a question you can indicate that you do not want to answer it. It would be highly appreciated if you could answer as many questions as possible.
- You can indicate each response by making a tick or a cross, or encircling each appropriate response with a PEN (not a pencil), or by filling in the required words or number.

Section 1: Your Personal Information (Extension Officer)

52. My gender is:
    - ❑ Female
    - ❑ Male

53. I grew up in:
    - ❑ A rural area
    - ❑ A semi urban area
    - ❑ An urban area

54. I belong to the following ethnic group:
    - ❑ An African / Black
    - ❑ Indian / Asian
    - ❑ White
    - ❑ Coloured

- ❑ A member of another ethnic group

55. My age falls within the range:
    - ❑ 20 to 29
    - ❑ 30 to 39
    - ❑ 40 to 49
    - ❑ 50 to 59
    - ❑ 60 or older

Section 2: General extension officer Information

56. I have the following number of years of experience in farming services/activities:
    - ❑ 3 or less
    - ❑ 4 to 9
    - ❑ 10 to 19
    - ❑ 20 or more

57. Do you have formal education:
    - ❑ Yes (certificate)
    - ❑ Yes (Degree)
    - ❑ Yes (higher than degree)
    - ❑ No

58. What is the size of farms you service:
    - ❑ Subsistent farm (small scale)
    - ❑ Commercial farm

59. By estimation, how often do farmers visit your offices:
    - ❑ Once a month
    - ❑ Twice a month
    - ❑ 3 – 5 times a month
    - ❑ 6 – 10 times a month
    - ❑ rarely

60.

	Never	Daily	Weekly	Monthly	Randomly
9.1 How often do you supply the farmers or people who run the farms you service with reading materials (e.g. magazines, newsletters)?					

61.

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

10.1 Information provided to farmers in English is more effective than information provided in indigenous language.					

62. Do farmers depend on you only for farming information?
- ❑ Yes
- ❑ No

63.

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
12.1 As an extension officer I am closely involved with the day-to-day running of farms					
12.2 As an extension officer I am on first name basis with farmers/employees					
12.3 As an extension officer I help remove unease in situations in which there are no clear guidelines					
12.4 In my opinion farming innovations lead by females are usually not adopted by farmers					
12.4 As an extension officer I encourage planning only on a seasonal basis					

Section 3: Information & Communication Technology (ICT)

ICT refers to technologies that provide access to information through telecommunications. This includes the Internet, wireless networks, cell phones, radio, television and other communication mediums.

64.

	Very small extent	Small extent	Never	large extent	Very large extent
13.1 To what extent do you use ICTs in your agricultural extension activities?					

65.

	Extremely hard	Quite hard	Neither	Quite easy	Extremely easy
14.1 How easy do you find ICTs are to use in your work?					

66.

	Extremely useless	Quite useless	Neither	Quite useful	Extremely useful
15.1 How useful do you find ICTs are in relation to your work?					

67. When did you decide to start using ICTs?
- ❑ Do not use ICTs
- ❑ 0-2 year ago
- ❑ 2-4 years ago
- ❑ 4-6 years ago
- ❑ More than 6 years ago

68. What means do you use to share information with farmers?

- ❑ Face-to-face
- ❑ Local radio
- ❑ Agricultural extension workers
- ❑ Gatherings/workshops
- ❑ Telephone
- ❑ Newspapers
- ❑ Internet-mail
- ❑ Posters/brochures

69.

	More than once per day	Once a day	2-3 times per week	Seldom	Never

18.1 To what extent do you use ICTs to share information with the farmers you service?					

70. What influenced you to adopt ICTs?
    - ❑ Desire to be innovative
    - ❑ Avoid being left behind by others
    - ❑ To solve a problem
    - ❑ Desire to use new technology
    - ❑ Institutional pressure

71. Please rank the following media in order of your preference of media you use (Place the number on the box besides the media type) 1 – Most preferred to 10 – Least preferred

Add ranking below	Media Type	Add ranking below	Media Type
	Mobile phone (voice calls & sms)		Telephone (landline)
	Smart phone(internet access)		Websites
	Local radio		Newspapers
	Agricultural extension workers		Internet-mail
	Gatherings/workshops		Posters/brochures

72. How often do you use the following:

	More than once per day	Once a day	2-3 times per week	Seldom	Never
21.1 Mobile phone (sms & voice calls only)					
21.2 Desktop Computer					
21.3 Laptop or tablet computer					
21.4 Smart phone (internet services)					
21.5 Satellite data					
21.6 Fixed line internet					

73.

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
22.1 I am willing to adopt new communication media to access information					
22.2 I am willing to adopt new communication media to share information					

74.

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
23.1 ICTs are compatible with the business needs of the farm					
23.2 ICTs are compatible with the information needs of farming					
23.3 ICTs are compatible with the cultural norms of farming					

23.4 ICTs are compatible with the existing infrastructure at the farms					

75.

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
24.1 Being given a chance to physically experience the use and functions of ICTs over a prescribed test period makes adoption easy					

76.

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
25.1 Being able to see ICTs in use encouraged me to adopt them					

Section 4: Geographic Information Systems (GIS)

A geographic information system (GIS) is a computer application used to store, view, and analyze geographical information, especially maps.

77.

	Very small extent	Small extent	Never	large extent	Very large extent
26.1 To what extent do you use GIS in your agricultural extension activities?					

78. I use GIS for:

	Tick where applicable
27.1 Determining suitable areas for growth of crops	
27.2 Assessing the health of crops using satellite imagery	
27.3 Detecting crop diseases (especially large farms)	
27.4 Detecting vulnerable areas to natural disasters e.g. floods	
27.5 Conducting suitability analysis of farm land e.g. soil, rainfall etc.	
27.6 Plotting the farms in order to determine fertilizer and crop seed use	
27.7 Estimating crop yields	
27.8 Identifying needy areas in terms of food supply by mapping populations	
27.9 Identifying areas where consistent access to healthy food is limited	
27.10 Mapping resources on farms e.g. infrastructure, irrigation pipes etc.	
27.11 Determining easiest access routes to markets	

Section 5: knowledge management systems (KMS)

Knowledge management Systems (KMS) comprises a range of practices used in an organization to identify, create, represent, distribute, and enable adoption of insights and experiences.

79.

	Very small extent	small extent	Never	large extent	Very large extent
28.1 In your interactions with farmers to what extent do you use indigenous knowledge?					
28.2 In your interactions with farmers to what extent do you use institutional knowledge?					
28.3 In your opinion, to what extent does indigenous knowledge influence your choice to use ICTs?					
28.4 In your opinion, to what extent does institutional knowledge influence your choice to use ICTs?					
28.5 To what extent are you involved in knowledge management practices (identifying, creating, representing, distributing, and enabling adoption of insights and experiences)?					

80. Do you use ICTs in your knowledge management practices?
- ❑ Yes
- ❑ No

81. Which of the following Knowledge Management System (KMS) do you use?

	Tick where applicable
30.1 Websites	
30.2 Spreadsheets	

30.3 Databases	
30.4 Notebooks	
30.5 Traditional stories	
30.6 Do not use any	

82. Which of the following areas do you encourage farmers to use Knowledge Management System (KMS)?

	Tick where applicable
31.1 Crop cultivation	
31.2 Fertilizer application	
31.3 Pest management	
31.4 Harvesting	
31.5 Post-harvest handling	
31.6 Transporting of food/products	
31.7 Packaging	
31.8 Food preservation	
31.9 Food processing	
31.10 Food quality management	
31.11 Food safety	
31.12 Food storage	
31.13 Food marketing	
31.14 Do not encourage in any	

83.

	Very small	small extent	Never	large extent	Very large

	extent				extent
32.1 To what extent do you encourage the use of systems that will allow for the tracing of the movement of farm products?					

84. Have you been allocated a digital pen?
- ❑ Yes
- ❑ No

85.

	Extremely hard	Quite hard	Neither	Quite easy	Extremely easy
34.1 To what extent do you find it easy to use?					

86.

	Extremely useless	Quite useless	Neither	Quite useful	Extremely useful
35.1 To what extent do you find it useful?					

Section 6: early warning systems (EWS)

EWS are systems of data collection and analysis to monitor plant well-being (including food security), in order to provide timely notice when an emergency threatens, and thus to elicit an appropriate response. These systems provide information on occurring hazards that might evolve into disasters unless early response is undertaken. The objective of EWS therefore is to monitor the first signs of emerging hazards in order to be able to trigger early and appropriate responses to these first signs and thus reduce or mitigate disaster risk.

87.

	Very small extent	Small extent	Never	large extent	Very large

					extent
36.1 To what extent do you use early warning systems (EWS) in your agricultural extension activities?					

88.

37.1 What kind of EWS do you use?	Tick where applicable
37.1 Websites	
37.2 Phones	
37.3 Radio	
37.4 Two way radios	

Thank you again for completing this questionnaire.

Appendix F: Gatekeeper Letter

agriculture
& environmental affairs
Department:
Agriculture
& Environmental Affairs
PROVINCE OF KWAZULU-NATAL

KZN Department of Agriculture & Environmental Affairs
Private Bag X9059, Pietermaritzburg, 3200
Tel: 033 355 9100 | Fax: 033 355 9122
Toll-Free: 0800 000 996
Email: callcentre.agriculture@kzndae.gov.za
Website: www.kzndae.gov.za

19 March 2013

School of Management, IT and Governance
University of KwaZulu-Natal (South Africa)
Private Bag X01
Scottville
3209

Attention: PROF H Wissink

PERMISSION TO CONDUCT RESEARCH: Ntabeni Jere (208529551) – (cell: 0839671105)

Dear Sir

Your letter dated 7th March 2013, refers.

Permission is hereby granted for the above mentioned student to conduct his research on the role of information and communication technologies in improving food security management in KwaZulu-Natal, on the understanding that the department of agriculture staff (extension officers) will voluntarily complete a questionnaire drafted by the student, and that the information requested does not impinge on the department of agriculture's security.

It is requested that a copy of the completed thesis be made available to the department in order to be able to pass on the relevant information to the applicable sections in the department, with intention that this information be used to improve service delivery/food security.

I would also like to see the draft preparations as this could help us in developing the Department's ICT policies.

This letter will also serve as the official document to inform the Regional Director, Mr T Van Rooyen and the Deputy Manager of Illembe, Mr G.M. Dlamini (the study area) of the intention of the student to conduct the necessary research.

Trust you find this in order.

Yours Sincerely

2013 -03- 19

KUBEN L. MOODLEY
GENERAL MANAGER : STRATEGIC SUPPORT SERVICES

C.C. **Mrs G. Mavundla – GM:BS**
Mr T. Van Rooyen – Regional Director
Mr G.M. Dlamini – DM: Illembe District

Appendix G: Ethical Clearance Letter

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

01 December 2015

Mr Ntabeni Jere (208529551)
School of Management, IT & Governance
Pietermaritzburg Campus

Dear Mr Jere,

Protocol reference number: HSS/0344/013D
New project title: The role of Information and Communications Technology in improving Food Security in KwaZulu-Natal

Approval Notification – Amendment Application

This letter serves to notify you that your application and request for an amendment received on 18 November 2015 has now been approved as follows:

- Change in Title

Any alterations to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form; Title of the Project, Location of the Study must be reviewed and approved through an amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

Best wishes for the successful completion of your research protocol.

Yours faithfully

.....

pp **Dr Shenuka Singh (Chair)**

/ms

cc Supervisor: Professor Manoj Maharaj
cc Academic leader Research: Professor Brian McArthur
cc School administrator: Ms Debbie Cunynghame

Humanities & Social Sciences Research Ethics Committee
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