

FACTORS AFFECTING ADOPTION OF AN INFORMATION COMMUNICATIONS
TECHNOLOGY SYSTEM FOR AGRICULTURE IN UGANDA

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ABSTRACT

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Agricultural extension services play a key role in improving the livelihoods of farming communities through the provision of expert assistance, disseminating of information and technologies; as well as helping to translate scientific research into practice. Unfortunately, agricultural extension services in Uganda and in many parts of the developing world are constrained by an array of challenges which include: (1) too few extension workers compared to the number of farmers; (2) a huge disconnect between research, extension and farmers; (3) and the language used in agricultural research and technical bulletins is often in the country's official language, which can be a foreign language such as English which farmers cannot read. Uganda's massive mobile phone revolution offers the promise of bridging the gap between available agricultural information and farmers but many information and communications technology (ICT) projects that have been implemented have not been adopted for a variety of reasons. This study uses a combination of praxical and theoretical approaches to identify factors that affect the adoption and diffusion of ICT for agriculture and other communication systems. To accomplish this, "Buuza Omulimisa" – a mobile-based information system was developed and assessed using a pretest-posttest research design. While offering information in farmers' own languages was the most important factor that spurred system use; lack of familiarity with text messaging was the most significant barrier to its use. Language did not only have a significant impact on ease of use but also on the system's usefulness. Results also show that cost, education, age and gender play a significant role in the adoption or rejection of a system.

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Chapter 1

Introduction

Traditional Agricultural Extension Services (AES) intended to serve smallholder farmers in Uganda and Sub-Saharan Africa have yet to make a significant impact. Productivity continues to stagnate, and acute food insecurity and hunger continue to affect the population (Eicher, 1999; Enete & Amusa, 2010; Jones, 2005). The World Health Organization (1996) defines Food Security as a situation “when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life.” The lack of food security in Africa is due, in part, to the lack of timely dissemination of agricultural information to smallholder farming communities that need it the most (Chapman, Slaymaker, & Young, 2002; UNDP, 2012) and weak linkages between researchers, universities, and farmers (Purcell & Anderson, 2007; Anderson & Feder, 2007). AES are crucial in supporting farmers to become more food secure by creating a linkage between farmers, research scientists and policymakers. AES are constrained by understaffing. For example in Uganda, one extension educator is required to serve up to 400 square kilometers where 4000 farm families may reside. Further, they are impeded by bad roads that are impassable during rainy seasons (Qamar 2001; Due, Magayane & Temu, 1997).

Technology and information transfer have often been the most important goals for successful agriculture extension (Aker, 2010; Ango et al, 2013). Consequently, various forms of Information Communication Technology (ICT), especially traditional ICTs such as radio, TV, pamphlets, posters and newspapers, have been widely deployed to disseminate information to farmers in Africa. The proliferation of mobile phones and their potential advantages—low cost, large geographical coverage and ease of use (Aker and Mbiti 2010)—makes mobile phones a

better tool for information dissemination than traditional ICTs such as internet, newspapers and radio. In Africa alone, there were almost 650 million mobile phone subscribers by the start of 2012; this is more than the United States and the European Union (Yonazi et al., 2012). Africa is currently the second fastest growing mobile market in the world, after Asia. This dramatic increase in mobile phones in a continent that relies mainly on agriculture, has led to the increased use of these phones in agriculture extension systems.

This increased adoption of mobile phones for agricultural information dissemination comes at a time when more than ever, information use in agriculture has become critical for effective decision making by farming communities. This growing significance is partly due to advancements in communications technology and the rapidly changing agricultural systems (Opara 2008; Gallowa and Mochrie 2005; Cash 2001), and partly as a result of climate change. Many consequences have emerged, such as new diseases, pests, changing growing seasons, and prolonged droughts. Farmers, most especially smallholder farmers, have been adversely affected. These challenges call for efficient transfer of pertinent information in order for farmers to cope. However, this necessary transfer of information has faced literacy and linguistic challenges in Uganda. There are at least 56 local languages spoken in Uganda, but the official language is English. Because most information systems are only available in English and most farmers are not literate in English (even though many are literate in their own languages), written information transfer between farmers and extension officers has failed. This study examines the impact of a solution created to be compatible with the existing heterogeneous linguistic landscape of Uganda, enabling immediate and effective use by farmers and extension officers.

Uganda, like most of its East African neighbors, has become a pilot ground for various mobile services aimed at delivering information to farmers (Hellstrom & Troften, 2010). Described as “m-agriculture,” the domain is mainly comprised of Grameen Foundation’s CKW initiative, Google SMS (short message service), and AgriNet and FIT Uganda. Grameen Foundation’s CKW initiative is a system that combines a live voice telephone system and a network of up to 4,000 community knowledge workers (CKWs) equipped with smartphones to provide information on weather, prices, crops and livestock management to farmers. Google SMS was a text-based service launched in 2009 by the Internet giant. It sent information on prices, weather, and pest and crop management upon sending a request to a telephone shortcode. It has recently been discontinued. AgriNet and FIT Uganda both link value chain actors--mainly farmers--to market information, provide market analyses and forecast; niche markets and customized agricultural market information market on mobile phone, emails, and information boards.

Existing m-agriculture systems in Uganda typically use SMS to deliver information directly from a project usually in the city to farmers in rural communities. In doing so, these systems overlook the importance of communicating through local extension systems and create an independent computer-based extension system. Often controlled centrally from Kampala, these interventions lack an understanding of farmers’ local conditions. By sidestepping the existing extension services, these m-service systems require a huge amount of resources to set up and maintain. Therefore, the proposed intervention system aims to restore the role of local extension systems by targeting farmers *and* extension agents. Typically, both groups face challenges in accessing information available through various SMS-based services, as many require access to the Internet to register or access information on emails and websites of the various m-agriculture

players. Additionally, most SMS systems require both farmers and extension agents to follow a strict syntax to register and are often available only in English (Chemweno 2012). Most farmers who cannot access Internet or do not understand English cannot use these services (Medhi et al 2011). Some text-based systems, such as Google Trader, used computer systems to automatically respond to farmers' queries. Although such automated systems can aptly respond to more generic questions, more sophisticated inquiries cannot be addressed by computer intelligence. As a result, some responses are either nebulous or do not provide the correct information (Fritz 2011; Hellstrom and Troften 2010; BBC, 2009). Additionally, most existing systems mainly involve routine "pushing" of text messages to farmers' phones without any feedback mechanism. There is no way to get clarification if a message is not fully understood by receivers. As such, much information is lost in translation between current systems and farmers. Enabling two-way communication and employing a human mediator with an understanding of local conditions would serve to consolidate these gaps and generate a more comprehensive flow of communication between not only farmers and extension agents, but also other value chain actors.

It is against this background that we developed and evaluated "Buuza Omulimisa" (Luganda for "Ask the Extension Officer"), a mobile- and Internet-based question and answer platform that enables farmers to interact with their local extension officers in their own languages. The extension officers are equipped with proficient Internet connectivity and are able to address farmer concerns accordingly. The application leverages mobile text messaging to create a mobile-based Q&A forum where farmers ask questions in their local languages, such as Luganda and Runyankitara, and receive relatively instant feedback from their extension officers. In this study, I describe the design and development of the system, and the viability and interest of the

system to rural farmers in Uganda. Using language specific keywords, such as “mulimisa” for Luganda and “muhingisa” for Runyakitara, a farmer types a text message in form of a question(s) and sends it to a telephone shortcode (#8228). The message is instantly delivered to a web-based platform where registered extension workers respond appropriately and the answers are instantly delivered back to the farmer’s phone. Both the questions and the answers are in the farmers’ distinct local languages.

This study thus uses a combination of praxical and theoretical approaches to identify factors that affect adoption and diffusion of ICT and other communication systems. The study focuses particularly on how individual characteristics of users and system attributes affect adoption of an ICT system in rural setting. It hypothesizes that language; age, cost and education are the most important factors in adoption of ICT systems in a situation such as rural Uganda with multiple languages, low literacy levels and low incomes. To test this, the “Buuza Omulimisa” project was assessed using pre- and post-project questionnaires and in-depth interviews. The results of the assessment are provided here, along with an analysis of how the research contributes to existing literature on ICTs for agricultural development, and literature on adoption of communication systems. The study presents an overview of literature on technology adoption and diffusion, highlighting the various factors that affect acceptance or rejection of a new technology in a social system.

Chapter 2

Literature Review and Conceptual Framework

The application of Information Communication Technologies (ICTs) for agricultural development has been an early and major focus of both ICT projects and research. As such, there is a rich and varied body of literature related to ICT for agriculture. This chapter traces the origins and evolution of the application of ICTs in development, especially agriculture, the various ICTD projects, especially mobile-based, across the developing world, along with studies that investigate the impact of these systems in farming communities. Additionally, the chapter presents an overview of literature on technology adoption and diffusion, highlighting the various factors that affect acceptance or rejection of a new technology in a social system. This synthesis of current literature highlights both emergent trends regarding factors behind other mobile-based systems' inefficiencies and ideas for possible solutions. The chapter also assesses ICT systems in the literature according to strengths and weaknesses of each individual method. This assessment supports the decision of a particular medium through which to achieve optimal communication with farmers.

ICTD for Agriculture Background

The role information and communication technologies (ICTs) can play in facilitating development has long been recognized (Aker & Mbiti, 2010; Jensen, 2007; Kelly & Minges, 2012; Lokanathan & De Silva, 2010; Steinfeld & Wyche, 2013). Their dramatic proliferation across the developing world presents a unique opportunity to deliver high value information to places and people that could not be reached before. Prior to the 1990s, governments in the developing world used information technology mainly for internal administrative functions as well as facilitating the activities of multinational companies (Heeks, 2008). With the

proliferation of the internet in the 1990s and the establishment of the Millennium Development Goals (MDGs), ICTs began to be looked at as a delivery mechanism of development and hence the rise of Information Communication Technologies for Developing (ICTD). International organizations and nonprofits were at the forefront of applying ICTs to the MDGs. Considering both the need to concentrate in rural areas where poverty persisted and the lack of infrastructure, the application of ICTs in this period involved the establishment of small community computer centers, called “tele-cottages” or “telecenters,” because they could be fairly quickly installed and easily provided tangible evidence of the organizations’ and nonprofits’ efforts. Heeks notes that a number of these colorfully named telecenters were set up in Colombia, India, Mali and many other places in the developing world. He states, however, that these efforts often resulted in failure as they were neither scalable nor sustainable, and positive reports of their impact were based largely on anecdotal evidence. This period of ICTD work was termed as ICTD 1.0. (Heeks, 2008).

Heeks notes that the period since 2000 marked yet another era of ICTD work which he termed ICTD 2.0. (Heeks, 2008). This era is characterized by the emergence of new wireless communications and devices marked by the explosive growth of mobile subscriptions in the developing world (Steinfeld & Wyche, 2013). Today, there are approximately 6.9 billion SIM connections among a global population of 7 billion people (GSMA, 2014). More than 5 billion of these connections are in the developing world where the main source of income and employment comes from agriculture. This dramatic increase has seen mobile phone technology emerge as the primary means to deliver information and services to the developing world (Steinfeld & Wyche, 2013).

Because agriculture plays a critical role in the economies of many developing economies (World Bank, 2012), most ICTD projects target this sector, especially smallholder farmers (Steinfeld & Wyche, 2013). According to the Food and Agriculture Organization, smallholder farmers produce over 70 percent of the world's food needs (FAO, 2013). Consequently, a myriad of ICTD projects target smallholders, offering advisory and extension services, market information, weather alerts, mobile payments, trader-buyer matching, and many others (Steinfeld & Wyche, 2013) (see Table for a summary of existing mobile-based agricultural services). Rural areas have been labeled as “information-poor,” and provision of information has been a major goal of most development initiatives (Chapman & Slaymaker, 2002). As a result, most ICT services aim to provide the rural poor, most of whom are farmers, with access to information vital to their lives and livelihoods. Traditional extension systems responsible for providing this important information have not been sufficiently effective considering the amount of funding that has been invested. For instance, Aker (2011) reports that a previous review of public extension systems worldwide found that they were barely functioning. She also acknowledges the high cost of obtaining information through traditional means such as radio, newspapers and travel as important significant barriers to technology adoption in the developing world. In the same vein, Nakasone, Torero, and Minten (2014) state that farmers face both high transaction costs and constraints to information access which limit their optimal production. With the rapid technological changes coupled with issues of climate change, farmers more than ever need accurate and reliable information to make effective farming decisions. Their information needs at every stage of the agricultural-cycle need to be met consistently if they are to cope with the emerging challenges.

By examining early and current ICTD efforts, we see an apparent shift away from the use of more centralized approaches, such as the use of telecenters, to current efforts that rely significantly on more decentralized approaches, such as mobile phones, to deliver information into the hands of farmers. This shift is largely driven by the proliferation of mobile phones in the developing world, and the rapid expansion of associated infrastructure at relatively low cost that has made mobile phones more affordable. Their near ubiquitous presence and their potential benefits, present a unique opportunity that if well leveraged, could significantly improve the transfer of knowledge and information and thus improve the adoption of technology and facilitate agricultural development. The next section examines the information needs of farmers from which applications of ICTs can be applied.

Information Needs of Farmers

Several studies have identified the information needs of farmers from which applications of ICTs can be derived (Steinfeld & Wyche, 2013). For instance, a national survey of farmers in India, Mittal, Gandhi, and Tripathi (2010) identified three broad categories of farmers' information needs:

- Know-how information which helps farmers decide what to plant and varieties to use
- Market information which includes prices and price indicators
- Contextual information which includes weather and information on best practices

These categories of information are needed at various stages of the agricultural life-cycle which includes crop planning, buying seeds and inputs, planting, growing, harvesting and selling (Mittal et al., 2010). According to their study, the most critical information farmers needed included weather, pest and disease control, seed information and market prices. In an earlier study, Chapman and Slaymaker (2002), identify two types of information needed by the rural

poor to make effective investment decisions as well as fast-track their livelihood activities: Type **A** information is core information that facilitates long-term capacity building and making of effective livelihood strategies. They suggest that this type of information is usually achieved through training and technical support. They contend that the provision of this of information has long been the focus of extension and health systems. If provided, type **A** does not only improve understanding of systems and processes, but might also assist the way assets are used as well as effective planning of livelihood strategies. This type of information may include information their rights in relation to public institutions so they can hold them accountable. On the contrary, type **B** information concerns local contexts and needs and requires regular updating for people to make effective decisions concerning their immediate livelihood activities. It helps the rural poor to maximize the potential of an asset one time, reduce vulnerability to shocks and helps them respond to immediate needs. Such information includes market and income-generating activities which the rural poor typically lack.

The two studies illustrate a clear transition away from more centralized ICT approaches such as the use of community knowledge centers discussed in Chapman and Slaymaker (2002), towards a more decentralized approach that leverages the dramatic proliferation of new ICTs especially mobile phones. For instance, Mittal et al. (2010) focus their attention on two notable mobile based systems in India: the Reuters Market Light (RML)—a service provided by Thomson-Reuters and provides farmers with weather, advisory tips and market information via text messages; and IFFCO Kisan Sanchar Limited (IKSL) service which provides Indian farmers with farming advisory information via voice messages. Chapman and Slaymaker (2002) focus

instead on what they call “community models,” such as IDRC’s Acacia initiative and UNESCO’s Multipurpose Community Centers (MCTs).

Although most existing ICT for agriculture services rely heavily on mobile phones to disseminate information, there are a few notable examples of projects that rely on participatory approaches. These approaches involve the integration of Internet, mobile devices such as portable projectors, TVs, and farmers in the production and delivery of agricultural content. Prominent among these include Digital Green, which uses short instructional videos featuring local farmers interacting with agricultural experts. The videos are taken using pocket video cameras and shown locally using pico projectors (Steinfeld & Wyche, 2013). Farmer feedback is encouraged through Interactive Voice Response (IVR). Shamba Shape Up is a reality TV farm makeover program that involves agricultural experts visiting family farms and demonstrating improved agricultural practices. Episodes of the show are posted on the show’s Facebook wall and on YouTube channel. Farmers can send text messages to receive a summary of the episode presented (Steinfeld & Wyche, 2013).

The emergence of new low cost technologies – especially mobile phones – has significantly reduced communication and information costs for the rural poor. The near ubiquitous presence of mobile phones has not only improved information access for rural farmers, but has also seen their increased use in agriculture to meet the information needs of the rural poor. In addition, there is also an emergence of participatory approaches that integrate a variety of ICTs and involve the farmers in the production of content especially videos. The next section examines the

potential of mobile phones in agriculture and provides an overview of existing mobile based ICT projects, applications and services across the developing world.

Mobiles Phones in Agriculture

The potential of information communication technologies (ICTs) especially mobile phones as a way to improve access to and use of agricultural information, has been well documented (Aker, 2011; Albu & Scott, 2002; Brugger, 2011; Jensen, 2007; Nakasone et al., 2014; World Bank, 2012; Yonazi, Kelly, Halewood, & Blackman, 2012). Although the revolution of ICTs in agriculture has not been driven by mobile phones alone (World Bank, 2012), their near ubiquitous presence, ease of use and low cost, makes them a better tool than other alternatives such as internet, Newspapers or radio. In Africa alone, there were almost 650 million mobile phone subscribers by the start of 2012; more than the United States and the European Union (Yonazi et al., 2012). This makes Africa the second fastest growing mobile market in the world, after Asia. With this dramatic increase from just fewer than 25 million in 2001, Africa, like much of the developing world, has become a testing ground for mobile based applications and services (Hellstrom & Troften 2010). Although other technologies, particularly radio, may reach more people than any other media, they offer a limited range of information and only offer one-way communication (Aker, 2011). Additionally, Aker and Mbiti (2010), state that in the developing world, the number of mobile phones per 100 people usually exceeds access to newspapers and radio. Albu and Scott (2001) argue that, the use of mobile phones in agriculture has the potential to enable rural farming communities effectively respond to economic opportunities. Further, they contend that mobile phones provide improved access to information and enhanced social network interactivity. The affordances of the mobile phones such as improved access to

information and enhanced social networks empower farmers to for instance respond to better market opportunities. A recent World Bank report (World Bank, 2012) suggests that of all the numerous ICTs, mobile phones have had the most remarkable impact in developing countries. The report emphasizes that there dramatic proliferation has been aided by their affordability and accessibility that has come with expansion of mobile networks that are cheaper to deploy than most ICTs such as fibre-optic cables.

McNamara (2009) lists five potential benefits of ICTs in agriculture extension and development. These benefits include: 1) promoting and including farmers in agriculture innovation, 2) helping farmers manage a wide range of risks, 3) improving land and natural resource management, 4) making agriculture market more efficient and more transparent, 5) linking farmers to markets etc. In that vein, a number of ICT based services, especially mobile based, have been developed and deployed in agriculture with the hope of tapping into such benefits it affords. This affirms the ability of the mobile phone not only to meet the information requirements of the agriculture value chain in general, but also to support the numerous business processes involved as Brugger (2001) illustrates in Fig 1.

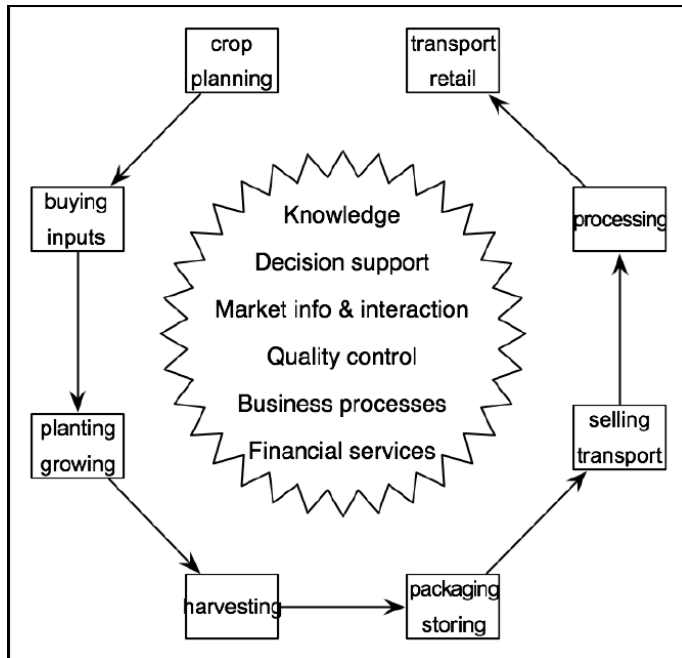


Figure 1: Information requirements and business processes offering opportunities for mobile applications along the value chain. Source: Brugger, 2001, pg.8

In a study of ICT based services for agriculture extension, Brugger (2001) describes m-agriculture services that have been developed and applied to transfer and exchange knowledge and experiences from research and extension services to farmers across the World. He holds that the information disseminated by these systems helps address significant skills deficit among farmers in a more effective manner devoid of traditional extension systems (Brugger 2001). Brugger further classifies mobile applications and services for agriculture or *m-agriculture* in two broader categories—*m-learning* and *m-farming*. He describes m-learning as services or applications that provide farmers with general know-how information on farming, plants and varieties and how to grow them. Such information may include information on crops, livestock, fisheries, weather forecasts etc. On the other hand, he describes m-farming as “individual support systems based on localized contextual information”. Through the use of GPS, these systems provide location specific information to farmers based on factors like microclimatic conditions,

soil and water conditions. Brugger provides a more comprehensive study and provides greater insight into the global m-agriculture domain. Donner (2007) offers an overview of what he calls “mobile-based livelihood services”. He explores a number of services which include: virtual marketplaces that match buyers and sellers; market information systems, which provide aggregated price information; and finally, mobile based agricultural extension services that use both the “push” and “pull” approaches to provide farming tips to farmers. Most of the services Donner describes are SMS based services, a phenomenon he attributes to the fact that SMS is widespread and relatively low cost. Additionally, a recent World Bank publication on mobile phones for development (World Bank, 2012) identifies four categories of mobile based services that have been developed to serve specific functions in the food and agriculture sector. These include:

- provision of agricultural information to deliver relevant information to farmers such as weather forecasts, farming techniques and prices. Mobile systems in this category include mobile information systems and farmer helpline
- improving access to financial services through affordable mobile payments systems tailored for agricultural services
- improving data visibility for supply chain efficiency by optimizing the supply chain across the sector and delivering efficiency improvements for transportation logistics. Potential mobile systems in this category may include — traceability and tracking systems, mobile management of supplier networks, smart logistics and mobile management of distribution networks.

- enhancing access to markets by enhancing the link between value chain actors i.e. traders, transporters and farmers. Mobile based systems in this category include agricultural trading, agricultural tendering and agricultural bartering platforms.

In a report prepared for Forum for Agricultural Research in Africa — *Inventory of Innovative Farmer Advisory Services Using Information Communication Technologies*, Gakuru, Winters, and Stepman (2009), provided a survey of ICT for agriculture projects in Africa according to their dissemination mechanism and their primary purpose (J. C. Aker & Mbiti, 2010). These include:

- **Voice-based information delivery services** — these provide farming advice and market prices via the telephone. Some of these services establish call centers and hotlines where farmers can call for extension support. Examples of such services include the Kenya Farmers hotline and Grameen Foundation's CKW initiative that partly uses a hotline to respond to farmers' queries
- **Radio dial-up and broadcasts** — these include regular radio programs on FM stations that provide agricultural information. They also include dial-up radio with a series of short audio clips on agriculture. In a bid to make radio programs more interactive, farmers can ask questions by calling in or sending text messages and responses are provided on air.
- **SMS-based extension services** — such systems use text messaging to collect and disseminate information to farmers. They can collect information via SMS-based questionnaires, request information via SMS short codes, and disseminate mass SMS on agricultural tips.

- **E-Learning Programs** — these include telecenters and internet kiosks that enable farmers to access computers and the internet for agricultural information.

A recent World Bank report (World Bank, 2012) notes that because basic phones are the most common type of mobile phones owned by farmers in the developing world, most systems available today employ short text service (SMS) as the main mechanism to deliver agricultural information. They also cite as contributing factors the low cost of SMS, usually a fraction of the cost of a voice call in many developing countries, and the fact that SMS does not require the two parties to be online at the same time.

In summary, there exists a rich body of literature on the potential of mobile phones in agriculture. Their rapid spread and subsequent diffusion in the developing world makes them an ideal tool to reach the rural poor. Among other advantages, mobile phones can help reduce transaction costs, link farmers to markets, and help bridge the gap between the various agricultural value chain actors. The affordability and accessibility made possible by the expansion of supporting infrastructure has greatly aided the increased use of mobile phones in agriculture. Most existing mobile-based agricultural services use SMS as their main channel of information dissemination. The low cost of SMS, its ease of use and its availability on most farmers' basic mobile phones, together drive this phenomenon.

M-Farming Project Examples

There are hundreds of mobile-based agriculture services and applications across the developing world. In the next section, I will review some prominent projects according to the literature, and

reflect on their strengths and limitations in terms of their scalability and potential utility for the farmer.

Operated by KenCall, the Kenya Farmers' Helpline (m-Kilimo) provides agricultural assistance to registered farmers through a helpline (Pshenichnaya, 2011). In-house specialists respond to farmers' queries in both Swahili and English. In the event that a question cannot be answered when the farmer calls, the question is referred to a consultant and the farmer is contacted with the answer within 24 hours. Similarly, Allo Ingenier in Cameroon enables farmers to call in with questions and get answers from experts in both French and local languages. If the answer is not readily available, the agent contacts an expert and responds to the farmer as soon as possible (Brugger, 2011). It is therefore not surprising that m-Kilimo's working budget over a period of 18 months, starting October 2008, was a whopping \$1.8 million. With the initial funding from the GSMA Foundation, the service is free to farmers but callers must pay the standard call charges. They were expected to ultimately commercialize to sustain the service. To do so successfully, they have to pass on the cost burden (standard call charges plus the service charge) to already poor farmers who may not be able to afford it even if they find the service useful. KenCall is currently seeking further funding to enhance the service (Project Innovation, 2012).

The Kenyan National Farmers Information Service (NAFIS, <http://www.nafis.go.ke>) provides weather, price and farming tips to farmers through the web and the phone via Interactive Voice Response. Information is updated by field extension and consequently made available to farmers. This system preceded the Banana Helpline, which provided tips to banana farmers. The current system caters to a wide range of crops and is available in English and Swahili. On the other hand,

the Kenya Plant Inspectorate Service provides an SMS service that enables farmers to request for information on the right corn seed varieties to plant based on your location. The request is sent to a telephone short code (#20354) and a response is consequently sent back to the farmer's phone.

The Kenya Agricultural Commodity Exchange (KACE) is a market information system that collects processes and sends market information daily to farmers and other value chain actors. It has established market information kiosks in villages that provide internet connectivity and market information to farmers via SMS and Interactive Voice Response (IVR). The award winning I-cow (<http://www.icow.co.ke>) application enables cattle farmers to track their animals' fertility cycle, maximizing each cow's potential. The application enables farmers to register each cow and receive individualized information on veterinary care, feeding schedules and cattle market prices. The application uses both voice and text messages to deliver information to farmers in Swahili and English.

Similarly, the Zambian National Farmers Union Information Service provides market information to farmers and traders in Zambia and the Katanga province in the Democratic Republic of Congo. The service is available in English in Zambia and French in Congo. The service was established in 2007 with support from IFAD (<http://www.znfu.org.zm>). In Senegal, Xam Marse, a service owned by the telecom company Manobi, provides market information to farmers in their local dialects as well as French (<http://www.manobi.sn>). In the same vein, Drumnet Kenya links farmers to buyers and other players in the value chain through SMS and the Internet (<https://www.poverty-action.org/node/1518>).

Esoko (esoko.com), formerly Tradenet, an Internet-based platform, also gives farmers access to information on markets, weather forecast, agricultural tips, bids and offers (Brugger, 2001). The platform has different features: (1) SMS Push, which sends extension text messages to farmers based on their groups, location and crops; (2) an automated system that sends alerts to specific farmer groups (e.g., market alerts or weather alerts); and (3) a mobile feature that enables administering of surveys through text messaging. It also provides online space for a farmer groups to advertise their goods and services. The service is available in Ghana, Uganda, Tanzania, Rwanda, Mali, Burkina Faso, Madagascar, Nigeria, Mozambique and Cameroon (<http://www.esoko.com>).

Most of the SMS-based systems described above collectively address the proliferation of market information to farmers in different African countries. While this information is indeed valuable to farmers, its value is supplemental in the sense that farmers cannot do anything with this information without first having a command of *how* to implement it. Farmers need to first develop an understanding of how the market affects each step in the production process. Otherwise, efforts to distribute market information are virtually ineffective. Concerns of sustainability also surface in evaluating these initiatives, as most of the mentioned programs rely on donor funding and would cease to operate in the event that donated resources are exhausted.

On the other hand, Hellström and Tröften (2010) describe a number of international nonprofit and for-profit organizations that have found their way to the East African market with specific mobile based ICT applications and services to support agriculture. These applications include: (1) the Ericsson Innovation Centre, a program based in Nairobi, Kenya and aimed at developing

innovations to meet the needs of poor communities; (2) Nokia Research Africa, also based in Nairobi and established with the aim of understanding and better serving Africa's market; and (3) the AppLab Uganda and Grameen Foundation, which aims to recruit and train people in rural communities that can in turn work as information intermediaries Hellström and Tröften (2010).

From the literature available, it is evident that with the proliferation of the mobile phone, there have been many projects across the developing world especially in Africa, providing agricultural information to farmers through the use SMS, and voice.

In summary, the projects discussed were established to enhance the agricultural arena in developing nations by increasing farmers' access to information. Although most projects use SMS as the main channel of information delivery, there are a few, such as m-Kilimo, I-cow and the CKW initiative, that solely used either voice or combined voice with a number of other delivery channels. The strength of such voice-based systems is their ability to overcome the literacy barrier by providing information in farmers' own languages. However, if they are to serve a critical mass, they require a large support staff, and a substantial budget to set up, run, and sustain. Additionally, although some services deliver information in farmers' local languages, most still use foreign languages (usually the official language) such as French and English. While the efforts of these projects are commendable, their strategies have been found lacking: lack of attention to language diversity limit most farmers from using these projects; lack of planning for future financial burdens and potential loss of donor funding leads to financial unsustainability; and lack of scalability results in inability to reach critical mass. While donor funding heavily contributes to establishing preliminary infrastructure (kiosks, human resources,

hardware, etc.), the resources needed to sustain this infrastructure are not guaranteed because funding is often limited to a specific time period.

As Carvalho, Partner, Klarsfeld, and Lepicard (2012) note, many ICTD projects have not survived beyond the pilot phase partly because many lack a sustainability plan when donor funds run out. The lack of sustainability plans is exacerbated by poverty and the sensitivity of farmers to pay for such services because they may not perceive usefulness in the service or cannot afford it. Because the system under study does not bypass the government-supported extension officers but rather integrates them as the principal specialists who respond to farmers' queries, we hope the government will adopt our system and ensure that it is free and easily accessible for those who wish to use it.

Related SMS Q&A Systems

A review of the literature reveals a number Internet based e-extension initiatives (Brugger, 2011; Renwick, 2012). Brugger (2001) further describes several initiatives that combine both the Internet and the mobile phone to provide extension services to smallholder farmers in the developing World. In India, AAqua (Almost All Questions Answered, aaqua.org) — an online open discussion forum enables users to post questions and receive responses from fellow users (Brugger 2001). The system has different discussion groups that include crops, animal husbandry and market prices. The system is available in English, Marathi and Hindi. A mobile version (aAqua app) that runs on feature phones and higher end phones enables users to send questions and attach pictures of affected crops for diagnosis and provision of solutions by hired experts. By June 2010, the platform had 14, 230 registered users. Brugger cites lack of internet connectivity

in the villages, lack of revenue for sustainability, and illiteracy as the major impediments to the service (Brugger, 2001).

M-Krishi on the other hand, relies on Frequently Asked Questions (FAQs) to respond to farmers' queries. Questions that are too complicated to be handled by the automated system are sent to a team of ten experts with access to the Internet. For Illiterate farmers who cannot use SMS, M-Krishi uses voice to assist such as their questions. Like AAqua, M-Krishi uses a mobile application that is installed on the farmer's java enabled phone (feature phone). Farmers pay a monthly charge of US \$ 2.20 to use the system.

On the other hand, there are several Q&A systems in the developed world that provide mobile based assistance majorly through SMS using human guides. A few are described next.

Knowledge Generation Bureau (KGB): "Got a question text it!"

A New York based company; KGB is a human-powered mobile search facility that answers questions through text messages on the mobile phone. In one year, this company answered more than a billion voice and text queries. It takes about 2-4 minutes to get an answer back. Its developers say they target a niche market by emphasizing accuracy and speed if one needs a quick answer in a few minutes for mobile phone users who may not have a smart phone to browse (<http://www.kgb.com>).

Chacha is another human guided search service providing real time answers to any questions through text messaging, Chacha website or through their mobile apps. This two-way mobile

texting service funnels queries to a team of human experts and allows users up to 20 freebie queries per month. According to their website, the mobile search uses paid human guides to answer questions sent via SMS text message in conversational English. The service matches queries by sending them to the most knowledgeable guides in that topic, who then answer back via text message (<http://www.chacha.com>).

In sum, not many human-guided SMS-based Q&A systems exist in the developing world. A few that exist such as M-Krishi and AAqua (Almost All Questions Answered) either solely rely on the internet through discussion forums to respond to farmers queries, or employ automated systems to respond to frequently asked questions. Some also employ mobile applications that can run on feature phones and high end phones as well as voice. However, quintessential examples of human-guided SMS-based systems exist in the developed world and typically handle general queries by sending them to the most knowledgeable guides in that topic, who then answer back via text message. But as expected, these systems do not focus on agriculture. Away from existing mobile based services, the next section examines literature related to the impact of mobile phones and their related services on the communities they serve.

Impact of ICTs in Agriculture

As mobile phones continue to establish a foothold in agriculture extension, research efforts (J. Aker, 2010; J. C. Aker, 2008; Cantor, 2009; Fu & Akter, 2012; McNamara, 2009) have also been initiated, focusing on their impact on agricultural and rural development. For purposes of this study, this section delves into what Donner classifies as impact studies — studies that examine the social and economic effects of mobile phone access and use. The content of these studies

served as guiding cues in the implementation of the system and the assessment of its efficiency, accessibility and usability among farmers and extension officers.

Jensen's study "The digital provide: information (technology), market performance, and welfare in the South Indian fisheries sector" has become canonical in the ICTD domain. Jensen delineates the economic effects of mobile phones access in the South Indian fisheries sector. By observing the performance of the market from the introduction of the mobile phone service in Kerala in 1997, through its gradual coverage to more than 60 percent of the state; Jensen suggests that price dispersion dramatically decreased with the introduction of the mobile phone. Jensen further posits that there was almost no violation of the Law of One Price — a good must sell for the same price in all location — after the introduction of the mobile phone, compared to 50-60 percent of markets pairs before. Jensen further suggests that, fish wastage averaging 5-8 percent of the daily catch was completely eliminated with the introduction of the mobile phone.

However, a follow up study by Srinivasan and Burrell (2013) suggests that the unique geographical and political-economic conditions in the Kerala fish market made Jensen's findings hold, and can therefore not be generalizable. They cite Kerala's coastal geographical location and the pervasive credit relationships as major factors that enabled fishermen to optimize profits by selling fish at different markets. Although their findings suggest that the mobile phone played an important role in enhancing trade relations among the various actors of the Kerala fish market; and facilitating coordination in times of emergency—they suggest Jensen's findings can be misleading by generalizing this to entirely the mobile phone and ignoring the role of special conditions that may not exist elsewhere.

In “Preliminary Insights into M-commerce Adoption in Ghana” (Boadi, Boateng, Hinson, & Opoku, 2007), the authors examined the investment cost and adoption practices of farmers and fishermen in Ghana. They suggest that mobile phones facilitate the delivery of time-sensitive information which enhances decision making. They further suggest that the mobile phone facilitates cost reduction and affords them opportunities for strengthening and deepening internal and external relationships.

Additionally, Akers’ study “Digital divide or provide?” which analyzes the effects of the mobile phone on the performance of the grain market in Niger, suggests that, as mobile phones become widespread, there is less dispersion of prices across markets. Furthermore, (Al-Hassan, Egyir, & Abakah, 2013) assess the impact of information communication technology (ICT) based market information service (MIS) on households in Northern Ghana. By comparing data from 159 project participants and 187 non-participants, they used propensity score matching to determine the impact of the MIS on the participants. They found that users of the MIS indicated increase in pesticides’ use as well as increased expenditure on food security. The study also indicated increased use of improved seeds among project participants.

Islam and Gronlund (2013) present findings from an interpretive case study and evaluation research of a mobile phone based Agricultural Management System (AMIS) locally promoted as Pallinet in remote villages of Natore district, Bangladesh. The system, developed and tested with 100 pre-registered farmers provided market information from the three big markets around the district. Findings from the study suggest that 32 percent of the farmers involved in the study had

difficulty in reading text messages. Many reported seeking help from friends and family yet price information is urgent; this was exacerbated by the use of the roman script in presenting price information instead of the Bangli script. However, the study further reports that despite the inconvenience in reading text messages, farmers reported that they were generally happy with the system as it served their need for market information. Farmers also expressed a sense of empowerment by knowing the conditions of their surrounding markets unlike before. They also reported increase in income, as they were able to negotiate better prices with middlemen or relocate to other markets that offered better prices. At least 34 percent reported having relocated to other markets more than once after receiving price information from the system. While more than half could not indicate how much their income had increased as a result of information from the system, 36 percent indicated their incomes had increased by 10 to 20 percent.

Boateng, Hinson, Galadima and Olumide (2103), studied the influence of mobile on the micro-trading activities of rural women traders in Nigeria. Using the Technology Acceptance Model (TAM), the results suggest that benefits obtained by women traders are partly ascribed to the extent of mobile phone access and usage by trading partners in their value chain. They also argue that women, who innovatively use mobile services in their activities, stand to reform their market structural processes and become more economically empowered. Furthermore, the study posits that enhancing communication and trading processes through the mobile phones improves revenue acquisition, decision making and control.

Sefika and Sefika, Mavetera, Mavetera (2012) studied the impact of ICTs among disadvantaged communities in rural Lesotho. The study suggests that although ICTs have the potential to

improve the socio-economic aspects of smallholder farmers, issues of cost, illiteracy, infrastructure, accessibility and lack of necessary skills impedes full realization of their potential and empowerment in rural farming communities. They also cited issues of lack of local content as a major impediment of their full potential. They hold that having access to ICTs is useless if there is no relevant content.

Additionally, Akter and Fu (2012) studied the impact of using mobile based agricultural services on the agriculture extension in India. Findings from the study suggest that the speed and quality of agricultural extension significantly increased with the integration of the mobile phone. They however note the dearth of empirical evidence on the impact of mobile based services on agricultural extension services. They hold that the little literature available such as Jensen's (2007) and Aker's (2008) studies only focus on the impact of mobile based services on provision of market prices to fishermen in Kerala and grain markets in Nigeria.

Fafchamps and Minten (2012) studied the impact of SMS based agricultural information on Indian Farmers. The study evaluated the benefits farmers derived from weather, advisory tips and market information delivered by Reuters Market Light (RML) — a service provided by Thomson-Reuters. Through a controlled randomized experiment of 993 farmers in 100 villages of Maharashtra, India, the study did not find significant effect of the treatment on price received by farmers, crop value added, or the likelihood of changing crop varieties or cultivation practices. The study partly attributes this to the slow take-up rate of the system after a period of rapid expansion right when it was introduced in 2007-09. They suggest that farmers possibly lost interest in the service and others probably did not know how to do the monthly service renewal.

Similarly, Nakasone (2013) studied the impact of market information on farmers' sales prices among 110 randomly selected households in Peru. All participating households were provided with cell phones and received market information through SMS for a period of four months. Price information for 17 different crops was collected in six regional markets and provided to farmers right after the end of the rainy season when farmers make most of the sales decisions. The study found that participants experienced a 13-14 percent increase in sales prices. There was also a 12 percent increase in the probability of engaging in a commercial transaction among participating households. There was no observed effect on non-participants and no differential effects on previous ownership of a mobile phone. Nakasone further notes that the observed effect on sales prices was driven by an increase of prices on perishable goods where information is more relevant.

Aker (2007) posits that empirical evidence regarding the impact of ICTs on rural communities such as knowledge adoption, income and cost effectiveness is either nonexistent or largely anecdotal. Sefika, Mavetera, Mavetera (2012) argue that issues of cost, illiteracy and accessibility among others impede the full potential of ICTs to realize meaningful development among rural communities. Donner (2007) provides a broader and in-depth review of literature in the mobiles for development realm. He examines close to 200 relevant studies in the ICT domain and identifies major concentrations of research.

In sum, the literature reviewed paints a mixed picture of success and failure as regards to the impact of mobile phones in agriculture development. Linking cause and effect is rather

complicated. It also seems to suggest that the impact of mobile phones and their related services on agriculture depends on existing socio-economic, geographical and socio-political conditions. Such factors as literacy, geographical setting, social networks and income, shape their impact. For instance, the impact of mobile phones in a community that is highly illiterate is most likely different from that of a literate community. Illiterate communities may not take full advantage of existing mobile based services because they simply do not know they exist or because they do not how to use them. There is evidence that such factors can lead to misleading findings and sweeping generalizations. For instance, Srinivasan and Burrell's (2013) challenge the findings of Jensen's study in the Kerala fish market in India that suggests that there was dramatic decrease in price dispersion with the introduction of mobile phones. They argue that Kerala's unique geographical and political-economic conditions confounded with Jensen's findings, and can therefore not be generalizable. They cite Kerala's coastal geographical location and the pervasive credit relationships as major factors that enabled fishermen to optimize profits by selling fish at different markets. Although their findings suggest that the mobile phone played an important role in enhancing trade relations among the various actors of the Kerala fish market; and facilitating coordination in times of emergency — they suggest that Jensen's findings can be misleading by attributing them entirely to the mobile phone and ignoring the role of special conditions that may not exist elsewhere.

It's also worth noting that experimental studies such as the Nakasone's which controls for all confounding conditions and examines the impact of mobile based price information, are far from reality. Because of the small number of participants involved in experimental studies and the attention and training they receive from researchers prior to the experiment; it is possible for

farmers, traders or any value chain actors involved to experience significant effect on income, profits or productivity. However, it does not guarantee the same results when the technology or service is scaled out to a critical mass. There is an apparent need for more empirical based impact and adoption studies carried out by neutral third parties to understand these impacts.

Generally, the impact of any ICT-based service will depend on how well it diffuses or is adopted by the user community. As the literature on adoption of innovations has shown, many factors shape the adoption or rejection of new technologies in a social system. The next section provides an overview of technology adoption literature by examining factors that affect the diffusion and adoption of technology.

Technology Adoption

Technology adoption refers to the acceptance of a group or an individual to use a new product or innovation. The process of adopting an idea or new product does not happen as a single unit act, but rather a mental process that consists of at least five stages (Beal & Bohlen, 1957): the awareness stage, the interest stage, the evaluation stage, trial stage and finally, the adoption stage. At the awareness stage, an individual becomes aware of the idea but lacks detailed information about it. At the interest stage, an individual gets more information about it and wants to know more about how it works, what it is and its affordances. At the third mental stage, when the user has obtained more information from the previous stages, Beal and Bohlen argue that he/she makes a mental trial of the idea. He wonders: “Can I do it; if I do it, will it be better than what I am doing.....” (Beal & Bohlen, 1957, p. 2). At the fourth mental stage, the individual makes a small scale trial of the idea, and requests for more specific information to answer

questions like “how do I do it; when do I do it.....?”. The last mental stage, adoption, is characterized by large scale adoption of the idea, and most importantly — its continued use.

Additionally, (Rogers Everett, 1995) provides an important theoretical framework for the study of technology adoption. He defines the diffusion of innovations as a process through which an innovation is communicated through certain channels over a period of time among individuals of a social system. The process is hugely dependent on the demographic and psychographic characteristics of adopter groups. He proposes four main factors that influence the diffusion of an innovation: perceived attributes of the innovation, time, communication channels and the social system. Rogers argues that an innovation is a new idea, thus, the way the unit of adoption perceives it, influences its adoption. He argues that the main characteristics of an innovation that affect its adoption include: relative advantage, compatibility, trialability, complexity and observability. He explains that the more an idea is conceived as better than the one it supersedes, the more likely it will be adopted. If and an innovation is perceived as compatible with existing values and beliefs, the more it's likely to be adopted. Trialability is defined as the degree to which an innovation can be tried on a small scale. If an idea is trialable, it results in less uncertainty and therefore more chances for adoption. Complexity is the degree to which an innovation is perceived as difficult to understand and use. If it is more complex, less people are willing to try it. Observability is defined as the degree to which the results of an innovation are visible. If its results are more apparent, the more likely people will adopt it.

Among other models that have been developed to understand the adoption of information technology, is the Technology Acceptance Model (TAM) developed by Davis Jr (1986).

Originally designed to test the acceptance of end-user information systems, TAM has become one of the most prominent models for the study of information technology adoption. Various studies have suggested that TAM is not only a robust model, but also one of the most prominent models in the study of technology adoption (Chen, 2008; Chin & Gopal, 1995; Davis & Venkatesh, 1996; Gefen & Straub, 2000). Adopted from the Theory of Reasoned Action (TRA) (Ajzen, 1985; Fishbein & Ajzen, 1975); TAM suggests the two constructs of perceived usefulness (PU) and perceived ease of use (PEU) as the most important factors affecting the take up of technology and as potent predictors in actual use of a technology. Davis (1989) defines perceived ease of use as the degree to which an individual perceives the technology or system to be free of effort. Perceived usefulness is defined as the degree to which an individual perceives the technology to enhance their performance at work. Combined, perceived usefulness and perceived ease of use determine the attitude (A) of a person towards using a technology. Ultimately, with the combined influence of Perceived Usefulness and Attitude, Behavioral Intention influences Actual Usage.

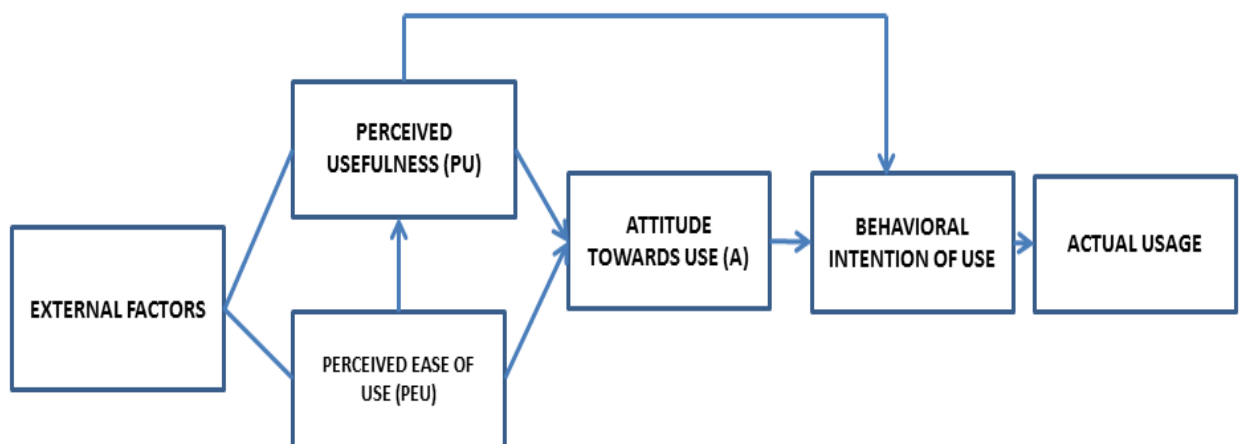


Figure 2: Technology Acceptance Model (TAM) (Davis, 1989)

Despite its robustness and prominence, some scholars (Davis, Bagozzi, & Warshaw, 1989; Malhotra & Galletta, 1999) have argued that the model leaves out the important aspect of social influence in the adoption of technology. Consequently, Mathieson, Peacock, and Chin (2001) extend the model by introducing a new construct of *psychological attachment*—“*the degree of commitment of the IS user toward system use based on the effect of social influences on his or her behavior*” (Mathieson et al., 2001, p. 3). Psychological attachment is measured in terms of three social processes — internalization, compliance and identification. *Compliance* is described as “when an individual adopts the induced behavior not because she believes in its content but with the expectation of gaining rewards or avoiding punishments” (Mathieson et al., 2001, p. 3). *Identification* is “when an individual accepts influence because she wants to establish or maintain a satisfying self-defining relationship to another person or group” (Mathieson et al., 2001, p. 3). *Internalization* is “when an individual accepts influence because it is congruent with her value system” (Mathieson et al., 2001, p. 3). They suggest that social influences have a negative influence on a user’s attitude toward system use if they generate a feeling of compliance. But if they generate a feeling of internalization and identification, they will have a positive influence on the user’s attitude toward system use.

Similarly, Mathieson et al. (2001) argue that the major limitation of TAM is its assumption that there are no barriers to usage if a user chooses to use an information system. Accordingly, they introduce a new construct — Perceived Resources (R) to cater for resource dependent variables. Perceived Resources is defined as the extent to which an individual believes that he/she has enough personal and organizational resources to use an information system. Perceived Resources include expertise, money, hardware, software, human assistance and time. Results from their

study suggest that expertise is related to Ease of Use — users with a higher bar expertise found ease to use the system.

In the context of farmers, farmers with higher mobile usage expertise would absolutely find it easy to use a new system. Resources also affected intention to use. As expected, an individual that has more resources faces fewer barriers to system use. This explains why most of farmers may not use a system even when it might be useful. They also found that resources are not related to actual usage. They explain that an individual can still see value in system even if they do not have the resources to use it. They also express their consternation at the link between resources and usage although they note that the effect was small. This link suggests that the more resources individuals perceive themselves to have, the more useful they might perceive a system to be.

Further extension of the TAM model to cater for social influence was done by Venkatesh and Davis (2000). Referred to as TAM 2, the extended model demonstrates the effect of three related social factors: subjective, norm, voluntariness, and image, in influencing an individual to accept or reject a new system. The model accounted for 40-60 percent variance in usefulness perceptions and 34-54 percent in usage intentions. Further, the Unified Theory of Acceptance and Use of Technology (UTAUT) developed by Venkatesh, Morris, Davis, and Davis (2003) is another model that combines a number of major adoption theories such as TAM, Theory of Planned Behavior and Diffusion of Innovation. The model reflects the influence of three variables of intention to use— performance expectancy, effort expectancy, and social influence; and two variables of usage behavior— intention and facilitating conditions. Gender, age,

experience and voluntariness—the degree to which use of the innovation is perceived as being of free will—are mediating factors in the influence of usage intention and behavior. They argue that the combined model was able to account for 70 percent variance which is a significant improvement from all previous adoption models. They contend that “given that UTAUT explains as much as 70 percent of the variance in intention, it is possible that we may be approaching the practical limits of our ability to explain individual acceptance and usage decisions in organizations” (Venkatesh et al., 2003, p. 471).

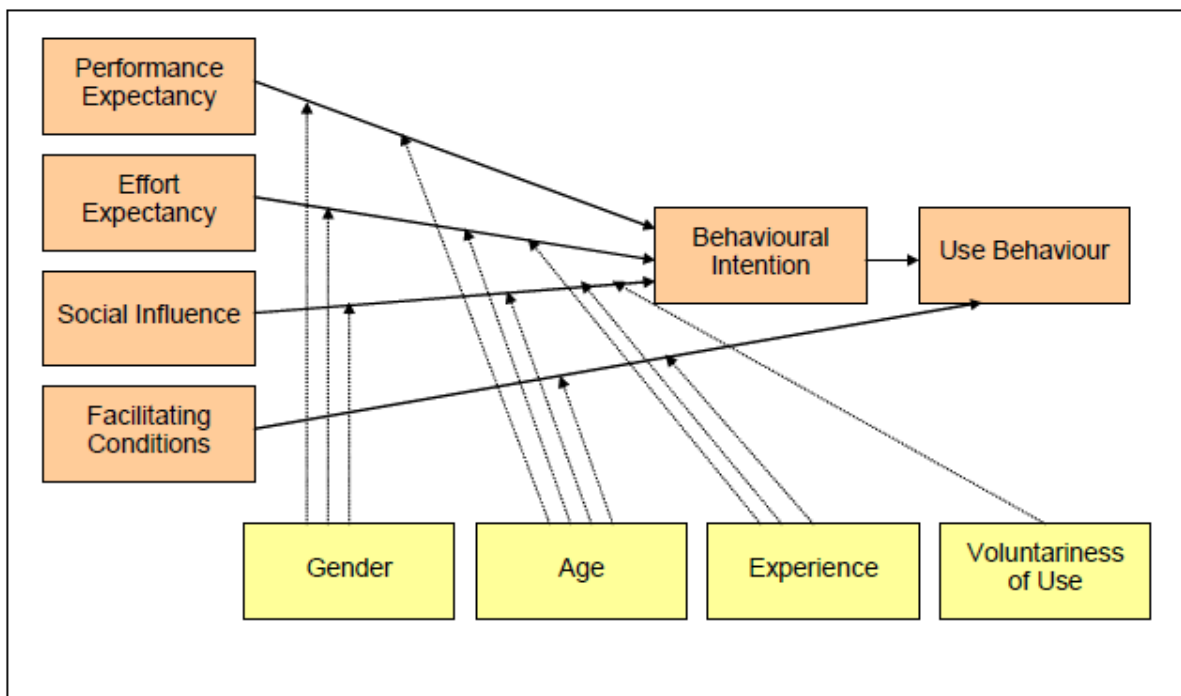


Figure 3: Diagrammatic representation of the Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003).

The literature concerning adoption theory reviewed so far is void of any model that specifically addresses the adoption of technology in a rural setting. Rural communities, especially in the developing world, face a host of challenges such as low literacy levels, poverty and poor

infrastructure all of which require special attention if adoption and diffusion of new technology is to be successful. It was for this very reason that Beaumont, Lu, and Swatman (2009) developed the Rural Area Technology Acceptance and Diffusion of Innovation Model (RuTADIM) to investigate the acceptance and diffusion of a mobile commerce technology among organic primary producers in rural Australia. The model combines a number of prominent information system theory such as the TAM (Davis, 1989), big three model of change (Kanter, Stein, & Jick, 1992); the Information System (IS) variance model (Agarwal & Prasad, 1997; Crum, Premkumar, & Ramamurthy, 1996), and the diffusion of innovation model (Rogers Everett, 1995). The model attempts to explain the specific constraints affecting acceptance or rejection of an innovation in a rural and remote settings by introducing two additional variables—Rural connectivity and Access and response time—to the Technology Acceptance model. However, the Rural Area Technology Acceptance and Diffusion of Innovation Model, (RuTADIM) has never been tested beyond its original context of a developed country like Australia. It's therefore unknown if it would produce the same results in determining the adoption of an information system among farmers in a developing country.

In a bid to extend TAM to account for technology adoption in rural settings, Islam and Grönlund (2012) developed the Rural Technology Acceptance Model (RUTAM) to study the factors that affect the adoption of mobile phones in rural Bangladesh. Akin to Mathieson et al. (2001), model heavily relies upon social influences to influence the adoption of an information technology especially during the early stages of adoption. Two factors —“Tech-service promotion” and Tech-service” attributes are introduced as external factors that affect behavioral intentions (I) of an individual through perceived usefulness (PU) and perceived ease of use (PEU). The most

salient assumption the model makes is that social influence is more important than the technology itself in determining technology adoption. This assumption is in contrast with the original TAM but consistent with later extensions of the model. However, they do not provide a formal testing of the model but rather provide empirical evidence to validate its contents. They note that the current version of the model is only a “hypothesis which can be considered as the first step of extending the prevailing TAM, specially fitted for rural people in poor countries” (Islam & Grönlund, 2012, p. 13).

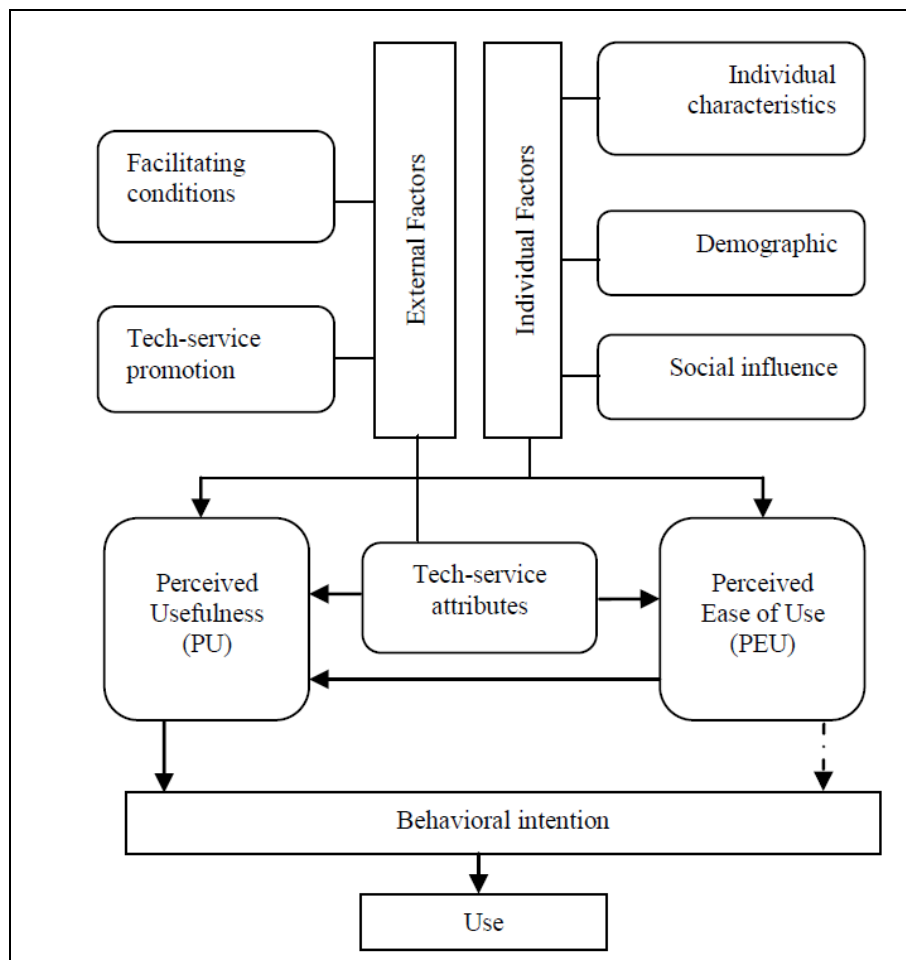


Figure 4: Technology Acceptance Model (Islam & Grönlund, 2012).

Factors affecting Technology Adoption

The next section provides a description of the factors associated with the adoption of information technology acceptance especially mobile based as identified in the literature.

1) Facilitating Conditions (FC)

Further extensions of TAM have gone further to introduce new external factors under External Factors construct in the original TAM. While Venkatesh et al. (2003) introduced facilitating factors to the model, Islam and Grönlund (2012) introduced Tech-service promotion. Adopted from the Model of PC Utilization (Thompson, Higgins, & Howell, 1994), Venkatesh et al. (2003) define Facilitating Conditions as “the degree to which an individual believes that an organizational and technical infrastructure exist to support the use of a system” (Venkatesh et al., 2003, p. 453). Additionally, Seneler, Basoglu, and Daim (2008) describe facilitating conditions as support given to a user while interacting with a new technology such as learning from a friend. In attempting to investigate the determinants for the adoption of mobile phones in rural India, Jain and Hundal (2007) argue that the choice of a provider is moderated by facilitating factors such as network coverage, service quality, easy availability of subscription and bill payment centers. Several other variables relevant to the adoption of mobile phone technology that fall under the broad category of “facilitating conditions” can be found in the literature. These include: modes of payment, quality and availability of support services, technological infrastructure, tax policy and distributions.

2) Tech-service attributes

Tech-service attributes refer to specific attributes of a technology, service or new idea that distinguishes it from other services. In a study of modern sorghum and rice varieties in

Burkina Faso, Adesina and Baidu-Forson (1995), found that farmers' perceptions of a technology characteristics affects their adoptions decisions. Tech-service variables found in the literature include cost of handsets and system related costs, technology characteristics — interface, network capabilities; interface characteristics, brand reputation and technology flexibility. Carlsson, Walden, and Bouwman (2006) found that cost is a significant barrier to the adoption of mobile based services. Similarly, Nkonya, Schroeder, and Norman (1997) found that farmers that had more resources were more likely to adopt improved maize and fertilizers because they could afford it.

3) Tech-service Promotion

Tech-service promotion involves informing people about the new product. Kalish (1985) defines awareness as “the stage of being informed about the product search attributes” (Kalish, 1985, p. 1569). He argues that awareness is one of the steps towards adoption. Similarly, Doss (2003) contends that lack of awareness if one of the main reasons why farmers don't adopt technology.

4) Social Influence

Developed by Fishbein and Ajzen (1975), the Theory of Reasoned Action (TRA) suggests that behavior intention depends on the person's attitude toward the behavioral and the subjective norm ($B=A+SN$). In other words, a person's voluntary behavior is predicted by his attitude toward that behavior and how he/she thinks people would view him if he performed the behavior. Kargin, Basoglu, and Daim (2009) also note that social influence is more important in determining adoption of mobile services than the user's characteristics. Similarly, Jain and Hundal (2007) reveal that rural consumers depended on the opinion of an influential person in deciding the type of mobile phone to buy.

5) Demographic studies

A number of studies have found that demographic factors play an important role in determining the adoption of a technology. The variables important in this category include age, education, Gender, Household income, occupation, culture and ethnicity. Age is the most studied variable in technology adoption literature. Existing literature concerning its effect on ICT adoption is mixed: some studies suggest that older adults have a favorable attitude towards ICT use while others suggest that older adults have a negative attitude towards ICT use. For instance, Kwon and Chidambaram (2000), found that age had a significant and positive association with social pressure to use a mobile phone. Older respondents felt more social pressure to use mobile phones than younger respondents did. Additionally, Olumide, Richard, Folake, and Kaka (2010), found that age as well as level of education significantly influence an older person's attitude toward perceived usefulness and perceived ease of use. Although they did not find significant difference between young and older adults in relation perceived usefulness of ICTs; they suggest that young adults have a more favorable attitude towards ease of use of ICTs than older adults do. Furthermore, Jain and Hundal (2007) found that more than 60 percent of the users of mobile phones in rural India were between the age of 20 to 40. Richardson, Ramirez, and Haq (2000) study of Grameen Telecom's Village Phone Programme showed that "higher expenditures for better service are more likely to come from younger phone users aged 20 to 30, an age group that would more likely be receptive to a wider range of phone services, including card phones" (Richardson et al., 2000, p. 37). On the other hand, Van Biljon and Kotzé (2008) suggest that culture influences mobile phone adoption and usage. Similarly, Phillips, Calantone, and Lee (1994) found that cultural

affinity — the degree to which rules, customs and communications or foreign culture resemble the usual way of doing business in the home culture”— positively influences technology adoption behavior. Musa, Meso and Mbarika’s (2005) study of the factors that affect the use of mobile phones in Kenya and Schiffman and Kanuk (2000) suggest that education and income are closely related — therefore, the more one is educated, the greater the likelihood of a higher income. Similarly, when an individual is educated, he faces fewer barriers to learn and use a new technology. In the context of farmers, especially in the developing world, they often face more barriers to mobile phone adoption than other groups due to low levels of education. In their study of technology adoption among farmers in Tanzania, Nkonya et al. (1997) found that farmers education affected the probability and intensity of technology adoption. Farmers that were more educated were more likely to use improved maize seed and fertilizer with each additional year of education increasing the probability of adoption by 5 percent. On gender, Gefen and Straub (1997) study the use of email between men and woman. They conclude that men and women differ in their perceptions but not use of email. Venkatesh and Morris (2000) suggest that men’s use of technology is more influenced by their perceptions of the technology’s usefulness while women’s use of technology is influenced by their perceptions of ease of use. Additionally, (Crandall et al., 2012) found that there were no gender differences in mobile phone use apart from mobile internet, which was dominated by educated male youth.

6) Individual Characteristics

The literature distinguishes individual characteristics that affect technology adoption from demographic attributes. Individual characteristics include individual innovativeness,

attitude towards new technology and knowledge about technology. In their study of maize seed and chemical fertilizer in Tanzania, Nkonya et al. (1997) found that the individual characteristics such as farmer innovativeness had a huge impact on adoption. Comparably, Sultan and Chan (2000) contend that individual characteristics are more important than technology characteristics in the technology adoption process. Thong and Yap (1995) studied the effect of CEO characteristics on the adoption of technology in small businesses. They suggest that regardless of the size of the business, small businesses are more likely to adopt technology when the CEO is more innovative, has more positive attitude towards adoption of information technology and possesses greater knowledge about information technology. Gatignon and Robertson (1989) argue that information-processing characteristics of the decision maker (the person who makes the decision to adopt a technology) , is what separates adopters and non-adopters. Such characteristics as exposure to personal information reduce the likelihood of rejecting a technology. In a rural context, Wei and Zhang (2008) suggest that psychological factors (i.e. perceived popularity of a mobile, perceived need of a mobile phone, perceived characteristics of a mobile); have a less significant effect on mobile phone adoption than behavioral factors.

7) Perceived Usefulness (PU) and Perceived Ease of Use (PEU).

Previous research suggests that these two factors are among the most important determinants for system use (Davis, 1989). People will use a system if they believe it is useful in their work. Even if a technology is useful, users may forego its performance benefits if it is too hard to use. In their study of mobile phone adoption, (Kwon & Chidambaram, 2000) suggest that perceived ease of use has a significant effect on users'

extrinsic and intrinsic motivations. They further found that apprehensiveness — the anxiety to use a new technology — had a negative effect on intrinsic motivations. Agarwal and Karahanna (2000), found that perceived ease of use and perceived usefulness accounted for 88 percent of the variance in behavioral intention. There is a stream of literature that has consistently supported the influence of perceived ease of use and perceived usefulness in determine adoption of technology (Anakwe, Anandarajan, & Igbaria, 1999; Majchrzak, Rice, Malhotra, King, & Ba, 2000; Mbarika, Byrd, McMullen, & Musa, 2002).

8) Behavioral Intention and Use.

According to TAM, Perceived ease of use and perceived usefulness predict attitude toward use of the system (Davis, 1989). Consequently, attitude toward use predicts behavioral intention to use.

In summary, technology adoption literature presents a number of key elements that determine the adoption or rejection of information technology. Prominent among them are the two constructs of perceived ease of use and perceived usefulness; facilitating conditions, demographic factors, personal characteristics, technology attributes such as cost and interface design; and social influence. TAM and its subsequent extensions bring together different aspects of other models such as the TRA and diffusion of innovation; and have been touted for their robustness in explaining and predicting technology adoption. However, the literature makes little effort to delineate the effect of language on technology adoption especially in the developing world where technology artifacts such as mobile phones are only available in foreign languages and

agricultural research findings usually produced in the country's national language which is often foreign.

Effect of Language on Technology Adoption

Although the effect of external factors such as gender, resources and culture and culture has been explored in various TAM extensions, there is little mention of the influence of language of technology use and adoption. Yet, in most developing countries where there are various diverse ethnic groups, and the national language is usually foreign, language does not only affect use but also access and trust of information technology. Wamala (2010b) argues that various ground breaking studies on access and use of information technology have often identified barriers to technology in the dichotomy of literate/illiterate. She contends that these studies have not done enough to unravel the multifaceted barriers to technology use and access. In her study of technology adoption among farmers in Uganda, she identifies ethnicity and language among others, as potential determinants to technology adoption. For instance, she found that farmers only listened to radio stations that broadcasted in their ethnic languages even if access to stations that broadcast in other languages could be accessed. This phenomenon also applied to educated people who could understand English stations. Further, she found that the language, in which content is broadcast, has an effect on whether the information will be trusted or not as well as the choice to access or not, and use the technology. "The technology wrapped in the in the local languages increases familiarity....." (Wamala, 2010b, p. 141). In regard to mobile phone use, Wamala quotes a 44 year old respondent who noted that, "as long as the SMSes are in Luganda" in response to whether he could read text messages. She acknowledges the existence of several locally created agricultural websites that were not used by farmers because they were in English.

Other scholars such as Warschauer (2004) emphasize the importance of language and content if access to and use of new technologies is to be provided. In the Ugandan context, because English is the national language and the language of instruction, all agricultural research findings and technical agricultural information is produced in English. Yet, only a minority of farmers has can read and understand it. As such, providing information in the farmers' local languages would arguably improve technology adoption and use.

However, as Wamala acknowledges, other factors such as age and education come into play. Also, the use of local extension workers in our model increases the level of trust as farmers rarely use their mobile phones in seeking agricultural information if the person they are communicating to is unknown to them (Wamala, 2010b).

In summary, there is much known and important theories about the adoption of agricultural techniques generally; and there are many ICT in agricultural projects that have been implemented. However, many of the ICT projects have been neither thoroughly evaluated, nor evaluated in the context of adoption theories. There are therefore important gaps in our knowledge about the causes of adoption of ICT for agriculture technologies. These gaps – as summarized below – have informed the basis of this study:

- How does language affect the adoption and diffusion of mobile-based agriculture services in rural farming communities of the developing world where there are diverse ethnicities and local languages?

- Adoption literature often identifies barriers to ICT adoption in the dichotomy of illiterate/illiterate – how does this play out in the case of SMS-based agriculture services in rural farming communities of the developing world?
- How does the integration of existing local extension systems affect the sustainability, usefulness and adoption of ICT for agriculture projects in the developing world?

The conceptual framework is based on the Technology Acceptance Model (TAM) (Davis, 1989). The model suggests that perceived usefulness and perceived ease of use are the major factors that influence Technology adoption. Davis (1989) defines perceived ease of use as the degree to which an individual perceives the technology or system to be free of effort in regards to use and perceived usefulness as the degree to which an individual perceives the technology to enhance their performance at work. The present study emphasizes technology attributes especially language and demographic attributes such as age and gender because these are hypothesized to be important in rural African communities. On demographic characteristics, the study hypothesizes that older adults in rural farming communities are not only less tech-savvy but also less curious and less interested to try out new technology and thus less likely to use ICT for agriculture services as well as perceive them as useful. On the other hand, younger adults are very innovative and open to try out new technologies and therefore more likely to use ICT for agriculture services. The study further hypothesizes that technology attributes such as language and cost have a profound impact on perceived ease of use and usefulness. Users in ethnically diverse rural farming communities will not perceive new technology as useful or even use it if it is not in their local language. Additionally, tech attributes such as cost, flexibility and network

capability of the service have a huge impact on perceived ease of use and perceived usefulness. For instance, if there are costs associated with using the service, farmers are less likely to use it irrespective of whether it is useful or not. Similarly, if the service is more flexible, provides actionable and localized content as well as available across multiple telecom carriers so that users do not have to switch carriers to use it, they are more likely to perceive as easy to use as well as useful and thus adopt it.

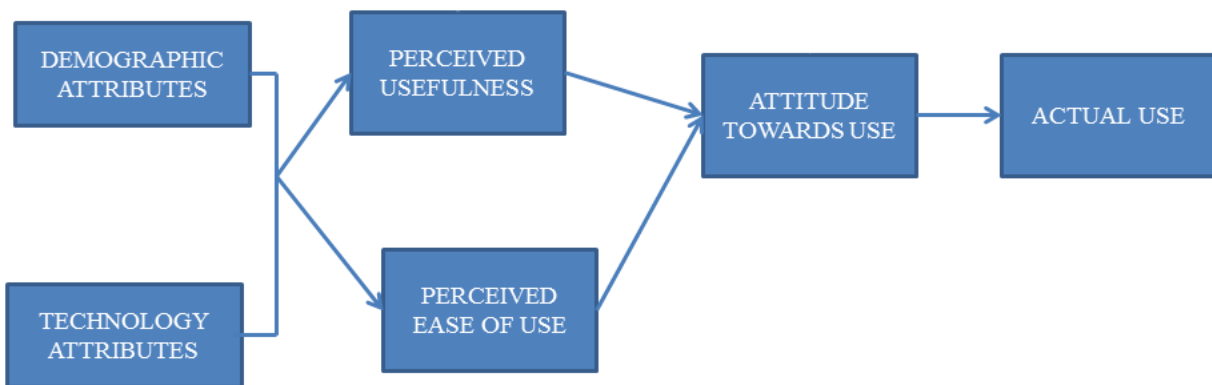


Figure 5: Conceptual Framework of Adoption of ICT for Agricultural Projects (or technology) for this thesis (adapted from Davis, 1989).

Research Questions

The conceptual framework thus leads to research questions for this study:

1. What impact does the offering of information in the farmers' own languages have on the adoption of an ICT for agriculture system in the developing world? What are the drivers/barriers, such as literacy and gender that affect its adoption?
2. What factors contribute to the utility of a system to farmers and thus system adoption?
3. What are the information needs of farmers compared to what SMS systems can provide?

These research questions guided the research conducted in a case study in Uganda. The case study area and project being evaluated are described in the next chapter.

Chapter 3

The Case Study: An ICT for Agriculture Project in Uganda

This chapter presents an overview of the Ugandan agriculture sector and highlights its challenges. The chapter also provides an overview of the telecommunication sector as well as a brief description of existing ICT for agriculture projects. It further provides a detailed description of the ICT for agriculture project being evaluated, as well as a conceptual framework for the study.

Agriculture in Uganda

Uganda's economy is heavily reliant on agriculture. The sector employs more than 80 percent of the country's workforce and remains the country's biggest contributor to GDP (Cole, Lee-Smith, & Nasinyama, 2008). Ugandan agriculture is generally very productive because much of the country has relatively good soils and sufficient precipitation. Nevertheless, the growth in food production has not kept up with food demands due to the rapid population increase, low uptake of improved technologies, underfunding, a huge disconnect between value chain actors, and a poorly functioning extension system. Whereas other sectors of the economy have grown rapidly since the end of the civil wars, agriculture has only shown a slight increase (J. C. Aker, 2011). With the rapid proliferation of mobile phones, ICTs have been seen as a tool to help overcome some of the major challenges, including bridging the gap between research and farmers and the need to supplement the conventional agricultural extension system.

Agriculture Extension

Like many developing countries, Uganda implemented a wide range of cross-cutting policies in the 1990s at the behest of international development organizations such as the International Monetary Fund (IMF) and the World Bank. These reforms included liberalization of trade including agricultural inputs and services, decentralization of services to lower local governments; privatization of state owned enterprises including those that supported production and marketing of agricultural produce on behalf of farmers; and downsizing of the public service that provided public extension services (Draa, Semana, & Adolph, 2004). At the advent of these wide-sweeping reforms, Uganda's extension system was supported by about 4,300 extension officers; this was cut down to 2,000 (Nygaard, Paarlberg, SANYU-MPAGI, Matovu, & Babu, 1997) which raises concerns about government's commitment to a sector that employs more than 80 percent of the population.

As a result, agricultural production significantly declined and the public extension system collapsed (Okoboi, Kuteesa, & Barungi, 2013). In an effort to reinvigorate extension and spur agricultural productivity that was dwindling (MAAIF 2000), the government with support from the World Bank restructured the public extension system to a public private partnership (PPP) extension system. This led to the establishment of the National Agricultural Services (NAADS) by an act of parliament (NAADS Act 2001). It was established as a semi-autonomous organization under the Ministry of Agriculture Animal Industries and Fisheries (MAAIF) (Okoboi et al., 2013). In this new PPP arrangement, the government planned to contract individuals and organizations to provide extension services to only those farmers who demanded it — creating a demand driven model. It was envisaged that this would increase efficiency and

reduce public expenditure (World Bank 2010). Furthermore, this process coincided with the implementation of the decentralization program as recommended by World Bank and IMF.

Extension officers were put under the direct supervision of lower local governments, and the cost of providing extension services would gradually shift to them and farmers — though the central government would initially bear the cost. It was envisaged that the NAADS program would ultimately help poor farmers be more informed about technology and improved agriculture practices so that they can adopt them and thus increase productivity and incomes (World Bank 2001). Privatization of extension also opened up the door for NGOs operating at the grassroots level to offer information and agricultural technologies to farmers (Friis-Hansen & Kisauzi, 2002). After more than 12 years of implementation, the system has not transformed agriculture as it was envisaged. Production is dwindling, poverty has hardly abated and malnutrition has reduced by negligible percentages (Jones, 2005). The major reasons cited for this phenomenon include fewer numbers of extension officers compared to the number of farmers to be served (Okoboi, Kuteesa and Barungi 2013); and a huge disconnect between research, extension and farmers. For instance, Uganda's census of agriculture (UCA) report 2008/09, revealed that only 680,000 households had been visited by an extension officer in the 12 months prior the survey out of 3.8 million farming households at the time.

As the population increases with no proportional increase in extension officers, coupled with declining government expenditure on the sector, the future of Uganda's highest employer looks grimmer. However, the advent of ICTs and their proliferation amongst Ugandans presents an opportunity to ameliorate this appalling situation. Indeed, government with support from the

World Bank is now implementing a 5 year project — Agricultural Technology and Agri-business Advisory services (ATAAS) with the aim of enhancing linkages between extension and research; increase agricultural productivity; increase farmer access to technology, advice and information. The project among other things intends to leverage ICTs to support knowledge and information exchange between farmers, researchers and extension staff (World Bank 2010).

Despite existing challenges, such as lack of infrastructure, farmers having different enterprises on the same farms, and few extension officers, farmers nevertheless have mobile phones in their hands. Evaluating the status quo as such, enables the construction of a plan that maximizes the benefits of existing structures without attempting to employ over-ambitious and complicated measures. By mistakenly attempting to repair the current information pathways within Uganda's agricultural system, many projects have failed. By building upon what is already available, a strategic solution that works around Uganda's lagging broadband infrastructure and English illiteracy may be possible.

Telecommunications in Uganda

According to the International Telecommunications Union (ITU), Uganda's telecommunication sector is one of the fastest growing in Africa. This is largely attributed to rapid proliferation of mobile phones. With 7 major operators Uganda had 25.5 million connections out a population of 38.5 million by the end of 2014 — a 24.9 percent increase from 2013 (GSMA Intelligence, 2015). These statistics also show that 98 percent of mobile subscriptions in the country are prepaid, 11 percent of the population uses mobile broadband and SIM penetration stands at 64 percent. There was tremendous growth in mobile broadband usage with a growth rate of 54

percent and SIM penetration growing at 20.87 percent. Additionally, 69 percent of farmers own mobile phones and approximately 90 percent of Ugandan households have access to mobile phones (Mercycorps, n.d.). In the mobile payments segment, by June 2014, the country had 17.6 million registered mobile money users compared to 12.1 million as of June 2013, representing a 46 percent increase (UCC, 2015). The number of registered mobile money users hugely surpassed the number of financial institution account holders which stood at 5,587,251. Statistics from the Uganda Communications Commission (UCC) also show that profit margins are waning in the prepaid segment (voice and SMS) due to the large number of operators in the sector and the subsequent price wars. They suggest that the next competitive battleground as already witnessed — will be in the mobile broadband segment. In fact, there was negative growth of -0.26 percent in the prepaid segment compared to 11 percent in mobile broadband (GSMA Intelligence, 2015).

ICT for Agriculture Projects in Uganda

Like many developing countries, Uganda has become a testing ground for a host of ICT especially mobile-based agricultural services. The country has become pilot site for a number of ICT projects although many have not lived beyond their pilot phase. There are several mobile based agricultural projects still running and prominent. They are described below.

Community Knowledge Worker (CKW)

Grameen Foundation's Community Knowledge Worker (CKW) initiative is a system that combines a live voice telephone system and a network of over 1,000 community knowledge workers (CKWs) equipped with smartphones to provide information on weather, prices, crops

and livestock management to farmers. Launched in 2009 with \$4.7M funding from the Bill and Melinda Gates foundation, the initiative combines information technology with social networks to get information into the hands of farmers. The network of local advisors is made up of farmers drawn from the communities they serve. The content used by CKWs is preloaded on an android smartphone so that CKWs can have access even when they are out of internet coverage. Also, the program runs a call center where farmers can call directly for assistance at subsidized rate of 8 Uganda shillings (equivalent to 3.5 US cents) per minute. But the subsidy is available only to subscribers of MTN. The CKWs are paid a small monthly salary depending on the number searches made on the phone. The CKWs help to localize and contextualize the information for farmers who would otherwise not understand. A number of issues emerge from the CKW model. Firstly, with a network of more than 1000 CKWs that receive salary from project funding; the investment in hardware (smartphones), and a bevy of personnel to run the call center and implement other project related operations, the costs involved are too high that it may be difficult to maintain when funding ends. Secondly, the initiative's voice service (call center) is out of reach of many smallholder farmers due to call costs as the subsidy is available only to subscribers of MTN. Yet, there are more than 7 telecom companies in Uganda.

SMS Services (AgriNet, FIT Uganda, CELAC, Agri-Fin)

There are a number of agricultural information services that provide information to farmers mainly via SMS: (1) AgriNet and FIT Uganda provide market information, market analyses and forecast and agricultural tips to farmers and traders through the mobile phone, email, and information boards; (2) Kenya based Agri-Fin Mobile also provides market information, weather updates, and agricultural tips; and finally, (3) Collecting and Exchanging Local Agricultural

Content (CELAC), a project owned by a local non-government organization BROSDI based in Eastern Uganda collects and shares local agricultural information with farmers through the internet, radio, print media, SMS, videos and drama. These systems typically use short message service (SMS) to deliver information usually in English directly to farmers. In doing so, they overlook the language challenges of farmers and the importance of working with local extension systems that have a better understanding of local conditions. Notably, the literacy rate of farmers in Uganda has been reported to be as low as 31 percent (Uganda Census of Agriculture, 2011). In a country where most of farmers are illiterate, with more than 56 different local languages, most existing SMS services are only serving an educated minority. Moreover, most of these services also require farmers to follow a strict syntax to register (Chemweno 2012). Thus, most farmers who cannot access Internet or are not literate enough to understand English, cannot use them (Medhi et al 2011).

None of the services described provide a hybrid model where the conventional extension system is fully involved and thus allows for extension officers to respond to their farmers' local information needs in their various local languages. They all tend to by-pass the system.

The Case Study Village

The case study village, Ssebbi, is located in Central Region's Wakiso District in Kakiri sub-county, off the Kampala-Gulu highway. The Central Region is a major crop producing region of the country where several other ICT in agricultural projects have been implemented. A study there would permit comparing results with those of prior projects. The village Ssebbi is 30 kilometers from Uganda's capital city, Kampala. It has a population of approximately 900 people

in 260 households, according to the Uganda population and housing census 2002. Agriculture, more specifically crop cultivation, is the major economic activity.



Figure 6: Map of Uganda showing the study site. Map source: www.ugandamission.net

The main crops grown are bananas, maize and beans. Farmers also engage in poultry and livestock keeping as a way to supplement their incomes. Like many Ugandan villages, agriculture is largely subsistence and rain fed although farm surplus is usually sold to cater for household needs. Like the rest of central Uganda, Luganda is the predominant local language. While the pilot village is representative of a typical Ugandan village, some of its characteristics such as education and age were somewhat not typical of any Ugandan village. For instance, according to statistics from the Uganda National Bureau of Statistics, (UBOS, 2010) the central region has a literacy rate of 83 percent with Kampala having the highest literacy rate of 92

percent. Additionally, according to UBOS (2002), only 43 percent of Ugandans had completed primary school in 2002. Despite the absence of official figures, this study's survey results indicate that the pilot village had a very high literacy rate of 96 percent and 43 percent of the respondents had completed secondary school. The high education levels and literacy might not be typical of a Ugandan village and can be attributed to the village's close proximity to Kampala which enjoys high literacy and education rates. Additionally, the percentage of older adults (40-60 years) in the survey is quite high and might not be representative of a typical Ugandan village. Similarly, the discrepancy might be caused by the village's close proximity to Kampala as young adults leave the village en masse to find non-agricultural work such as "boda boda" (motorcycle taxi driver) in Kampala.

According to this study's survey, most of the households and most adults own at least one mobile phone and more than 50 percent of the households reported owning more than one mobile phone. Most of the phones owned are basic cheap phones imported into the country from Chinese manufacturers. The most pressing livelihood challenges that the farmers report included diseases and pests that attack their crops, poultry and livestock, low prices for their products, lack of or poor extension services, counterfeit inputs such as seed and fertilizer, and highly priced inputs. Although the sub-county under which the pilot village is located has three full time extension officers, most farmers reported they rarely interact or visit them.

Like children that need a teachers' guidance for continuous improvement, I need the extension officers' assistance to learn and adopt improved technologies — but I have spent close to a year without seeing one. Jane, a 57 year old widow lamented.

Another farmer stated:

I know that we have extension officers at the sub-county and they draw salaries from the government every month, but if you asked me what they do, I do not think I would point to anything.

Many farmers also stated that seasons have vastly changed with less and spotty rain and prolonged dry seasons that negatively affect agriculture production. “The seasons have changed greatly, they are no longer predictable”, one participant says. “It does not rain when you expect it and the dry season is much longer than it used to be,” he continues. On the other hand, extension officers claimed it is not entirely their fault that they do not visit farmers. They cited challenges like the high ratio of extension officers to farmers, lack of transport and lack of interest or motivation from farmers as major factors that constrain their performance.

Farmers do not attend trainings we organize to pass on important information and technologies. They will only come when they know we are giving out something such as inputs, seeds or animals. There is also a dependency syndrome among farmers—they want to be given everything yet our budget is not enough, one of the extension officers stated.

Description of the Buuza Omulimisa SMS Platform

To examine the role of various factors affecting ICT adoption as identified in Chapter 2, particularly the need to use local languages, we developed, and field tested and evaluated an

SMS platform (named *Buuza Omulimisa*, or ask the farmer, in the Luganda language) that enables farmers to interact with their local extension officers in their various local languages. Buuza Omulimisa is a mobile and Internet-based platform that enables farmers to exchange information with their extension officers anywhere and anytime. The application leverages mobile text messaging to create a mobile and Internet based “Q&A forum” where farmers use their mobile phones to ask questions in their local languages, and receive relatively instant feedback from their extension officers.

Using language specific keywords, such as “mulimisa” or “muhingisa” (Luganda and Runyakitara for extension officer respectively), a farmer types a text message in form of a question(s) and sends it to a short code (#8228). Luganda is spoken by more than 6 million native speakers in the central region, and is the lingua franca of almost half the Ugandan population—that is 16 million people (Mulumba and Masaazi, 2012). This makes it the most widely spoken indigenous language in Uganda. Runyakitara on the other hand, a language based on the combination of the four Western Uganda interlacustrine languages—Runyankore, Rukiga, Runyoro and Rukiga; is spoken by more than 20 percent of the population (Bernsten, 1998). Upon sending a message, a farmer is charged 50 UGX (\$0.018). The cost of sending an SMS via short code is usually shared between the DMARK (SMS Company that owns the short code) and the content provider. However, for purposes of the study, the system was provided free to all farmers and all costs were borne by the researcher with support from the Borlaug Higher Education Agricultural and Research Development (BHEARD). These charges were covered upfront and funds were paid to a local SMS company (DMARK) that owns the short code (#8228). Each text message sent from the system in response to a farmer query was

charged at the same rate (\$0.018) across all carriers in Uganda. The message is instantly delivered to a web-based platform where registered extension workers employed by the government respond appropriately using a personal computer and answer (s) is delivered back to the farmer's phone. To an extension officer, the system improves his/her efficiency as it helps him/her reach out to more farmers by just a click of mouse. The farmer can also opt to register to receive weekly agricultural information in their local languages and specific to their districts and sub-counties. Over the one month pilot period, farmers sent well over 25 questions which we viewed as an encouraging number considering that most of the farmers in the pilot village are majorly engaged in crop cultivation, and the study was carried during the off-season when they were waiting for onset of the rains to start planting. A selection of questions received and answers is presented below:

Question: “Nkoko zirese amabwa ku mitwe tukole tutya”— my chickens have wounds on the head—what should I do?

Answer: “Gula eddagala lya OXYVETO 50S otabule ekijiiko kimu ekya supu mu liita abiri ezamazzi oteeke mukiyumba zinywe. Kino kikole okumala wiiki. Kuba ku 0774113391”—buy OXYVETO 50S—mix one table spoon in two liters of water. Put the mixture in the poultry house for them to drink. Do this for one week. You can call the extension officer at 0774113391 for further guidance.

Question: “Kiwotoka mukole ntya?”— how do I control banana bacteria wilt?

Answer: “Kiwotoka tarina ddagala wabula sigula otemeteme ekitooke ekirwadde obiziike oba obyokye. Enkumbi oba ejjambiya jokozezeza giyise kumuliro oba oyoze ne JIK”—Banana wilt has no cure — to prevent spread, you must uproot and burn or burry all infected plants. Tools used must be washed in JIK or heated on fire.

Question: “Embizzi kirungi bwelya ebikola bya muwogo nebikuta bye?”—is it healthy for pigs to eat cassava leaves or/and its peelings?

Answer: Ebikola bya muwogo ku mbizzi tebirina mutawaana. Wabula ebikuta byetaaga okufumbako olwokuba nti muwogo omu aba wabula—cassava leaves or its peelings have no known bad effect on pigs—but some cassava varieties are poisonous and so you need to boil them before you feed them to pigs.

Question: “Omusujja gwentte ngukola ntya?”—how do I treat fever in cows?

Answer: Yita omusawo agikebere amanyire ddala ekika kyomusujja ogwo. Kubira Dr. Mwanje ku 0776552316 oba Dr. Kasirye ku 0772584707—call the veterinary extension officer—Dr. Mwanje at 0776552316 to diagnose the type of fever and recommend the appropriate treatment.

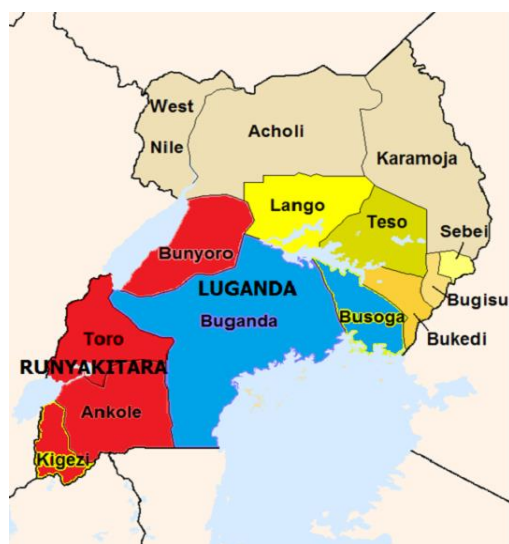


Figure 7: Map of Uganda: Red shaded areas where Runyakitara is spoken, while blue indicates areas where Luganda is spoken as the native language. However, Luganda is used as the lingua franca across Uganda.

Farmer registration/database

For farmers to receive weekly agricultural tips on their phones, they register their mobile phones using a predefined SMS syntax. Since the platform handles information in various local

languages, each language is assigned a special keyword that farmers who speak that particular language use to register. For instance Luganda speakers use the keyword Mulimi while Runyakitara speakers use Muhingi—they are not case sensitive. For a farmer to register, they type their respective language keyword e.g Mulimi <space> their two names separated by a space, their district <space> and then their sub-county. The message is then sent 8777. E.g Mulimi Kizito Eric Wakiso Nangabo and send to #8777. This one time registration costs a farmer 220/ and this information is used to send messages specific to the farmer's district, sub-county and language.

Scheduling and Sending of Learning Content (SMS) to Registered Farmers

This feature enables the scheduling of SMS messages so that registered farmers receive agricultural information (SMS) in their respective languages. The messages are sent to registered farmers on specific days and time as determined by the implementing organization in. For example; if one is sending content about bacterial wilt to registered farmers twice a week, the system enables you to schedule all the messages for a specific period of time, set the time and day when they should be sent out. The system also sends the messages according to the date the farmer joined. For example, if a farmer joins the two months after the start of the SMS campaign, that farmer will start receiving the very first message of the campaign as everyone did. That is, the system will intelligently send the messages to registered farmers depending on their dates of joining to make sure every farmer receives the complete syllabus (text messages).



Figure 8: A farmer reading a message sent from the platform

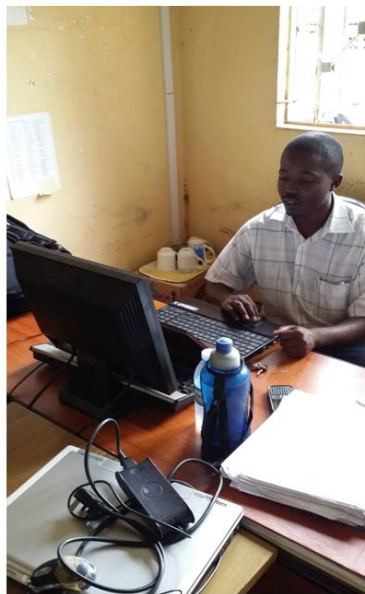


Figure 9: An extension officer responding to farmer questions at Kakiri sub-county offices



Figure 10: A banana farmer trying out a concoction of cattle urine to fight pests. She learnt the practice from the messages sent by extension officers through the system.

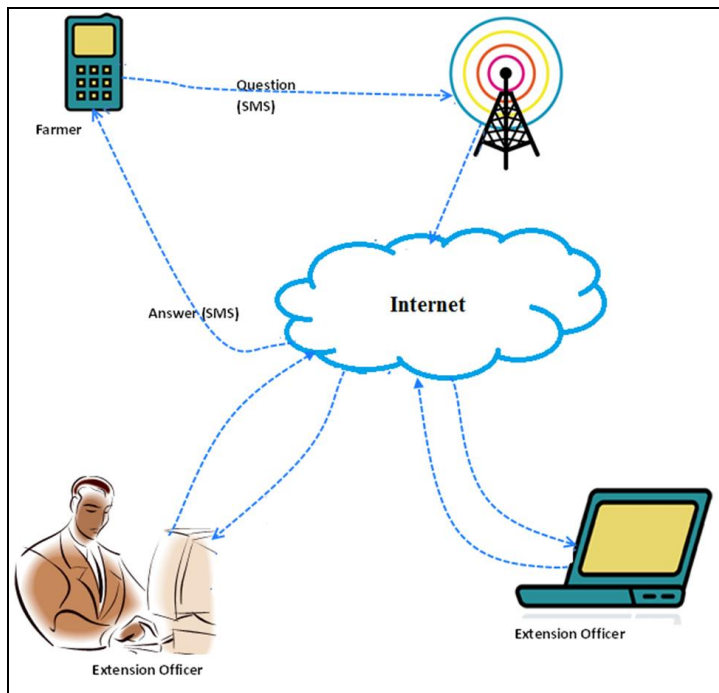


Figure 11: Function diagram of Buuzo Omulimisa

The aim of the case study was to examine how the offering of information in farmers' local languages would affect use of the system, and how adoption varied by other demographic and

technology factors. We adopted the technology acceptance model from (Davis, 1989) but emphasize two factors—demographic attributes and system attributes as two separate external factors instead of one parsimonious factor as provided by Davis. Demographic factors included two variables of age and education, while technology attributes included language, cost, and existing systems.

To summarize this chapter, although agriculture is an important sector to the Ugandan economy and employs more than 80 percent of the population, it has not experienced substantial development due to a host of reasons. Prominent among them include the a high population increase that puts strain on natural resources, low uptake of modern technology, a huge disconnect between research, extension and farmers and underfunding. However, the proliferation of ICTs especially mobile phones, presents an enormous opportunity to overcome some of these challenges. The use of mobile phones in agriculture development has potential to overcome the inefficiencies of the agricultural value chain by facilitating effective information dissemination, lowering transaction costs, linking farmers to markets and helping farmers deal with a wide range risks.

To test the importance of language on ICT for agriculture adoption, a system called “Buuza Omulimisa” was designed and evaluated. By enabling farmers’ use of their local languages, the aim of Buuza Omulimisa was to fit into the existing heterogeneous lingual landscape of Uganda unlike many existing systems that provide information in English only. Coupled with the integration of existing agricultural extension services that help to localize and contextualize

highly technical agricultural research, the platform increases chances of technology adoption and improves the efficiency of the struggling extension system.

Chapter 4

Research Methodology

This chapter summarizes the methods used to collect information to address the research questions posed in Chapter 2 in a case study assessing an ICT project in Uganda. The study aimed to examine the effect of offering information in farmers' own languages on adoption of an SMS system, investigating farmers' information needs, as well as investigating factors that contribute to the utility of a system on farmers. The study is an impact assessment of the project, and thus examines the knowledge of farmers before and after participating in the ICT project.

Events in the country altered the original research methodology, which had included a control group of farmers who would not participate in the Buuzo Omulimisa project but receive information from the extension workers only in person: The government had for long mulled over deprecating the private-public extension system under the National Agricultural Advisory Services (NAADS) due to incessant allegations of corruption, misuse of funds and lack of value for money. The government's plan to end the extension service was finally executed in mid-July well into the study and the contracts of all extension officers were terminated. Without the extension officers, this study was in jeopardy. For them to continue working on the project and providing the services they often provided, I had to pay them, which I could not afford. To complete the project and considering the project budget, I negotiated with the crop husbandry expert and paid him for his time for the remainder of the project – approximately one month. Fortunately, the sub-county administration allowed him to continue using his office, modem and computer till the end of the project. Although most of the questions posted to the platform were

on livestock, the crop husbandry expert was not only flexible to work with but also a well-rounded agriculturist.

The planned control site did not receive any visits or assistance from extension officers. Similarly, the treatment village did not receive any physical visits by the extension officers and the assistance they received was only through the system. Since there was no extension services provided to the control village, it was impossible to make a comparative analysis of the SMS system and the conventional extension system.

The three extension officers that initially took part in the study were public civil servants contracted by the government to provide advisory services to farmers in Kakiri sub-county. Under the National Agricultural Advisory Services (NAADS) program, each sub-county is assigned three extension officers to provide expert assistance to farmers as well as help translate scientific research into practice. They include one expert in animal husbandry, one expert in crop husbandry, and one senior person in an agriculture related field who acts as the supervisor. The extension officers must be university graduates and must speak the local language.

To collect the required data, a *pretest-posttest mixed methods approach* was adopted. Creswell, Plano Clark, Gutmann, and Hanson (2003) define this type of research method as a “collection and analysis of both qualitative and quantitative data in a single study in which the data are collected concurrently or sequentially, are given priority, and involve integrations of the data at one or more stages in the processes of research” (Creswell et al., 2003, p. 165). The move towards a mixed approach was motivated by the need to offset the shortcomings of any single

method. Quantitative methods intrinsically enable the generation of statistical data but sometimes fall short in uncovering the subtle processes involved in social phenomena. On the other hand, qualitative methods explore phenomena and processes in a given society, but hardly provide any categorical data that account for the structural differences between different groups in a society. The use of a mixed approach may provide a more comprehensive understanding of the complex social world (Degefa, 2006).) Snape and Spencer (2003), point out that the major purpose of blending quantitative and qualitative methods together is to produce different types of intelligence about a study subject rather than to coalesce the output from two different approaches of enquiry.

Further, (Creswell et al. (2003)) identified the major advantages of the mixed approach method: First, they state that “the use of multiple methods can cancel out some of the limitations of certain methods”—since both methods (qualitative and quantitative) have their own intrinsic weaknesses. Secondly, they argue that “mixing different types of methods can strengthen a study”; and thirdly, “the complex social phenomena are best understood through different methods”. This is justified by the fact that some phenomena are multi-faceted and have linkages with a wide range of variables. Thus, understanding them may require a fusion of methods (Creswell et al., 2003, p. 211). In the present study, although survey questionnaires were the main data collection tools, in-depth interviews with first adopter type of farmers and extension agents provided crucial information to complement survey data.

Village and Sample Selection

The study was conducted in Ssebbi village, Kakiri Sub-county, Wakiso district central Uganda from June through August 2014. Wakiso district was randomly selected from a list 20 districts in the Central Region where the researcher had had prior contact with extension officers and farmers by virtue of his work with his previous employer. In Wakiso District, Kakiri sub-county was selected because the sub-county extension officers showed interest and embraced the project right at outset; they were willing to dedicate their time to the project without expecting any financial gain. The village Ssebbi was then randomly selected from a list of the 13 villages that make up the sub-county.

To gain smooth entry into the communities, local leaders such as village authorities were initially engaged — their primary role was to act as community gatekeepers to help the researcher gain entry to the communities as well as helping in farmer mobilization. With the help of the village local authorities and local extension officers, a list of all households with mobile phones was generated. Out of approximately 260 households (76 percent), two hundred reported owning at least one mobile phone. More than 50 percent of the households with mobile phones reported owning more than one cell phone. Thirty households were then randomly selected from the list of households with phones to participate in the project. Only one adult (head of household or the immediate adult incase the head of household was absent) from each of the 30 participating households was allowed to participate in the project.

Thirty participants (13 females & 17 males) were involved in the study and were administered surveys before and after the pilot activity. Seven in-depth interviews with were also conducted with two first farmer-adopters, two extensions agents, one input dealer and one person from an

ICT for agriculture project operating in Uganda. The in-depth interviews were concerned with identifying farmer experiences in regard to extension services, problems farmers encounter in production, experiences of extension officers, problems they encounter and how they overcome them. Interviews with ICT for agriculture projects were aimed at understanding what works and what doesn't work. The three farmers that were interviewed were selected from the 30 project participants and selection was based on their innovativeness and adoption to previous new technologies promoted by extension agents.

Implementing the Buuza Omulimisa Project with the Participant Farmers and Extension Agents

The participant farmers and three government extension officers were trained to use the “Buuza Omulimisa” system in late June 2014. Training for farmers centered on how to register on the system and sending a SMS to send questions to the system. Three government extension officers that are responsible for provision for of extension officers at Kakiri sub-county were trained on how to respond to farmer queries as well developing SMS content to share with registered farmers in the treatment site. To access the web-based platform that receives farmer queries, the extension officers used their own office desktop computer that had access to internet through a USB Modem. Messages developed by extension officers were sent to registered farmers two times a week—Monday and Friday. Farmer queries were responded to during normal office working hours—8:00 AM-5:00 PM. Response time depended on the complexity of the question but it averaged from 1 hour to 24 hours. Questions sent during the night were answered during day when extension officers were in office and had access to the internet. For questions that

needed further explaining than could fit in 160 characters permitted by a single text message—extension officers advised farmers to call back and provided their cell phone numbers.

Data Collection

Using a pretest-posttest research design, 7 in-depth interviews and 30 questionnaires were conducted prior to the administration of the Buuza Omulimisa project, and then one month following the administration of the project. Due to the low number in the sample, statistical methods were inappropriate and results are presented in terms of percentages of the total. The qualitative interviews and quantitative surveys were conducted simultaneously. Both semi-structured in-depth interviews and personal structured interviews were conducted simultaneously to generate categorical data and at the same time gain a deeper insight into their personal accounts and experiences as farmers and their attitudes about the system after one month of use.

The survey questionnaire had three main sections: demographic characteristics such as information about age, education, gender and occupation, individual use of the mobile phone for agriculture information access and questions on perceived ease of use, usefulness, efficiency and intended future use of the system (see Appendix 1). Perceived ease of use, perceived usefulness, behavioral intention or intended future use of the system were measured using Likert Scales adopted from (Shroff, Deneen, & Ng, 2011). However, the statements were revised to end in form of a question instead of passive statements used in Shroff et al. (2011). Two research assistants—a female and male were recruited to assist in the administration of the survey questionnaire. The two lived in the same village as the study participants and the village being a tight-knight community, the research participants knew everybody they interviewed.

The research survey instrument was pretested four days prior the beginning of data collection. Questions that led to biased answers or were ambiguous to participants were identified and revised. All interviews (both in-depth and personal structured interviews) were conducted in the participants' local language—Luganda. This was easily achieved since the author and the two research assistants speak the local language fluently. All survey interviews were conducted in the homes of participants and lasted an average of 45 minutes. Additionally, all six in-depths interviews were recorded using an Edirol R-09HR voice recorder and later transcribed for analysis. As compensation for their time and inconvenience for their participation in the study, participants were given 1000 Uganda shillings (\$0.4) worth of airtime for their phones. The research was reviewed and approved by the Michigan State University Institutional Review Board as required of all research involving human subjects.

System Log Reports

Every interaction between the farmer and the system is recoded — phone number, question, response and the details of the extension that responded. This information was collected to gain insight of every user's patterns of use and the kind of information they requested.

Data Analysis

For quantitative data, SPSS was used to analyze and generate statistical data and draw conclusions. Because the sample size was too small to permit inferential statistical analysis, the study largely employed basic descriptive statistics to describe the data. For qualitative data from the in-depth and open ended questions in the survey questionnaire, the study adopted the constant comparative technique developed Wimmer and Dominick (2011). After transcription,

respondents' statements were read and codes assigned to them. This was achieved by summarizing lengthy statements that presented the respondent's ideas into succinct phrases that represent the main theme of the statement, and then assigning one- or two-word codes to these phrases. For instance, "I find the system ease to use because I use my own language to ask questions and get feedback"; was summarized as, "I use my own language for questions answers". This was then assigned a code "own language". In assigning codes, the context of the statements was also considered. This was done to make sure the statements were precisely represented. Once all statements were assigned codes, they were group and assigned categorized through a constant comparative process as defined by Glaser and Strauss (1967). Where necessary, some respondents' statements concerning the use of the system are quoted verbatim.

Chapter 5

Results/Findings

This chapter presents empirical findings and observations from the study based on factors discussed in the conceptual framework. It starts with demographic characteristics of the study participants, results concerning system use which includes participants that used and those that did not the system; examining reasons for their use and non-use, analysis of questions asked on the system and messages disseminated to farmers. The next section presents empirical findings on the perceptions of participants on the system's ease of use, perceived usefulness and effectiveness of the system in agriculture extension.

Respondents Demographic Characteristics

This section presents results regarding the demographic characteristics of the project participants. The findings presented in this section come mainly from the survey questionnaire. Results presented in Table 1 show that most respondents fall in the age group of 40-60 (53 percent), followed by 20-40 (33) and 60 and above (13percent) respectively. Results also show that the minimum age of respondents is 28, the maximum 66, and the mean 45. The table also shows that most the respondents attained secondary school education (43 percent), followed by primary school education (40 percent), 6.7 percent adult education , 3 percent post-secondary education, while the 7 had no formal education. All but one respondent could not read or write. 80 percent of the respondents reported that they were married, 13 percent divorced and 3.3 percent divorced. Though not indicated in the table, participants reported that farming is their major occupation and that all other activities such as bricklaying and crafts making, contribute a

fraction to their household income. Additionally, 83 percent of the households reported that they owned more than mobile phone.

Table 1: Demographic Statistics of sampled respondents

<i>Variable</i>	<i>Number of respondents</i>	<i>Percent</i>
Gender		
Male	17	56%
Female	13	44%
<i>Total</i>	<i>30</i>	<i>100%</i>
Age in years		
20-40	10	33%
40-60	16	53%
60 and above	4	13%
<i>Total</i>	<i>30</i>	<i>100%</i>
Education		
Post-secondary	1	3%
Secondary education	13	43%
Primary education	12	40%
Adult education	2	7%
No formal education	2	7%
<i>Total</i>	<i>30</i>	<i>100%</i>
Literacy		
Reads	29	97%
Cannot read	1	3%
<i>Total</i>	<i>30</i>	<i>100</i>
Writes	29	97%
Cannot write	1	3%
<i>Total</i>	<i>30</i>	<i>100%</i>
Marital Status		
Married	24	80%
Separated	1	3%
Divorced	1	3%

“Table 1 (cont’d)”

Widowed	4	13%
<i>Total</i>	<i>30</i>	<i>100%</i>
Household Mobile Phone ownership		
1	5	17%
2	17	57%
3	5	17%
4	1	3%
5	2	7%
<i>Total</i>	<i>30</i>	<i>100%</i>

System Use

To answer research question 1 regarding how offering information in farmers’ own languages affects ease of use of the system, participants were asked to rate their perceptions about the ease of use of the system using a Likert Scale with responses on a scale of 1 (strongly disagree) to 7 (strongly agree). Participants were then asked to provide reasons for their perceptions about the system in open ended questions that followed each statement. Results on system use over one month of the pilot test indicate that overall, 25 participants out 30 (83 percent) used the system. Results also show that 94 percent of male participants used system while only 6 percent did not. On the other hand, 69 percent of women participants used the system while 31 percent did not. The results are presented in Table 2.

Table 2: System use over the pilot period

	Have you ever used Buuza Omulimisa					
Gender	Men		Women			
	Yes	No	Total	Yes	No	Total
N	16	1	17	9	4	13

“Table 2 (cont’d)”

Row %	94%	6%	100%	69%	31%	100%
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Reasons for non-use of the system

Through responses to open ended questions, we further investigated reasons as to why some participants did not use the system (see Table 3). Findings show that 60 percent of the participants did not use the system because they did not know how to text, 15 percent said they were too old to either text or start learning to text, 10 percent did not know how to read and write, 7 percent reported that their mobile phones were faulty, 5 percent reported that they had eyesight problems, and 3 percent said they just hadn’t started using the system.

Table 3: Main reasons as to why some participants did not use the system	Percent (N)
• I do not know how to text	60%
• I’m too old for this	15%
• I don’t know how to read and write	10%
• My phone got a problem	7%
• I have poor eyesight due to old age	5%
• I just hadn’t started using it	3%

The fact that most of those that did not use the system are women is quite telling about gender differences in mobile phone use. The results suggest that to overcome gender-based inequalities in ICT use, we have to deal with more than just access inequalities. Even when women and men have equal access, as was the case in the study; women still more face barriers to ICT use. For instance, according to the Uganda Bureau of Statistics (UBOS, 2002), in 2002, 54 percent of Ugandan males were literate compared to 46 percent of females. The gap is even wider among

the older population where the literacy rate between males and females in the ages of 45-49 is 61.2 percent for males and 38.8 percent for females; 72.3 percent for males and 27.7 for females in the age bracket of 60-64. Similarly, despite government efforts to provide education for all through its universal primary education (UPE) policy and the subsequent elimination of gender disparities in primary school enrollment (Ssewanyana & Kasirye, 2010), not all aspects of education have attained gender equality. Girls are not only more likely to drop out of primary school, but also less likely to transit to secondary school (Ssewanyana & Kasirye, 2010). Additionally, according to (Nalwadda, 2011):

Girls have continued to be disadvantaged compared to the boys in all aspects of education access, participation and performance at both primary and secondary school levels, except at pre-primary level where there is gender equality in access.

Although results from the study show a smaller gap between men and women in terms of literacy and education as shown in Table 4; generally, women's low levels of literacy and education contribute to gender disparities in ICT use and there is no doubt this played out in the study. As shown in Table 3, barriers to ICT use such as lack of mobile phone facility, especially text messaging, and illiteracy affected women participants more than men. Not only 80 percent of non-users were women, but also, 40 percent of them (non-users) either only attended/attained primary school education or had no formal education.

Table 4: Gender versus Education

Gender	Male	Percentage	Female	Percentage
Level of Education				
Adult education (N)	1	6%	1	8%

“Table 4 (cont’d)”

Primary Education (N)	7	41%	5	38%
Secondary Education (N)	8	47%	5	38%
Post-secondary (N)	0	0	1	8%
No formal education (N)	1	6%	1	8%
Total	17	100%	13	100%

Results also show that age had an effect on system use as some older participants felt that the use of SMS was for the young and some cited eyesight problems due to their advanced age. For instance, 40 percent of non-users were aged 40 and above. However, age seems a secondary factor as there are several participants aged 50 and above who used the system. However, due to a small sample size, these results cannot be conclusive and generalizable. Similarly, participants who could not read or write did not use the system. Only one participant was illiterate and she did not use the system.

Finally, it is also apparent that reading literacy in one’s own language does not automatically translate into mobile phone literacy or facility: Despite the high levels of reading literacy (97 percent) as indicated in Table 1, 60 percent of participants who did not use the system attributed their non-use to unfamiliarity with text messaging. This was largely due to the fact that they could not navigate mobile phone menus which are in English — a language foreign to them.

How the System was used by Farmers

Over the one month pilot period, farmers sent via SMS over 25 questions. We viewed this as an encouraging number considering that most of the farmers in the pilot village are mostly engaged in crop cultivation, and the study was carried out during the off-season when they were waiting for onset of the rains to start planting. Most questions asked were about pests and disease management—in chickens (32 percent), cattle (28 percent) and bananas (12 percent). The rest of the questions were quite diverse. They included seeking advice on chicken feeding, pig nutrition and feeding, the application of pesticides and weed control and management (Table 5).

Although the primary occupation for most participants in study is crop cultivation, most of the questions asked were about poultry and large animal related issues. This can be attributed to the fact that most crops grown in the pilot site such as maize and beans are seasonal and therefore the information needs of farmers are seasonal and time bound. It is for this reason that there a number of questions on perennial crops such as bananas. When asked to explain why they received fewer questions about crops yet most farmers are crop cultivators, a crop extension officer explained:

You came in a dry season when there is no much activity as far as crop cultivation is concerned. Most farmers are now threshing and winnowing and such activities do not need much technical information. I am sure the situation would be different if it was a rainy season when farmers are planting.

Table 5: Questions asked by farmers through the system

Luganda		English Translation	
Question	Answer	Question	Answer
Nkoko zirese amabwa ku mitwe tukole tutya?	Gula eddagala lya OXYVETO 50S otabule ekijiiko kimu ekya supu mu liita abiri ezamazzi oteeke mukiyumba zinywe. Kino kikole okumala wiiki. Kuba ku 0774113391	My chickens have wounds on the head—what should I do?	Buy OXYVETO 50S—mix one table spoon in two liters of water. Put the mixture in the poultry house for them to drink. Do this for one week. You can call the extension officer at 0774113391 for further guidance.
Kiwotoka mukole ntya?	Kiwotoka tarina ddagala wabula sigula otemeteme ekitooke ekirwadde obiziike oba obyokye. Enkumbi oba ejjambiya jokozezeza giyise kumuliro oba oyoze ne JIK	How do I control banana bacteria wilt?	Banana wilt has no cure—to prevent spread, you must uproot and burn or burry all infected plants. Tools used must be washed in JIK or heated on fire.
Embizzi kirungi bwelya ebikola bya muwogo nebikuta bye?	Ebikola bya muwogo ku mbizzi tebirina mutawaana. Wabula ebikuta byetaaga okufumbako olwokuba nti muwogo omu aba wabula	Is it healthy for pigs to eat cassava leaves or/and its peelings?	Cassava leaves or its peelings have no known bad effect on pigs—but some cassava varieties are poisonous and so you need to boil them before you feed them to pigs.
Omusujja gwentende ngukola ntya?	Yita omusawo agikebere amanyire ddala ekika kyomusujja ogwo. Kubira Dr. Mwanje ku 0776552316 oba Dr. Kasirye ku 0772584707	How do I treat fever in cows?	Call the veterinary extension officer—Dr. Mwanje at 0776552316 to diagnose the type of fever and recommend the appropriate treatment
Obukoko obuto nga buzibye ebiwawatilo mbuwa ddagala ki?	Ebiwawatiro okuziba kiva ku bulwadde bwa mulalama. Gula eddagla lya AMPROLIUM oziwe nga endagiriro bw'egamba.	Mu chicks' wings are droopy—how do I treat them?	Drooping of wings in chickens is a sign of Coccidiosis. Buy amprolium and give them as instructed at the shop.

“Table 5 (cont’d)”

Enkoko eyina senyiga ojijanjabo otya?	Gula Vitamini w'enkoko ozitabulire mumazzi zinywe. Oba oyinza okukozesa eddagala eriyitibwa HYPRADOX-XL noyongerezaako Vitamini w'enkoko.	How I treat flu in chickens?	Buy Vitamins, mix with water and feed them. You can as well use HYPRADOX-XL and vitamin simultaneously.
Njagala kugema nkoko typhoid, ngule dagala ki?	Eddagala baliyita FOWL TYPHOID VACCINE era likubibwa kukisambi oba mu kifuba. Kyandibadde kirungi n'okozesa omusawo omutendeke okukuba empiso	Which drug should I use to vaccinate against typhoid in my chickens?	Buy a drug called FOWL TYPHOID VACCINE—it's injected on the thigh or in the chest. You are advised to use a qualified veterinarian to conduct the procedure.
Enkoko okufuna amabwa ku maaso no mutwe ne guzimba buba bulwade ki?	Obulwadde bwandiba SHS. Laba anti amazzi goziwa mayonjo ate oziwe ne vitamin nga omutabula mu mazzi. Laba nti ekiyumba kiyingiza bulungi omukka.Kuba 0774113391	My chickens have facial swellings and wounds. What kind of disease causes that?	These symptoms point to Swollen Head Syndrome (SHS). Make sure the water they drink is clean, mix vitamins in the water they drink and avoid respiratory stressors. Call 0774113391
Enkoko bweba efuluma kalibwe owakyenvu bulwadeki elangiwa dagalaki?	Buno bwandiba NEWCASTLE oba TYPHOID oba COCCIDIOSIS. Kala ki endala eyatabudde mu kalimbwe? Wamazzi? alimu kakiragala oba alimu akeeru nolutaayisaayi?	My chickens discharge is yellowish poop—what diseases could this be?	This could be Newcastle, Typhoid or Coccidiosis. What other color do you see? Is the poop watery? Do you see any shades of green or white?
Enkoko bweziba zibazirwadecocodiosis nkolatya?	Kozesa eddagala lya Amprolium. Laba nti ogema enkoko nga zikyali nto. Kuuma ekiyumba nga kiyonjo ate ne fiida ginaaze buli lwokyuusa amazzi.	How do I treat coccidiosis in chickens?	Coccidiosis can be treated with Amprolium. Please vaccinate your chickens at an early stage to
Enkoko bweziba zidukana kalimbwe wa brown buba bulwadde ki?	Bweziba nga teziraga bulwadde bwonna kalimbwe owa brown taliiko kizibu.	My chickens discharge runny, brown poop. What kind of disease could this be?	If they don't show any other signs of disease, brown poop are normal.
Enkoko emu nga yamaji elya kilo meka olunaku?	Zino enzungu ezirya emisana n'ekiro orina kugiriisa kiro bbiri; kiro emu	How many kilograms should a laying chicken eat	Exotic laying chickens should eat 2 kilograms per day

“Table 5 (cont’d)”

	emisana n'emu ekiro.	per day?	
Kiwotoka mukole ntya?	Kiwotoka tarina ddagala, kuula era oyokye ebikolo ebirwadde mu bwangu. Wewale okugatta ebikozesebwa ng'enkumbi, obuso, ejambiya nebirala.	How do I control banana wilt?	Banana wilt has no cure. Uproot and burn or bury the infected plants and make sure to disinfect the tools you used using JIK or passing them on fire
Ebitooke biyina kuba fuuti meeka?	Rekawo amabanga ga futi 10 okuva kukitooke okudda kukirala ate era futi 10 wakati wenyiriri	What is the right spacing for bananas?	The right should be 10 ft within rows and 10 ft between rows
Kiwotoka mulwanyisa ntya?	Kiwotoka tarina ddagala, kuula era oyokye ebikolo ebirwadde mu bwangu. Wewale okugatta ebikozesebwa ng'enkumbi, obuso, ejambiya nebirala.	How should I prevent BBW?	Banana bacteria wilt has no cure. Uproot and burn or bury the infected plants and make sure to disinfect the tools you used using JIK or passing them on fire
Embizzi kirungi bwelya ebikola bya muwogo nebikuta bye?	Ebikola bya muwogo ku mbizzi tebirina mutawaana. Wabula ebikuta byetaaga okufumbako olwokuba nti muwogo omu aba wabutwa.	Is it healthy for pigs to eat cassava leaves or/and its peelings?	Cassava leaves or its peelings have no known bad effect on pigs—but some cassava varieties are poisonous and so you need to boil them before you feed them to pigs.
Embizi oba ente bweba enatera okuzala, ojiwa bujjanjabi ki?	Bweba terina bulwadde bwonna teyetaaga bujjanjabi bwonna. Wabula wewale okujitambuza ennyo.	If a pig or a cow is pregnant, what kind of treatment do I need to give it?	If it does not have any disease, you don't need to give any treatment. But avoid walking for long distances.
Omusujja gwentente nkoze ntya?	Yita omusawo agikebere amanyire ddala ekika kyomusujja ogwo. Kubira Dr. Mwanje ku 0776552316 oba Dr. Kasirye ku 0772584707.	How should I treat fever in cattle?	Call a veterinarian to examine which type of fever your cow has.
Yafulumiza obusajja bwayo tebudayo nkole ntya?	Yita omusawo webisolo agikebere akuwe namagezi. Kubira Dr. Mwanje ku 0776552316 oba Dr. Kasirye ku 0772584707.	My bull's penis is sticking out. What should I do?	Call Dr. Mwanje at 0776552316 or Dr. Kasirye at 0772584707 so it can be examined

“Table 5 (cont’d)”

Enyana yange bukedde nga teyimuka njkole ntya?	Gula eddagala lya OXY 12.5 oba CURAMYCIN ogikube empiso buli luvanyuma lwa nnaku ssatu okumala wiiki bbiri oba nga omusawo bwanaaba akugambye.	We woke up in the morning when my heifer is not able to stand. What should I do?	Buy a drug called CURAMYCIN at the vet shop and inject it after every three days for two weeks.
Ente eyegwako ngirisa ntya?	Mukulu Ssentongo ente gyiriise nga bulijjo bw'ogiriisa naye ogiwe omunnya mungi. Era bweba nga yamukiyumba, ogite etambatamburemu (ekola ekisasayizi)	How do I feed a pregnant cow?	Mr. Sentongo, feed it as you have always fed it but give it more mineral lick.
Emikyungwa bagifuyiza ddagalaki?	Emicungwa kibadde ki? Gyirina buwuka, ebimuli bikunkumuka oba gyiriko obuwuka?	Which drug should I use on oranges?	What is wrong with your orange trees? Have they been attacked by some pests or the leaves are dropping off?
Mbuza eddagala lyona lyetufuyiza okujako obuwuka	Bw'egiba tegirina bulwadde bwonna oba buwuka, tegyetaaga kufuyira. Wabula oyinza okugitekako nakavundira nga wetolooza omuti mita nga ssatu okuva kukikolo	I'm asking about any pesticide that I can use to prevent or kill any pests	If they are not under any attack, you don't have to spray. You can instead apply compost manure in a circular form, three meters from the tree.
Omuddo gwa kanyebwa namalanga babifuyiza ddagala ki?	Kozesa eddagala lya 24D AMINE erimanyiddwa nga 24D	Which herbicide can I use to control goat weed?	Spray with 24D amine.
Nandyagade Okulima Ku Bit Root. Musimba Ntya Era Netaga Ki?	Osobola okusimba ensigo oba endokwa 2cm okukka wansi ate 10cm okuva kukikolo okugenda kukirala. Yetaaga ettaka nga teriliimu mayinja oba bifunfugu byonna.	I would like to grow beetroot, how I plant it and what do I need to prepare?	Beetroot requires light rich soil in an open sunny area. You can directly plant seeds or seedlings. Plant the seeds or seeds 2cm deep and 10cm within a row.

Standardized SMS messages disseminated to farmers

Over the period of the pilot project, extension officers prepared standardized SMS messages on various topics including livestock and crop diseases, and disseminated them to project participants through the Buuzo Omulimisa system. Because bananas are a major staple food in pilot site and the central region as a whole, most of the messages sent to farmers were about identifying preventing and controlling the spread of banana bacteria wilt — a disease that has no cure and has wiped out entire plantations across the country. The messages were written in Luganda, the dominant language spoken in the pilot site, and sent to farmers by extension officers twice a week (Table 6). When asked why they wrote more messages on bananas instead of other crops or enterprises, the sub-county NAADS coordinator responded:

First of all, bananas are staple crop in Wakiso district and Buganda [central region] as a whole. Most families depend on it for food and sell the surplus. Secondly, there is an on-going national campaign on banana bacteria wilt and that campaign is spearheaded by NAADS [the government extension agency]. So, that is why most of the messages we sent out to farmers were about banana wilt.

Table 6: Standardized messages disseminated to farmers

Luganda	English
Enkoko bwezipama kalimbwe owakyenvu nga alimu ebyeeru nolutaayisaayi, buno buba bubonero obulaga obulwadded bwa COCCIDIOSIS era zifunire eddagala lya COCCID	If your chickens' poop appears yellowish white with traces of blood, they may be signs of coccidiosis. You are advised to buy and treat them with coccid.
Wekwate omusulo olwanyise ebiwuka mubitooke. Funa omusulo gw'ente oba abantu ogutereka okumala wiiki bbiri. Tabulamu evvu olwo otandike okuyiwa ku buli kitooke	Did you know urine can help prevent pests in bananas? Collect human or animal urine and keep it for two weeks in a covered container. At the end of the two weeks, mix it with ash and apply on your banana trees.
Nga otabula evvu mumusulo gw'oterese okumula wiiki 2, buli liita 2 tekamu ekipo kimu eky'evvu. Nyenya by'etabule bulungi olyoke omanse liita 2 ku buli kitooke	In every two liters of urine, add one cup of ash and mix well. Apply two liters of the mixture on each banana tree.
Obulwadde bwa kiwotoka obutegeera otya? Ettooke litandika okwengerera nga terinakula, empumumpu ekala nevunda nga ekyaali kukitooke nendagala okwengera nezikala	Do you know the symptoms of banana wilt? The fruits start ripening prematurely, shriveling and rotting of the male bud and the progressive yellowing and wilting of leaves.
Oluvanyuma lwetooke erirwadde kiwotoka okutandika okwengera nga terinakula, mu budde butono nnyo, ettooke lyonna livunda nerikala	A short while after the yellowing of leaves and ripening of the fruits, the entire will wilt and rot.
Okulwanyisa ebiwuka ebireeta obulwadde buno oba olina okwanguwa okusalako empumumpu. Gezaako okwewala okugatta ebikozesebwa ng'enkumbi, obuso, ejambiya nebirala.	To prevent the transmitting the disease to the entire plantation, you are advised to quickly remove the male bud using a forked stick and avoid mixing the tools you use on infected plants with other garden tools and remember to disinfect the tools used by passing them on fire or JIK.
Bwowaata kuttooke nga lirina obulwadde bwa kiwotoka, munda liba namabara nga gari mu langi enzirugavu oba eya kitaka.	When you peel or cut a diseased banana finger, spots of black or brown can be visible inside
Okusigula ensukusa mu lusuku orurwadde kiwotoka nozisiimba awalala kiretera obulwadde buno okusasaana. Wewale okutambuza nokumala gasiimba nsukusa zotomanyi	Using suckers from an infected plantation and plating them in another further spreads the disease. Avoid moving and planting suckers from gardens you are not sure of.

Ease of Use of System by Participants

Next examined is how easy the participants found the system to use as seen in Table 7. Results show that 80 percent of the participants strongly agreed that the system was easy to use. They

also show that being able to use their own language other than English was often mentioned as an important reason for it being easy to use as compared to other ICT for agriculture services. While 63 percent strongly agreed that the system was easy to learn, especially because it was in their own language, almost 37 percent did not strongly agree. The difficulty that later group experienced was largely attributed to the fact that the system required familiarity with text messaging instead of voice calls, which all respondents were familiar with. For instance, only 66 percent of the participants reported using texts messages although infrequently; yet, all respondents reported making voice calls regularly (see Tables 8 and 9). They attributed this to the fact that it is difficult for them to navigate to the message menu on their phones as opposed to merely pressing the green call button to initiate and the red button to end a call. Justine, a 35 year old farmer said,

I would use SMS if I knew how to do it on my phone. But the phone menu is in English which makes it difficult for me. But with making calls, I have mastered the green button to make a call and the red button to end it.

Another wondered:

There were adverts on radio a few years ago that MTN [one of the telecom providers] had brought phones with menus in Luganda. I thought those would be very helpful for people like me that cannot read English, but I have never seen any such phones being sold in shops.

When asked how she reads mobile money messages when she cannot read or write, one elderly woman said, “I live with my grandchildren, so when expect money from someone, as soon as I hear the message tone on my phone; I call one of them to help me read the message”

Table 7: Perceived Ease of Use of the Buuzza Omulimisa system (PEU)

Question	Strongly agree	Moderately agree	Slightly agree	Strongly disagree
Do you find the system easy to use?	N=21	N=2	N=1	N=1
	70%	7%	3%	3%
Does it make it easier to use because it is in your own language other than English?	N=24	N=1	N=0	N=0
	80%	3%	0%	0%
Was it easy for you to learn using the system?	N=19)	N=3	N=2)	N=1
	63%	10%	7%	3%
After using the system for one month, how confident are you at using it?	Very confident	Moderately confident	Low confidence	
	N=18	N=3	N=3	
	60%	10%	10%	

Text messaging versus making voice calls

As illustrated in the tables above, study participants make voice calls more frequently than sending text messages regardless of the fact that the cost of sending a text message is only a fraction of the cost of making a voice call. For instance, the price of a voice call in Uganda averages 200 UGX (0.07 USD) compared to 50 UGX (0.02) for sending a text message. Considering how price sensitive farmers are, they would most definitely use SMS more frequently if it were not for the barriers. Considering the high levels of literacy (97 percent) one would expect to see frequent use of text messaging as it is much cheaper compared to voice calling. But as we found, literacy does not necessarily guarantee mobile phone use. The language used to text does make a difference. One participant opines:

The fact that I can use Luganda to ask questions makes it easy for me to describe my problem without difficulty. I would definitely not use the system if it was in English—I only completed primary seven so I am not proficient in English.

Even participants who attained secondary school education would not have the necessary English proficiency to describe a complex farm situation in English. A middle-aged farmer and former school teacher attests to this fact: “Some things are hard to describe in English, I don’t think I would be able to use frequently if I had to type the messages in English”.

Table 8: Frequency of Sending Text Messages

	Frequency	Valid Percent
Several times a day	1	3%
Everyday	2	7%
Several times a week	3	10%
Around once a week	4	13%
A few times a month	11	37%
I don’t send text messages	9	30%
<i>Total</i>	30	100%
<i>Mean messages sent per day by those who text</i>	0.21 SMS/day	

Table 9: Frequency of Making Voice Calls

	Frequency	Valid Percent
Several times a day	5	17%
Everyday	6	20%
Several times a week	15	50%
Around once a week	2	7%
A few times a month	2	8%
<i>Total</i>	30	100%

“Table 9 (cont’d)”

<i>Mean calls per day</i>	0.69 calls/day	
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Additionally, participants who do not use their phones to send text messages are more likely not to use the Buuza Omulimisa system as indicated in Table 10. As results indicate, 80 percent of non-users reported that they do not use their phones to send text messages. Furthermore, among participants who use their phones to text, those who text regularly (several times a day, every day, several times a week), are more likely to use the system than those who text occasionally (once a week or a few times a month) as seen in Table 11. For instance, 100 percent of those who text regularly used the system compared to 86 percent of those who text occasionally. Similarly, participants who call regularly are more likely to adopt the system than those who call occasionally. As results show in Table 12 – 88 percent of regular callers used the system compared to 50 percent of irregular callers. However, in terms of gender, results show that among participants who use their mobile phone to text, women appear to text more often than men do (See Table 13). It should however be noted that generally, all participants call more often than they do text. On the contrary, findings indicate that men call more often than women do (See Table 14).

Table 10: Text Messages Use versus System Use

		Have you ever used Buuza Omulimisa?		Total
		Yes	No	
Do you use the cell phone to send text messages?	Yes	19	1	20
	No	6	4	10
Total		25	5	30

Table 11: Frequency of Text Messaging versus System Use

		Have you ever used Buuza Omulimisa		Total
		Yes	No	
How often do you send texts messages?	Several times a day	1	0	1
	Everyday	2	0	2
	Several times a week	3	0	3
	Around once a week	3	1	4
	A few times a month	10	1	11
Total		19	2	21

Table 12: Frequency of Calling versus System Use

		Have you ever used Buuza Omulimisa		Total
		Yes	No	
How often do you make calls?	Several times a day	5	0	5
	Everyday	6	0	6
	Several times a week	12	3	15
	Around once a week	1	1	2
	A few times a month	1	1	2
Total		25	5	30

Table 13: Gender and Frequency of Text Messaging

How often do you send texts?				
Gender	Male	Percentage	Female	Percentage
Frequency				
Several times a day (N)	0	0%	1	11%
Every day (N)	0	0%	2	22%
Several times a week (N)	2	17%	1	11%
Around once a week (N)	1	8%	3	33%
A few times a month (N)	9	75%	2	22%
Total	12	100%	13	100%

Table 14: Gender and Frequency of Calling

How often do you make calls?				
Gender	Male	Percentage	Female	Percentage
Frequency				
Several times a day (N)	3	18%	2	15%
Every day (N)	2	12%	4	31%
Several times a week (N)	11	65%	4	31%
Around once a week (N)	0	0%	2	15%
A few times a month (N)	1	6%	1	8%
Total	17	100%	13	100%

Perceived Usefulness (PU)

Next we examined the system's perceived usefulness as seen in Table 15. According to the survey, most farmer respondents (83 percent) strongly agreed that the system was very useful and that it enhanced their effectiveness in caring for their crops and animals. 87 percent strongly agreed that the system improved access to extension services, 90 percent had recommended the system to fellow farmers; 83.3 percent reported that they had acted on the information they received from the system and 53 percent reported that the information from the system was very satisfying. Additionally, 23.3 percent reported that the information from the system was satisfying. When asked what they liked about the system, participants provided a wide array of responses (Table 16).

The extension agents also found it easy to use. One extension agent remarked:

The system makes it easy and cheap for me to reach many farmers at once. This is difficult under our traditional extension service, as we have to travel long distances looking for farmers. It has actually eased my work....the time, the fuel.....it is absolutely cheaper.

Most farmers commended the system for its convenience and helping them to be better farmers.

One said:

This has been very helpful; I do not have to wait for an extension officer to ask my questions, I can now use my phone anytime I want. It is as if I have the officer in my pocket.

Table 15: Perceived Usefulness (PU)

Question	Strongly agree	Strongly disagree	Did not answer	Row Total
Has using Buuza Omulimisa enhanced your effectiveness in caring for your crops/livestock?	25	0	5	30
	83%	0%	17%	100%
Did you find using the system very useful?	25	1	4	30
	83%	3%	13%	100%
Does the system improve access to extension services?	26	0	4	30
	87%	0%	13%	100%
Have you recommended the service to anyone?	27	0	3	30
	90%	0%	10%	100%
Did you use the information you received?	Yes	No		
	25	5		30
	83%	17%		100%
Please rate the value of information on the scale of 1 - 5 where 1 is unsatisfactory and 5 is satisfactory	Very satisfied	Satisfied	Did not answer	
	17	7	6	30
	57%	23%	20%	100%

Table 16: Main reason participants like the system (open ended question)

Reason	Percent
• It's fast and convenient	26%
• It provides us with messages on how to control diseases and pests	23%
• It is easy to use since it's in my own language	20%
• It's free	17%
• It teaches us to be better farmers	7%
• It helps us with knowledge and solutions to our problems	7%
Total	100%

Table 17: Attitude towards use (ATU)

Overall, how satisfied are you with the system?	Very satisfied	Satisfied	Did not answer	Row Total
	19	7	4	30
	63%	23%	13%	100%
Do you like the idea of using the System?	Strongly Agree	Did not answer		
	26	4		30
	87%	13%		100%

Overall, participants were very satisfied with the system (63 percent). They liked using it, and all that respondents that had tried the system indicated that they would continue using it. One of the main reasons cited for their continued use of the system was its low cost. Most farmers (83 percent) indicated that they would continue using the system because it was giving them useful information yet it is free. One said:

I will continue using the system as long as it continues to be free. It is of course useful but it would be hard for me to use if I had to buy airtime to use it. There are so many competing needs—salt, soap, food—it is hard to spend money on other things [non-basic needs].

The system was so appreciated by the district extension department that they wanted to extend it to other places. A meeting was arranged with the district production where I presented the system to him. I suggested that we should wait for the project evaluation report before we could take any further action. However, any further work involving the government extension agents will have to wait until government re-appoints new ones. The previous extension system under

the auspices of the semi-autonomous National Agricultural Advisory Services (NAADS) was deprecated and a new one under the ministry of agriculture is being planned. Any further implementation before the establishment of the new extension system will have to involve NGOs engaged in the provision of extension services.

Effectiveness and Efficiency of the System

This next section will examine the impact of the system by comparing survey results from before and after the system was implemented. To measure the effectiveness and efficiency of the system, data on the number of interactions between farmers and extension officers before and the one month pilot was compared. Results from a pre-test survey indicate that more than 70 percent of the participants had interacted with an extension only once in six months before the system had been initiated (Table 18). These interactions include both physical visits by extension officers as well as interactions through mobile phone communication. After the system had been operational for 4 weeks, results from the post-test survey suggest that farmer-extension officer interactions had increased by over 400 percent.

Table 18: In the last six months, how many times have you interacted with an extension officer?

	In the last six months, how many times have you interacted with the extension officers?								Mean last 6 mo.
	0	1	2	3	4	5	6	Total	
Group	21	1	5	2	1	0	0	30	
	70%	3.3%	16.7%	6.7%	3.3%	0%	0%	100%	0.7
	95.5%	50%	71.4%	50%	14.3%	0%	0%	50%	
Posttest	1	1	2	2	6	12	6	30	

“Table 18 (cont’d)”

	3.3%	3.3%	6.7%	6.7%	20%	40%	20%	100%	4.7
	4.5%	50%	28.6%	50%	85.7%	100%	100%	50%	
Total	22	2	7	4	7	12	6	60	
	36.7%	3.3%	11.7%	6.7%	11.7%	20%	10%	100%	
	100%	100%	100%	100%	100%	100%	100%	100%	

Perhaps there would be a substantial increase in physical visits as well if the government during the pilot period had not suspended the services of extension officers. Data from in-depth interviews with extension officers seems to corroborate the data in Table 18 in terms of the system enhancing interactions between extension officers and farmers. Extension officers reported a spike in the number of mobile phone interactions with farmers, most especially from farmers that had asked questions via SMS and were advised to call for more information. These interactions largely came from poultry and livestock farmers. One officer stated:

There was a substantial increase in the number of phone calls from farmers especially poultry and livestock farmers. There are a number of poultry farmers in Sebbi [the pilot village], and you know with poultry, unlike crops, a disease like Newcastle is highly contagious and fatal if left untreated for even a few days. That is why you also see many of the questions we have are about poultry. They are quick to seek help because a delay might lead to a heavy loss.

Perceptions of Extension Officers about the System

The extension officers welcomed the system as a huge boost to their overstretched services due to the large number of farmers yet there are very few extension officers to serve them. For

instance, there are only three extension officers to serve close to 40,000 farmers in Kakiri sub-county. They also decried what they called the “dependency syndrome” where farmers expect government to provide everything for them and yet they carelessly handle the inputs and supplies government provides. They further lamented the lack of interest by farmers in the trainings they organize yet these trainings are crucial to pass on new technologies and practices to farmers.

Farmers do not attend trainings we organize to pass on important information and technologies. They will only come when they know we are giving out something such as inputs, seeds or animals. There is also what I would call a dependency syndrome among our farmers — they want everything to be given to them yet our budget is low — noted, the lead sub-county extension officer.

They commended the system for not only being easy to use but also helping them to reach out to many farmers easily without the necessarily having to move long distances to meet them physically. One extension officer remarked:

The system makes it easy and cheap for me to reach many farmers at once. This is difficult under our traditional extension service, as we have to travel long distances looking for farmers. It has actually eased my work....the time, the fuel.....it is absolutely cheaper.

In summary, this chapter presented findings from two surveys and in-depth interviews regarding the system’s ease of use, usefulness, and effectiveness in complementing conventional agricultural extension systems. The study aimed to examine how offering of information in farmers’ own languages affects adoption of an SMS system – including the impact of age and education; examining factors that contribute to the utility of a mobile phone-based system to

farmers; and examining the information needs of farmers in relation to what SMS systems can offer. The main reasons for the adoption of the system include:

- Farmers' use of their own language (Luganda) instead of English (the national language) was the most important factor for the adoption of the system.

Other important findings from the study include:

- Literacy and education were significant drivers of the system's adoption. Literate participants with higher education levels were more likely to use the system than illiterate ones. However, literacy only does not guarantee use: Although most of the non-users were literate (could read and write in Luganda), they could not use the system because they did not know how to text.
- The fact that system use was free of cost was a very significant driver of the system's adoption. It is very possible that most of the participants would not have used the system if it was not free.
- The fact that using the system was fast and convenient than the traditional extension system.
- Participants who called and texted regularly were more likely to use the system than those who texted or called occasionally.
- The most significant barrier to the adoption of the system was unfamiliarity to text messaging. For instance, 60 percent of non-users reported not knowing how to text as the sole reason for not using the system.
- The gender bias in system adoption is strong: barriers to system use such as education, unfamiliarity to text messaging, literacy and broken phones affected more women than men –

80 percent of non-users were women most of whom had either only attended primary school or had no formal education.

- Though important, age appears to have been a secondary barrier to the adoption of the system. Although some older adults had reservations about text messaging due to their advanced age, most of them used the system.
- The system was very useful especially to livestock and poultry farmers because it was fast and convenient in a trade where delay in getting assistance could lead to heavy losses; and
- The system significantly improved the effectiveness and efficiency of the conventional agricultural extension system.

Chapter 6

Discussion

Introduction

This thesis attempted to examine the impact of various factors affecting the adoption of an SMS system. To do this, it had the following research questions: What impact does the offering of information in the farmers' own languages have on the adoption of an ICT for agriculture system in the developing world including the drivers/barriers that affect its adoption? What factors contribute to the utility of a mobile phone-based system to farmers? What are the information needs of farmers in relation to what SMS systems can offer?

The main findings from the fieldwork are: (1) providing information in farmers' own languages has a significant impact on system adoption; (2) Language, in relation with literacy and education, have a combined stronger impact on system adoption; (3) Literacy does not guarantee use of a system; (4) though important, age appears to be a secondary factor behind language, literacy and education in influencing adoption; (5) barriers to system use affected women more women – 80 percent of non-users were women; (6) English literacy is associated with education; (7) providing information in farmers' own languages has a significant impact on the usefulness of a system; (8) Farmers that used the mobile phone often i.e. called and texted regularly – were more likely to adopt the system than those who used it occasionally; and (9) the system significantly improved the effectiveness and efficiency of the conventional agricultural extension system by increasing farmer-extension officer interaction over 400 percent. Some of these findings confirmed what was expected in the literature, whereas others did not. This chapter discusses these findings in relation to existing literature.

Barriers to Use of Mobile Phone-Based Agricultural Services

Findings from the study illuminate a number of factors that affect the adoption and diffusion of mobile phone-based agricultural services in rural communities of the developing world. Prominent among these include; language, familiarity to mobile text messaging (in case of SMS based services), education, age, cost and age.

Language

This study's findings suggest that offering information in farmers' own language has a significant effect on adoption or rejection of a system. Results indicate that 80 percent of the participants strongly agreed that the system was easy to use while 63 percent strongly agreed that it was easy to learn using the system. They largely attribute the system's ease of use to the fact that they were able to text in their own language — Luganda — and not in another language such as English which is Uganda's official language. Although English is the national language and the language of instruction, English proficiency in rural schools whether primary or secondary is relatively poor. Therefore, irrespective of what appears to be relatively higher education levels among the study participants, it is not surprising that they feel more comfortable texting in their local language than in English. Additionally, the measure of literacy and education depended on self-reported responses in which the participant judged himself or herself and was assumed to tell the truth. The question asked whether he/she could read or write. However, the best way to measure literacy and education levels would be administering a "flash card" on which an individual could read aloud or write and the interviewer judges whether he/she is literate or not (Schaffner, 2005). Therefore, the seemingly high levels of literacy and education might have

been an exaggeration. However, education levels notwithstanding, technology wrapped in the users' local language increases familiarity and hence adoption as Wamala (2010b) argues.

Furthermore, results indicate that most of the older adults in the pilot village had relatively lower education levels compared to the young adults. For instance, 53 percent of respondents between the ages of 25-45 at least attended secondary school compared 30 percent of respondents in the ages of 46-66. This suggests a negative correlation between age and education. This indicates a modest education system between the 19650s and 90s when the latter were of school going age. This discrepancy is also evident in national literacy and education rates where the difference between the literacy rates of 15- to 19-year-olds and 45- to 49-year-olds ranges from 13% to 18% (Demographic and Health Surveys 2003-2006). And because English literacy is associated with education, particularly higher education, old adults are more comfortable texting in their local language as they lack the proficiency to text or read English texts.

The discrepancy in education and literacy is even more evident between males and females. According to the Uganda Bureau of Statistics (UBOS, 2002), in 2002, 54 percent of Ugandan males were literate compared to 46 percent of females. The gap is even wider among the older population where the literacy rate between males and females in the ages of 45-49 is 61.2 percent for males and 38.8 percent for females, and 72.3 percent for males against 27.7 for females in the age bracket of 60-64. Results also show that offering information in farmers' own language does not only affect ease of use, but also has a significant effect on the system's usefulness. The usefulness of the system is due to the fact that users can aptly understand the information. Additionally, participants cited having provided information in their local language as the third most important reason (20 percent) as to why they liked the system. However, they still lamented the English phone menus as an obstacle to the maximum utility of the system.

Though not widely studied, the importance of providing information in users' local languages and how that affects adoption, access and use of ICT systems is consistent with present literature on adoption of ICTs in the developing world. For instance, Wamala (2010) found that farmers in Uganda only listened to radio stations that broadcasted in their ethnic languages even if they had access other stations that broadcast in other languages that they understood. She found that this phenomenon also applied to educated people who could understand English stations. Further, she found that the language broadcast has an effect on whether the information will be trusted or not, as well as the decision to adopt the promoted technology.

In many developing countries, especially in Africa, foreign languages such as English and French are the official languages; as a result, agricultural research results and technological advice are disseminated in languages that only a minority can speak. In the end, information that would be beneficial to rural farming communities remains idle on the archives of research institutions and is only accessible to a few. If optimal use and adoption are to be attained, ICT services that target rural populations in the developing world need to take into account the ethnic diversity of local populations in delivering content. As Wamala (2010) suggests, information produced in user's local languages increases familiarity hence rapid adoption and diffusion of mobile based services. Participants in the present study found it easy to use the system were more confident to use it because it was in their own language. Although this study is limited by the small sample size to make generalize the findings, the effect of offering information in the farmers' own language undoubtedly had a significant effect on its adoption.

Familiarity with Text Messaging

Findings suggest that lack of familiarity with text messaging and navigating mobile phone menus in general have a significant impact on adoption of mobile based services in rural communities. While there was almost 97 percent Luganda reading literacy rate among participants, 60 percent of participants who did not use the system reported unfamiliarity with text messaging as the main reason for non-use. The mobile phone menu to reach the messaging service is in English, even though the project's information was in their local language. Even among those that used the system, 20 percent did not strongly agree that the system was easy to use or easy to learn using due to their unfamiliarity with text messaging. One participant stated:

I cannot say that it was easy to learn using [the system].....I did not know how to send a message on the phone.....I usually just call. It was after the training that started trying it.....but you know the brain ages so I keep forgetting.

The language used in the system also affects use of SMS. Even participants with a relatively high level of education such as secondary school felt that they would not have the necessary English proficiency to describe complex on-farm situations if the system required them to use English. A middle-aged farmer and former primary school attests to this fact: “Some things are hard to describe in English, I don't think I would be able to use it frequently if I had to type the messages in English”.

Additionally, results show a significant difference between the use of mobile phones for text messaging and making calls. Participants make voice calls almost 4 times more than they send text messages despite the fact text messages are three times cheaper than voice calls. The irony between the high levels of Luganda reading literacy and the difficulty in text messaging illustrates that Luganda reading literacy does not necessarily guarantee mobile phone literacy.

In many parts of the developing world, menus of technological devices such as mobile phones and computers are in foreign languages such as English. Although users as those in the present study might be able to read and write in their own languages, they usually lack the English proficiency to navigate mobile phone menus and write text messages. Although some studies such as Mathieson et al. (2011) and Pan (2003), stress the significant effect of personal barriers such as knowledge and self-efficacy on perceived ease of use, perceived usefulness and actual use, these studies were conducted among urban and educated participants in developed countries where systems studied were in their native languages. For instance, Pan's study was conducted on college students' use of WebCT—a blackboard learning system, and Mathieson's study was conducted on the voluntary use of a bulletin board system (BBS) among accountants belonging to a professional organization. There is a dearth of literature on both the effect of language and familiarity to text messaging on adoption of SMS services in the developing world.

Many studies have often identified barriers to mobile phone use in the dichotomy of literate/illiterate. This study showed that we must go beyond this usual script if we are to truly understand and overcome the multifaceted barriers to mobile phone use and adoption especially in the developing world. Considering the low cost of SMS and its availability of basic mobile phones, illuminating barriers to its use will help achieve its full potential and the potential of mobile phones in general. We must understand that providing access will not necessarily guarantee optimal use.

Age of Users

Findings from the study show that older people were either reluctant to use the system out of sheer disinterest or due to health related factors related to old age such as seeing problems. For

instance, 15 percent of participants that did not use system reported that they were too old to text and 5 percent reported that they had eyesight problems due to old age. “These things are for young people; don’t you see I’m too old for this?” a 66 year old woman asked. The influence of age on ICT adoption and diffusion has long been established (Jain & Hundal, 2007; Kwon & Chidambaram, 2000; Olumide et al., 2010).

The findings from the study are thus consistent with the literature that older people are less likely to adopt mobile based services compared to younger people who are more receptive to ICT services especially mobile based. For instance, Richardson et al. (2000) study of Grameen Telecom’s Village Phone Programme showed that “higher expenditures for better service [were] more likely to come from younger phone users aged 20 to 30, an age group that would more likely be receptive to a wider range of mobile phone services.....” (Richardson et al., 2000, p. 37).

Cost of Use

The fact the system was free to use for all had a significant effect on its use. 17 percent of the participants reported that the most important reason they liked the system was because it was free. Undoubtedly, if using the system necessitated payment, only a few participants would have used it: “I only load airtime when I need to call.....so I don’t have airtime lying idle on the phone. I sincerely would not have afforded using it frequently” one participant remarked. Farmers are cost-sensitive; much of their income is spent on basic items such as food and health care. Even if a service is useful to them, they face so many competing needs that they hardly have money to spend on mobile phone airtime. Generally, they buy credit when they want to make a call and usually leave little credit but enough to “beep” (the practice of calling someone

and ending the call before they answer with the hope that they will call back) in case of an emergency.

This finding is similar to findings described in the literature, but often not emphasized sufficiently in prior studies. Farmers especially in Africa are highly cost-sensitive and therefore less likely to use a system that requires payment regardless of its usefulness. Farmers with more resources are more likely to adopt new technology because they can afford it, while farmers with fewer resources are less likely to adopt technology. In their study of the adoption of 3G+ services in Finland, Carlsson et al. (2006) found that high prices and age were significant barriers to their (3G+ services) adoption and diffusion. Similarly, in their study of fertilizer and improved seed adoption in Tanzania, Nkonya et al. (1997) found that farmers with higher incomes were more likely to adopt this new technology than those with lower incomes. Policy makers especially in the developing world where most of the world's poor live must do more than just enabling access if everyone is to benefit from the mobile phone revolution. Factors that affect cost such as taxes on importation and actual use (voice and SMS) need to be revised and competition among providers encouraged to bring down the cost of access and use.

Time Sensitivity of Agricultural Messages

Results from the study indicate that the information needs of farmers are time-bound and highly seasonal. Although farmers in the pilot site depend heavily on crop cultivation, 32 percent of the questions were about poultry, 28 percent about cattle and 12 percent on bananas. This was partly due to the fact that the study was conducted in the dry season of June and July, when most of the main annual crops grown such as maize, beans and vegetables were not being grown. Additionally, livestock and poultry diseases are highly contagious; farmers suffer heavier losses

if they delay in seeking assistance compared to with crops. Also, due to the large investment in poultry and livestock, farmers tend to quickly seek help whenever they are attacked by disease. We therefore need to take it account the time sensitive nature and the complexities of farmers information needs if we are to develop appropriate services and satisfy their information needs of farming communities. This has not been emphasized in the literature.

Gender Differences

The results from the study are consistent with existing literature on gender differences on ICT use and access. Although the sample is too small to generalize the findings to the entire population, the findings suggest significant gender differences in terms of system use. While 94 percent of male participants used the system, only 69 percent of women participants used the system. Indeed, most people who did not use the system were women. The results suggest that to overcome gender-based inequalities in ICT use, we have to deal with more than just ICT access inequalities. Even when women and men have equal access to an ICT intervention, as was the case in the study, women still face more barriers to ICT use than men. As results have shown, women are not only less literate but also less educated than men are. For instance, 48 percent of men participants had attended/completed primary school compared to 38 percent of women. Similarly, 47 percent of men participants had attended/completed secondary school in relation to 38 percent of women. The gender disparity in terms in education and literacy is even greater nationally where 54 percent of men were literate compared to 46 percent of women as of 2002; and the gap widens with age. Consequently, barriers to ICT use such as lack of mobile phone literacy especially text messaging, and illiteracy affected women participants more than men.

Implications for Understanding Technology Acceptance

This study used the Technology Acceptance Model (TAM) as a basic conceptual framework. TAM has received much acclaim as a robust, powerful and parsimonious model in predicting and explaining technology adoption. It was initially developed and applied to predict computer technology acceptance in a developed world context (Davis, 1989). This study illustrated, like other prior studies, that the model does not aptly capture the complexities involved in technology adoption in a developing world context (Al Nahian Riyadh, Akter, & Islam, 2009). Additionally, Venkatesh and Davis (2000) argued that although the original TAM is parsimonious and elegant, it over simplifies the complex realities of technology adoption. This assertion is especially applicable in the developing world where users especially in rural communities have to contend with diverse underlying issues.

The findings from the current study illuminate a number of issues that have been often overlooked in adoption and ICTD literature:

- In parts of the developing world where there are diverse ethnicities and languages, offering information in the users' own language (s) might be the difference between adoption or rejection of a system.
- Users in rural communities of the developing world are cost sensitive – cost has a huge influence on the adoption or rejection of a system. Irrespective of the usefulness of a technology, if use comes with an additional cost – no matter how small it might be – users are more likely to not use it.
- Due to the low levels of education and literacy in many parts of the developing world, difficulty in using certain functions of technological devices such as text messaging on mobile phones is one of the most important barriers to technology adoption or rejection.

- Language and Cost are classified as Tech attributes (Islam & Grönlund, 2012) and were found to be crucial in the adoption of the system. Language not only influences use but also usefulness. Additionally, irrespective of the perceived usefulness or perceived ease of use of the system, cost influences actual system use.
- Infrastructure is categorized as a facilitating condition (Venkatesh et al., 2003) and was found to mediate adoption.
- Irrespective of the perceived usefulness or ease of use of a system, if it does not take into account the infrastructural challenges of the developing world such as low internet connectivity and low-end mobile phones – only a few will adopt it. That is, for a system to be adopted, it must be compatible with existing infrastructure – usually low tech infrastructure. For instance, Buuza Omulimisa is so light that it can run well on slow internet connections used in rural Uganda.

Based on the study's findings, the author proposes a modification of TAM to incorporate factors that influence mobile-based ICT services in the developing world (Figure 7).

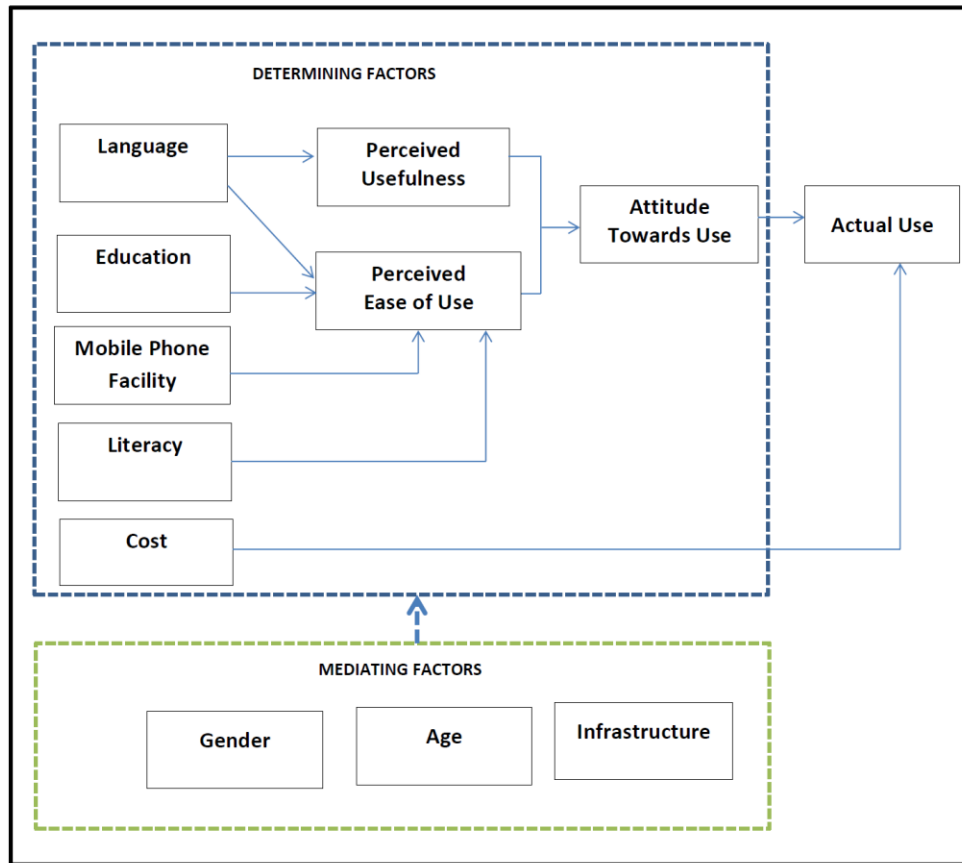


Figure 7: Factors influencing the adoption mobile based ICT for agriculture services among farmers in Uganda based on Van Biljon and Kotzé (2007).

The modified framework uses color coding to improve clarity between determining factors and mediating factors (Van Biljon & Kotzé, 2007). Mediating factors influence determining factors and may impede adoption. The revision differs from the original TAM in the refinement of demographic and technology attributes and its adaptation to mobile based services in a developing world context. In this framework, attributes such as gender, age, literacy, education and mobile phone facility (the person's knowledge of the mobile phone and ability to use it) are classified as demographic attributes. However, according to the findings, not all demographic influenced the adoption of the system the same way. Some attributes such as education, literacy

and mobile phone facility had a stronger effect than age or gender. Gender and age appeared to be mediating factors in the influence of adoption (Venkatesh et al., 2003).

Implications for ICTD Projects

The study highlights a number of issues that ICTD practitioners should take into account in designing and implementing projects – especially mobile-based projects in developing countries.

Language

Many parts of the developing world are made up of many diverse ethnicities with many different local languages. Yet, due to the influence of colonization, most developing countries adopted foreign languages such as English and French as their national language and language of instruction. As a result, proficiency in a given national language is dependent on the level of education. However, due to the low levels of education in most developing countries, most people especially rural communities do not understand these foreign languages and only speak their ethnic dialects. Therefore, ICTD practitioners must take into the language requirements of each specific target community if they are to achieve meaningful adoption. Offering project content in local languages will not only improve utility and ease of use, but will also improve trust. As Wamala (2010a) noted, “technology wrapped in the in the local languages increases familiarity.....”.

Cultural Considerations

Most users in the developing world proudly identify with their ethnic and cultural heritage. Peoples’ decisions to adopt or reject a project are culturally dictated. For instance, some study participants with higher levels of education and could understand English liked the system

simply because it offered information in their mother-tongue other than any other language be it English or local. Wamala (2010a) argued that farmers' choice of radio stations they listened to depended was purely influenced by culture. In her study one participant explicitly stated, "CBS is a cultural preference, because it belongs to the Baganda people and I am a Muganda" (Wamala, 2010a, p. 141). Therefore, ICTD projects should be culturally complaint in all aspects – be it language or other relevant aspects.

Need for Decentralized / Locally Specific and Relevant Recommendations

The use of locally existing extension officers meant that they were not well conversant with the community specific language but also the locally specific and relevant recommendations for each question they answered. Farmers were especially very delighted when they called and interacted with people they knew in cases that required extra interaction with the extension officer. Being able to relate with the person providing the information conjured up notions of confidence and trust towards the system. Such a relationship is often lacking in most projects where the source of information is more centralized and where the advice provided may not be locally relevant to all the communities reached by the project. Additionally, assigning important roles to extension officers motivated and made them feel important and in control of the system unlike most ICTD projects where they are bypassed or assigned less crucial roles.

Sustainability and Low Cost of System

From the outset, the system was designed to integrate into the existing extension system instead of bypassing it by creating an independent structure. This helped to minimize costs and create a more sustainable model. By using the existing extension system, we did not only leverage the

personnel but also the necessary infrastructure such as computers and internet. We did not have to pay salaries to extension officers – the main anchors of the system, pay for internet or buy new computers. These were already available at sub-county offices – the work station of government extension officers. Extension officers did all the work: right from responding to farmers questions to developing all the SMS content sent out to farmers and training farmers on system use. Project funds went into buying credit for sending out SMS alerts to farmers as well as responding to farmer questions. These costs are only a fraction of what a similar project with an independent structure would have spent.

Chapter 7

Conclusion

Existing literature on ICT adoption has often identified barriers to ICT use in the dichotomy of literate/illiterate. Although this inference is not entirely wrong, this study suggests that literacy alone does not guarantee ability to use ICTs in a developing world context. Although over 97 percent of the participants were literate (could read and write in their own language), they lacked English proficiency and would therefore not have used the system if it was in English. In a developing country like Uganda with over 42 diverse ethnic groups and languages, we found that offering information in the farmers' own languages does not only affect ease of use, but also the perceived usefulness of and the actual use of the mobile-based agricultural service. Participants found the system easy because they could use their own language - Luganda - to ask questions and receive feedback in the same. In many developing countries, foreign languages such as English are the de facto official languages. As a result, agricultural research findings and technological advice replete in technical jargon are produced in these official languages yet most of farmers cannot read them. This study shows that by leveraging mobile phones and the existing extension system and providing information the farmers' own languages; we can create a more localized, more efficient extension system that can overcome the literacy and infrastructural challenges of agriculture extension systems.

The study also shows that providing information in the farmers' own language does not guarantee ease of use. Imported from abroad, technological devices such as mobile phones come with menus designed in foreign languages. Users such as farmers who do not have a certain level of that language's proficiency will therefore find it difficult to accomplish tasks such as navigating the menu. In the case of the study, participants found difficulty in writing text

messages because mobile phones menus in Uganda are in English, the country's official language. If the full potential of mobile phones is to be achieved, we must look beyond access and look to how to achieve optimal use. For rural communities in the developing world to participate fully in the mobile phone revolution, we must take into account their ethnic and language diversity in not only designing mobile phones but also designing relevant local content - local in both language and context.

The limitations of this study include the small sample size, and the limited time of the pilot. Being a new idea, and the fact that the impacts of ICT projects are often long term and indirect, one month of use might not have been long enough for farmers to make accurate impressions of the system. Nevertheless, the findings suggest important directions for future research and ICT project design. These include the impact of language on adoption of ICT services especially in the developing world; the impact of mobile based services on the effectiveness and efficiency of the extension systems, as well as comparative studies of mobile-based systems that provide information in local languages and those that provide it in non-local languages such as English.

APPENDICES

Appendix A: Survey Questionnaire

Project Title: FACTORS AFFECTING ADOPTION OF AN INFORMATION COMMUNICATIONS TECHNOLOGY SYSTEM FOR AGRICULTURE IN UGANDA

Investigators: Susan Wyche, Ph.D. and Daniel Ninsiima

Research Consent Form

You are being asked to participate in an interview. You must be 18 years of age or older to participate.

Purpose:

The purpose of this study is to examine the efficiency, ease of use and usefulness of a Mobile and web-based SMS system in delivering agricultural information to rural farming communities and enhancing interaction between extension officers and smallholder farmers in Uganda.

Procedures:

If you decide to be in this study, I will interview and observe you for approximately 40 minutes to an hour. I will ask you questions about your daily Information Communication Technology use especially the use of your mobile phone for accessing agricultural information. After interacting with a mobile based agricultural information system for a period of one month, I will also ask you to tell me about your perceptions concerning its usefulness, efficiency and ease of use with regard to your farming activities

If you agree to it, I also will audio tape these interviews to help with the accuracy of our memories.

Risks/Discomforts

The risks involved in this study are no greater than those involved in talking with people in general. I do not plan to ask you questions that may make you feel uncomfortable. If I do ask you a question that makes you feel uncomfortable you do not have to answer it.

Compensation to You

You will be compensated with mobile airtime worth 1000 Uganda shillings (\$ 0.4) participating in this study. You will receive this compensation prior to conducting the interview.

Confidentiality

I will follow these procedures to keep your personal information confidential:

- I will keep collected data private to the extent allowed by law.
- I will keep your records under a code number rather than by name. In other words your real name will not appear on the files associated with this project.
- I will keep your records (e.g., recorded interviews) on a password-protected computer in a locked office. Study staff will only be allowed to look at the interviews. I will destroy the information at the end of the study.
- When results of this study are published your name and other facts that might point to you will not appear.
- To make sure that this research is being carried out in the proper way, the Michigan State University IRB may review study records.

Subject Rights

- Your participation in this study is **voluntary**. You do not have to be in this study if you don't want to be.
- You have the right to change your mind and leave the study at any time without giving any reason, and without penalty.
- You will be given a copy of this consent form to keep.
- You do not waive any of your legal rights by signing this consent form.

In Case of Injury/Harm/Concerns

If you are injured because of being in this study, please contact Susan Wyche at telephone 716 899 067. Neither the Principal Investigator nor Michigan State University have made provisions for payment of costs associated with any injury resulting from participation in this study.

If you have any questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this research study, you may contact, anonymously if you wish, Michigan State University Human Research Protection Program at 517-355-2180, FAX 517-432-4503, or e-mail irb@msu.edu, or regular mail at: 408 W. Circle Drive, Room 207 Olds Hall, MSU, East Lansing, MI 48824.

Consent to participate

_____ Yes, I have read the consent form and will participate in the interview.

_____ No, I have read the consent form and will not participate in the interview.

Consent to be audiotaped

_____ Yes, I am willing to have the interview audiotaped.

_____ No, I am not willing to have the interview audiotaped.

To make sure that this research is being carried out in the proper way, the Michigan State University IRB may review study records.

Your signature below means that you voluntarily agree to participate in this research study.

Subject's Name

Subject Signature

Date

Signature of Person Obtaining Consent

Date

Daniel Ninsiima

Masters Student

Dept. of Telecommunication, Information Studies, and Media

Michigan State University

ninsiima@msu.edu

Phone number: (517) 775 8201

+256776035192

Interviewer:

Date of interview:

Time of interview:

Village:

GPS or other locational information:

Type of construction of house: 1. Brick 2. Mud and wattle

Type of roof: 1. Metal sheeting 2. Grass thatched,

Name of respondent (s):

A: Personal data

1. Respondent's gender 1) Male 2) Female
2. Age of respondent: _____ years
3. Position in family of respondent (head of household, spouse, son/daughter, parent, other.....)
4. Does the husband usually reside here? 1) Yes 2) No.
5. If no, where does he live?
6. Main occupation of the respondent
 1. Crop cultivation
 2. Livestock keeping/crop production
 3. Agricultural labourer
 4. Business
 5. Craftsman. What do you do? E.g., carpenter, brick making...)
 6. Salaried employment. What job do you do? (e.g., teacher)_____
 7. Other specify:.....
7. Main occupation of the head of household (if not the respondent)
 1. Crop cultivation
 2. Livestock keeping/crop production
 3. Agricultural labour
 4. Business
 5. Craftsman. What do you do? E.g., carpenter, brick making...
 6. Salaried employment. What job do you do? (e.g., teacher)_____
 7. Other specify:.....
8. What is the Education level of respondent?
 1. Adult education
 2. Primary education
 3. Secondary education
 4. Post-secondary
 5. No formal education

9. Can you read 1) Yes 2) No

10. Can you write? 1) Yes 2) No

11. What is your marital status?

1. Unmarried
2. Married
3. Separated
4. Divorced
5. Widowed

12. How many adults (18 years and older) live in this household?

Women: _____

Men: _____

13. How many children (under 18 years old) live in this household?

Girls: _____

Boys: _____

B: Land Tenure

No.	Question	Response Categories
1	Does the household own land?	1.Yes 2.No
	If yes, how much land (in acres) does the household own?	Own: _____ acres
2	Does the household rent or borrow land? Yes: rent Yes: Borrow for free	Rent: _____ acres Borrow (free): _____ acres
3	If yes, how many acres?	
2		1.
3	How did you acquire the land you own?	1. Inherited 2. Purchased 3. Gift/Donation 4. Allocated/given by government 5. Other specify.....

14. Do you own any animals? Yes/No.

If yes,

Cattle : _____(number)

Sheep : _____(number)

Goats : _____(number.

15. Do you do work as an agricultural laborer? Yes/ No

16. Do you hire in labour? Yes/No

C: Information about your cell phone usage

17. Do you own a mobile phone? Yes/No. If yes, skip to question 20.

18. If no, do you ever use someone else's phone? If no, skip to question 20.

19. Whose cell phone do you use? How often?

20. Does anyone in the household own a mobile phone currently? 1) Yes 2) No. If no, skip to question 23.

21. If yes, how many phones are in the household?

22. Who owns them? Tick: head of household, spouse, son, daughter, mother, father, other-----

23. When did you start using a cell phone?_____

24. When did you last use a cell phone?_____

25. What do you use your or the borrowed cell phone for? (Please check all that apply)

Sr. No.	Use of cell phone	Yes	No	If "Yes" how frequently do you use? 1) several times a day, 2) Everyday, 3) Several times a week , 4) Around once a week, 5) A few times a month, 6) rarely or never
1	Receiving calls			
2	Making calls			
3	Receiving texts			
4	Sending texts			
5	Other (Please specify)			

26. Broadly speaking, for what reasons do you use your cell phone? (Please select all that apply). Please also indicate the frequency of each use.

#	Please estimate how often you use your cell phone for each of the following?	Never	A few times a month	Around once a week	Several times a week	Every day	Several times a day
1	Interacting with immediate family members						
2	Interacting with friends and relatives						
4	Listening radio						
5	Playing games						
6	Seeking information						
7	Making business calls						
8	Receiving business calls						
9	Getting help for emergencies						
10	Other (Please specify)						

27. In case of serial no. 4, 5, 6, 7, 8 and 9 please let us know;

- Which radio channels do you listen to? _____
- Which games do you play? _____
- What type of information do you seek and from whom? _____
- What type of business calls do you make and to whom? _____
- What type of business calls do you receive and from whom? _____
- In what sort of emergencies do you get help and from whom? _____

D: Knowledge and attitude/practice of using; a) cell phone to access agricultural related information service and b) mobile based agricultural initiatives

28. Do you obtain agricultural information from anyone outside of your household? Yes/ no (skip to **).

29. If yes, from whom do you obtain Ag information? Tick all that apply:

- Relatives
- Friends
- Ag input shop
- Ag extension agent
- Radio
- TV
- NGO
- Mobile phone.

30. Have you ever used your cell phone to ask someone for agricultural advice?

- 1) Yes (From Whom?.....) . Skip to question 31.
2) No.

30 (a) If not, do you intend to use a mobile phone for agricultural information related purposes in future?

- 1) Yes 2) No (Why? -----)

31. Are you aware of any mobile based agricultural information service?

- 1) Yes 2) No

#	1.Name each mobile agricultural information service you know	2. How did you know about it?	3. Have you ever used it? (1) Yes or 2) No)	4. If not, why?	5. If yes, How frequently do you use it?	6. For what purpose do you use it?	7. Do you still call/text this service? (Yes or No)	8. If yes, do you find this service useful? (Yes or No)	9. Have you recommended this service to anyone?
1.									
2.									
3.									
4.									

Choices for question 5: 1) A few times a month 2) Around once a week 3) Several times a week 4) Every day 5) Several times a day

E: Agricultural information received/accessed

#	Type of agricultural information you have accessed.	Yes or No	Did you use the information? (Yes or No)	If "No" why did you not use it?	Please rate the value of information on the scale of 1 - 5 where 1 is unsatisfactory and 5 is satisfactory 1 2 3 4 5	What is the reason for your rating? (What did you like OR what you did not like about the information?)
3	Pest and disease management					
4	Financial Literacy					
5	Savings and credit					
6	Harvesting and Drying					
7	Storage					
8	Group formation and management					
9	agricultural market information					
10	Book keeping					
	Others—please specify					

E: System use

1. During the last month, have you used Buuza Omulimisa? Yes / no. If no, skip to question 2.
2. If yes, how frequently in the past month?

1. once
2. A few times a month
3. About once each week
4. A few times a week
5. About once a day
6. Several times a day

3. What's your opinion about the system?

4. Why.....

?

5. After using the service for one month, how confident are you at using it?

1. Low confidence
2. Moderately confident
3. Very confident

Comment: in the next few questions, I'm going to ask you whether you agree or not with these statements.

Part 4: Perceived Usefulness, ease of use and perceived future use

6. Has using Buuza Omulimisa enhanced your effectiveness in caring for your crops/livestock?

1. Strongly Agree
2. Moderately Agree
3. Slightly Agree
4. Neutral
5. Slightly Disagree
6. Moderately Disagree
7. Strongly Disagree

6. Do you intend to continue using the system to frequently get information from extension officers?

1. Strongly Agree
2. Moderately Agree
3. Slightly Agree
4. Neutral
5. Slightly Disagree
6. Moderately Disagree
7. Strongly Disagree

7. Do you find the system easy to use?

1. Strongly Agree
2. Moderately Agree
3. Slightly Agree
4. Neutral
5. Slightly Disagree
6. Moderately Disagree
7. Strongly Disagree

8. Why?

.....

9. Does it make it easier to use because it is in your own language and not English?

1. Strongly Agree
2. Moderately Agree
3. Slightly Agree
4. Neutral
5. Slightly Disagree
6. Moderately Disagree
7. Strongly Disagree

10. Do you intend to use the system as often as possible?

1. Strongly Agree

2. Moderately Agree
3. Slightly Agree
4. Neutral
5. Slightly Disagree
6. Moderately Disagree
7. Strongly Disagree

11. Do you like using the system?

1. Strongly Agree
2. Moderately Agree
3. Slightly Agree
4. Neutral
5. Slightly Disagree
6. Moderately Disagree
7. Strongly Disagree

12. Why?.....

13. Does using the system help you access agricultural information and assistance more quickly or disseminate agricultural information and assistance more quickly to farmers?

1. Strongly Agree
2. Moderately Agree
3. Slightly Agree
4. Neutral
5. Slightly Disagree
6. Moderately Disagree
7. Strongly Disagree

14. Was it easy for you to learn using the system?

1. Strongly Agree
2. Moderately Agree

3. Slightly Agree
4. Neutral
5. Slightly Disagree
6. Moderately Disagree
7. Strongly Disagree

15. Did you find using the system very useful?

1. Strongly Agree
2. Moderately Agree
3. Slightly Agree
4. Neutral
5. Slightly Disagree
6. Moderately Disagree
7. Strongly Disagree

16. Why?.....

17. Overall, how satisfied are you with the system?

1. Very satisfied
2. Satisfied
3. I can't decide whether I am satisfied or not
4. Dissatisfied
5. Very dissatisfied

18. Does the system improve access to extension officers?

1. Strongly Agree
2. Moderately Agree
3. Slightly Agree
4. Neutral
5. Slightly Disagree
6. Moderately Disagree
7. Strongly Disagree

19. Why?.....
.....
.....

20. Anything more you would like to say about Buuza Omulimisa?
.....
.....
.....
.....

21. Do you have any questions for me?
.....
.....
.....
.....

Appendix B: Interview Protocol

1. Extension agents:

- a. Pre: What are your experiences with farmers: problems farmers mention, difficulties in meeting with farmers, if use mobiles with farmers, if other projects (NGOs or others).

What are the big info gaps farmers have? Why?

How do you address this now?

- b. Post: What are your experiences now? (If you use the system, how do you use it? how many questions do you get? What topics? What you can answer and what you cannot answer, do you need additional info to help farmers? If yes, what info? What are your experiences with the system? (Good & bad, and why), other questions about the system, see your research questions. Do you intend to continue using the system? Why?

2. First adopter type of farmers

- a. Pre: what enterprises are doing well? What problems are you facing? Why? What info needs do you have? What are your experiences with extension agents?
- b. Post: What are your experiences with the system? Will you continue to use it? Why?

3. ICT projects.

Describe how project works? What are your experiences? How many farmers use the system? What challenges do you face? What works and doesn't work? Is the project continuing or not and why... (Funding & sustainability issues)

4. Input suppliers: pesticides, seeds, fertilizers, etc.

What do farmers buy the most?

What are the major problems that farmers face?

What farmers buy the products?

What advice do you give farmers?

Where did you get that information?

Do you have any connection with ag extension?

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