FACTORS AFFECTING THE ADOPTION OF MOBILE PHONE TECHNOLOGIES BY SMALLHOLDER DAIRY FARMERS IN LIMURU SUB-COUNTY

MAINA RICHARD WANJOHI

A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE IN MARKETING DEGREE, SCHOOL OF BUSINESS, UNIVERSITY OF NAIROBI

NOVEMBER 2015

DECLARATION

This research project is my original work and has not been presented for award of any degree in any university.

Signed: _____ Date: _____

Richard Wanjohi Maina D65/60385/2013

This research project has been submitted for examination with my approval as the University Supervisor.

Signed: _____Date: _____

Catherine Ngahu

Senior Lecturer

Department of Business Administration

School of Business, University of Nairobi

DEDICATION

With the inspiration, enduring support and confidence through this academic point, I thank my parents' Agnes Nyawira and my late father Duncan Paul Maina for untiringly encouraging us to pursue our academic aims to the highest possible level. My wife Njeri Wangari and daughters Naomi Nyawira and Wanda Wangari for exercising their fortitude, faith and reassurance. To my siblings and larger family, for your conviction and prayers, I'm forever grateful.

ACKNOWLEDGEMENT

For the gift of life and good health, my indebtedness to God during the pursuit of this course amidst seemingly insurmountable challenges.

For the guidance, support and invaluable contribution, special thanks to my moderator and supervisor Dr. Justus Munyoki and Ms. Catherine Ngahu in developing and completing of this paper.

For the fledging course of Master of Science in Marketing, gratitude to The University of Nairobi and course partners GFK Verein, as well as staff, colleagues and friends during my time at the Chiromo and Lower Kabete Campus' respectively.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS & ACRONYMS

CDMA	Code Division Multiple Access
CAK	Communications Authority of Kenya
CCK	Communications Commission of Kenya
CPI	Consumer Price Index
EAC	East Africa Community
FAO	Food and Agriculture Organisation
GDP	Gross Domestic Product
GPRS	General Packet Radio Services
GPS	Global Positioning System
GSMA	Global Services for Mobile Association
ICT	Information Communications and Technology
ICT4D	Information Communications Technology for Development
ITU	International Telecommunications Union
KACE	Kenya Agricultural Commodity Exchange
KDB	Kenya Dairy Board
KNBS	Kenya National Bureau of Statistics
NLMIS	National Livestock Marketing Information System
PDA	Personal Data Assistant
SMS	Short Messaging Service
SPSS	Statistics Package for Social Scientists
SSA	Sub-Saharan Africa
UN	United Nations
USAID	United States of America International Development
USSD	Unstructured Supplementary Service Data
VAT	Value Added Tax
WLAN	Wireless Local Area Network
3G	3rd Generation (of Mobile Network technology)
4G	4th Generation (of Mobile Network technology)

ABSTRACT

With the high penetration of mobile phone networks in Kenya, there is bound to be appreciation and adoption of these technologies' in agriculture. According to a GSMA Report 2014, 96% of the population is covered by a mobile network. The study also suggests that there are still a few millions of unconnected Kenyans predominantly in the rural areas with a market penetration of only 33% in these areas. Rural users are likely to be farmers; entrepreneurs have been quick to pick up on the opportunities for engaging rural people in mobile services. This study was done to determine adoption of mobile phone technologies among smallholder dairy farmers. The main objective of the study was to determine the existence, adoption and flow of mobile technologies in the dairy sub-sector. Literature was collected from various authors and publications who focused on mobile phone technologies, dairy farming practices as well as factors influencing adoption of these technologies. This research used the descriptive research design which involved acquiring information on a group of dairy farmers about their characteristics, opinions, attitudes and previous as well as current experiences. To achieve this, the main data was collected using structured questionnaires. Strata comprised of county assemblies within Limuru Sub-County. The study revealed that the factors that were considered among the variables and demographics which included innovativeness, reliability, penetration, relevance and affordability. The study found that respondents were aware of various mobile phone technologies and also demonstrated that respondents had a high adoptability towards attributes that these technologies. A good majority of the respondents indicated using mobile phone technologies for payment, animal health and complementary dairy services. The findings also found that nearly all respondents are positively adoptable to these technologies. The researcher recommended that similar studies can be carried out in other counties with a high concentration of dairy farmers and farmers are on the look-out for new mobile phone solutions to assist in animal health. The study found that there are number of mobile phone technologies in use largely for extension services and animal health. Adoption of these technologies dependent on their reliability, relevance and information provided about them. It is recommended that those developing these technologies work closely with farmers to find out what challenges are currently in existence. Learnings from countries that adopted mobile phone technologies widely in their dairy farming can be used and adapted by Kenyan dairy farmers and other forms of farming too.

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

In Kenya today, agriculture has become more complex and with this, a need for changing and enhancing the means of production. Information Communications Technologies (ICTs) have formed products and services adopted by agricultural practitioners in developing better methods to improve their yields and farming practices. Using mobile phones and SMS, for example, farmers have been able to expand their distribution channels to more remote rural areas and offer products and services to farmers that were not available to them before (ICT Applications and Agricultural Input Supply Companies, USAID, 2013).

The proliferation of mobile phones on the continent has impacted agriculture in various ways. Mobile phones are being used as tools to raise farmer households' incomes, lowering information costs, reducing and making the marketing channels more efficient, reducing incidental and transport costs as well as continually serving as platforms for innovation. Mobile phones are in the vanguard of ICTs in agriculture. (ICT in Agriculture- Connecting Smallholders to Knowledge, Networks and Institutions, World Bank e-Sourcebook, 2011).

While the main focus of this study is on the adoption and use of ICT technologies and in particular mobile phone technologies, it is important to remember that ICT is a tool, not a universal remedy, and not all solutions fit all business models or contexts. In addition, the landscape is changing so rapidly that it is important to carry out this research on how ICT continues to be used, both effectively and poorly, by input suppliers. One of the objectives of this study is to cover the main constructs derived from Technology Acceptance Model (F.D. Davis, 1989); including intention to adopt mobile technologies products and services, perceived usefulness, and perceived ease of use. The additional variables perceived risk and social influence are included in the Technology Acceptance Model in order to develop a research model to probe variables affecting adoption of mobile phone technologies by farmer households in Kenya.

Mobile phone technologies are the most flexible technology for improving connections within farmer organizations and providing a wider range services. Documented benefits of ICTs include improved connections to members, better accounting and administration,

and stronger collective voice. Mobile phones are in the vanguard of ICTs in agriculture. (ICT in Agriculture- Connecting Smallholders to Knowledge, Networks and Institutions, World Bank e-Sourcebook, 2011). The mobile phone has been one of the most rapidly adopted forms of Information, Communications and Technology in Sub-Saharan Africa. There are 253 million unique mobile subscriptions in Sub-Saharan Africa, growing at an average rate of 18% per annum, by June 2013 (GSMA Sub-Saharan Mobile Economy Report, 2013). The Report further indicates that Kenya had 13.4 million unique mobile subscriptions within the same period. Mobile telephony has brought myriad opportunities in different economic sectors, to both rural and urban dwellers, connecting single entities and individuals to businesses, co-operatives and institutions as well as markets and information hubs across the country. The increased ubiquity of the mobile phone and associated technologies is presenting both opportunities and challenges in the agricultural sector.

Agriculture is the mainstay of the Kenyan economy contributing 24% of the GDP directly and 27% indirectly through various linkages with the manufacturing, distribution and other service-related sectors (Food Security Report-KARI; KNBS Statistical Abstract, 2013). Part of the reason it remains a major sector is the growing population, urbanization and increase in incomes of households, all increasing the demand for food. The current estimates from the Kenya National Bureau of Statistics and the World Bank 2013 data estimate the number to be 44.35 million people. This indicates the integral part that agriculture plays. This paper will concentrate on the study of the dairy sector as a sub-sector of the agriculture sector. In Kenya, the dairy industry is the single largest agricultural sub-sector contributing 14% of the agricultural GDP and estimates of 3.5 % of the country's GDP (KNBS Statistical Abstract 2013,). It has been one of the fastest growing agricultural sectors in the country contributing an average of KES 320 billion per year and supporting the livelihoods of 10 million people (Nestle, Model Milk District Report 2013). There are many players in the dairy sector: those offering services and inputs; industry facilitators and development partners; and the users of services/inputs. A unique characteristic of dairy production in this setting is that milk supply comes predominantly from smallholder farmers in both informal and formal markets.

There are more than one million smallholder dairy farmers according to surveys done by the Smallholder Dairy (Research and Development) Project. These farmers contribute

70% of the gross marketed production from the farms. There are about 30 licensed milk processors, two of which process more than 60 percent of the total processed milk (KDB). Part of the rapid growth in the sector can be attributed to the use of improved forms of production. Technologies such as mobile technologies have been playing an integral role in auxiliary services such as payment processing, loan repayment and other services made to dairy farmers (ICT in Agriculture, e-Sourcebook, World Bank, 2011). Diffusion of mobile phones in rural areas presents one of the most profound changes in rural Kenya and Sub-Saharan Africa (GSMA SSA Mobile Telephony, 2013). Farmers, market players along with milk processors have shifted from a culture of long communication lines to one where the mobile phone is an important tool for communication as well as information sharing and dissemination.

Timely adoption and appropriate use of the easily and widely available mobile phone technologies in agricultural operations is one of the opportunities that may help in realizing the 'digital opportunities' of enhancing rural productivity and contribute to reducing rural-urban inequalities (Islam, 2011). There are digital platforms developed to work as information intermediaries to farmers agricultural data including the Kenya Agricultural Commodity Exchange, e-Soko, i-Cow and m-Farm to name but a few. These platforms communicate agricultural inputs such as product or input advertisements, price fluctuations, breeding and extension services and advisory services among others. Although the dairy sub-sector farmers have become targets for mobile phone services, studies of technology adoption and diffusion in such context are currently limited (Adesina & Baidu-Forson, 1995). These limitations inform this study and the subsequent review of literature and data collected. The next section looks at the concepts which will form the basis of this study, theories and models relating to the topic of the study.

1.1.1 Concepts in Mobile Phone Technology and Agriculture

Mobile phone technology is one form of Information Communication Technologies used for cellular communication. It has evolved from the simple pager with two-way communication and PDAs and hand-held devices to the CDMA technology, GSM, 3G and 4G networks along with Internet-enabled phones and devices fitted with Wi-Fi and GPRS features. Currently mobile technology is revolving around smartphones and tablets each with features to enhance communication and use of technology in different sectors

of the world economy (Information Office, UK, 2012). Feature phones are the most preferred by farmers and majority of the both rural and urban populace in Kenya. However this trend is changing the country as well as the rest of Sub-Saharan Africa. This can be attributed to affordable entry-level smartphones, affordable Internet and data plans as well as deployment of the 3G mobile network technology (Communications' Authority of Kenya - Quarterly Report, 2014)

The mobile phone has the fastest penetration among Information Communication Technologies. In developing countries, mobile-cellular penetration will reach 90% by end of 2014, compared with 121% in developed countries. (ITU, 2014). Mobile telephony has made it possible for citizenry in the continent to connect among themselves; individuals, information, markets and services. In Ghana, farmers can send a text message to learn the prices of corn and tomatoes in Accra, which is 400 kilometres away (Aker and Mbiti, 2010). The regulatory design has improved in recent decades helping boost competition among the telecommunications companies, which in turn has made it possible for innovation in business models in mobile telephony (Ling and Bonner, 2009). The mobile phone has been identified as the first form of telephony for many of the world's poor including those in Sub-Saharan Africa and Kenya. Mobile telephony has extended to the poorer populations across the world, majority of whom are small-scale farmers and engage in agriculture as their main source of livelihood. Agriculture accounts for a majority of the rural employment. Thus any improvement seen in agriculture will largely help improving the lot for the rural communities and those involved in the various agricultural value chains such as the dairy sub-sector. The increase in usage of mobile phones in Sub-Saharan Africa has caused disruptions in the agricultural sector in a number of ways. This includes making agricultural information more accessible and lowering information costs, making agriculture marketing more efficient, connecting previously un-served and under-served agricultural potent areas, reducing transport costs and providing a platform for delivering advisory services and innovations.

For the purposes of this study, the mobile phone technologies to be considered include mobile applications for both hardware and software. The hardware include mobile gadgets, PDAs, smartphones and tablets. Software that sits on top of the operating system or on top of a platform, for example, served-based applications such as Vodafone/Safaricom's M-Pesa that provide services to mobile users are considered too as

part of the study (InfoDev, 2012). The M-Pesa is an example of USSD platform, which runs on the GSM cellular phones and more recent mobile networks.

1.1.2 Adoption of Mobile Phone Technologies

Available data on adoption of improved agriculture technologies indicates a low level of adoption in developing countries such as the majority of Sub-Saharan African countries where Kenya lies. This shows a disparity compared with other sectors such as financial services which have grown exponentially (GSMA Sub-Saharan Africa Report, 2013). The rate of adoption can be attributed to learning; where learning that a new technology is not as effective will thus reduce adoption in the next period (Foster and Rosenzwig, 2010). This is from the deduction that mobile technologies reduce communication and information for those in the rural areas engaging in agriculture.

Foster and Rosenzweig (1995) show that there are two potential opposing effects of social networks on adoption of mobile technologies by farmers. The first is the individual farmer's incentive to adopt increases as those members within a social network use the new technology. For example, a farmer in a Farmers' or Savings' Co-operative is likely to adopt the technology on the influence of other farmers or members of the SACCO. This may also create an incentive to delay adoption due to the free-riding behaviour and information spill-overs. Most studies have come to a general consensus on the determinants of or constraints to mobile technologies adoption to include other reasons. These include levels of education, expected returns, tastes, wealth, risk preferences and access to information and learning.

Islam and Gronlund in the Rural Area Technology Acceptance and Diffusion of Innovation model explore the factors that affect the adoption of mobile phone technologies in Bangladesh. The model among other studies explore the rural areas in understanding the adoption or lack thereof of mobile phone technologies. In Kenya, mobile phone technologies have been adopted following the success of the mobile money platforms such as M-Pesa. This has led to other forms of mobile technologies adopted in even in agriculture such as m-Farm, i-Cow which have changed the face of agricultural practices in the country (i-Hub Research and GSMA Sub-Saharan Reports, 2013). These technologies have been accepted by farmers to embrace better farming practices. These

technologies have also been made for marketing services and easier access to information.

1.1.3 Dairy Farming in Kenya

Milk is produced everyday giving regular income to many small-scale producers. Milk production is labour-intensive and provides employment to a large part of the world's population. It can be obtained from domesticated animals including cows, goats, sheep and camels and in other economies such as the Asian sub-continent, buffaloes (McGee, 2004 and FAO, 2013). Dairy farming is the rearing of these animals to produce and process the milk. This can be through single small-scale farmers, large-scale farms, dairy co-operative schemes who pass on the function of processing to the different milk processors. Commercial dairy farming started in 1902 with indigenous Kenyans being allowed to rear dairy animals from the mid-1950s. The sector has witnessed a shift from the export-oriented and large-scale holders in the 1960s to growth of small-holders and local consumption in the 2000s (Kenya Dairy Board, 2010). Milk production in Kenya is mainly from cattle, camels and goats with dairy cattle produce accounting for about 70% of the total national milk output. In 2013, recorded milk production stood at 523 million litres, a rise from the decline seen in 2012 of 495.2 million litres. Earnings from dairy produce increased from KES. 15.4 billion in 2010 to KES. 16.8 billion in 2013 (KNBS, 2014).

1.1.4 Dairy Farming in Limuru Sub-County

Limuru Sub-County (also known as Kiambu West) is one of the five sub-counties that make up Kiambu County. Sub-county is the administrative formerly known as constituency in Kenya. The sub-county has a population of 131,132 (National Census, 2009) in an area covering 281.8 square kilometres. This study is based on the farmers from this sub-county due to the high incidence of dairy farming in this area. The area has a total of 22,484 cows and 5765 goats (National Census, 2009). The area was also part of a pilot study commissioned by the Kenya Dairy Board under the *Promoting the Adoption of Management Information Systems in the Dairy Industry* where one of the objectives was to "facilitate electronic and mobile commerce in the dairy industry". This study was undertaken at the Limuru Dairy Farmers Cooperative in 2012. The population in this area is homogenous such that the farmers are exposed to similar climatic conditions and

practice similar livestock and crop production structures. A distinctive characteristic of dairy production in this locale is that milk supply comes predominantly from smallholder farmers in both informal and formal markets.

1.2 Research Problem

While mobile telephone technologies have witnessed phenomenal growth and penetration, studies show there is still a large part of the population that is under-served and not enjoying mobile services at all. This majority is in the agricultural rural areas of most parts of the world (Islam and Gronlund, 2011). Mobile technologies have also been adopted in other sectors of the economies such as financial and banking services, utilities and health, education and to some extent in agriculture. Studies in Bangladesh assessed the factors that have led to the adoption of mobile technologies in general and the larger agricultural sector (Islam and Gronlund, 2011; Kalba, 2008 and Jain and Hundal, 2007).

Mobile financial applications such as ‘m-money’ and ‘m-banking’ have been widely adopted in Africa with examples such as m-Pesa and m-Shwari from mobile services provider Safaricom and Commercial Bank of Africa respectively (Aker and Mbiti, 2010). A variety of applications, services and applications have been developed and deployed using the mobile as the primary tool of collection or delivery. This is the case in a number of m-health projects such as monitoring and tracking of epidemics and illnesses in parts of Africa and Caribbean. The crowd-sourcing application *Ushahidi* relies heavily on texts and messages from mobile phone users to source for information and manage emergencies as was the case during the 2008 post-election crisis in Kenya and earthquake in Haiti (Granot, Ivorra and Rubinsky, 2008; Aker and Mbiti, 2010). In agriculture, mobile phones are facilitating access to agricultural marketing information replacing message boards and radio programs of traditional marketing information systems. They are also providing agricultural extension services in Kenya, Uganda and India for technical agricultural advice (Donovan, 2010).

A study was conducted on mobile phone communication in diffusion of goat rearing in Kitui in 2013. This study looked into the role played by the mobile phone in undertaking goat rearing (Adongo, 2012). Another study conducted in Limuru sought to explore how dairy farmers can access credit better using mobile technologies (Kinuthia, 2012). Though these aforementioned studies were focusing on mobile telephone technologies,

there is limited evidence and information on the impact of the same in the dairy sub-sector in Kenya. Emerging patterns from other studies looking at the smallholder farmers' adoption of new technologies and market participation is that there is a highly variable of participation and non-participation or adoption and non-adoption cycles of improved production techniques. Gaps identified in these studies are that they have not assessed what technologies are currently in existence, the level of adoption and continuous usage of these technologies and impact of the mobile technologies on improving dairy farming productivity. No clear distinct finding offers an explanation to address the exogenous factors constraining continuous participation of smallholder farmers in dairy production. Hence the question, how many smallholder farmers have adopted mobile technologies in their dairy farming activities?

1.3 Objectives of the Study

The overall objective of the study was to determine the existence, adoption and flow of mobile technologies in the dairy industry while the specific objectives are as follows;

a) To establish the proportion of farmers engaging in dairy farming who have adopted mobile phone technologies.

b) To investigate the factors that affect the adoption of mobile phone technologies relevant to smallholder farmers in Limuru.

c) To identify the attitudes towards mobile technologies in dairy farming.

d) To determine constraints and challenges facing the dairy farmers in adopting the mobile phone technologies.

1.4 Value of the Study

The findings of this study are expected to enrich the existing studies in mobile applications and the agricultural sector. It will contribute further to theory building, policy issues in mobile application and services development and the management information services in the dairy sub-sector. It will assist developers on existing gaps and challenges in mobile phone technologies and how they can overcome them. The study will also form a source for future researchers as the trove of information will help advance similar

studies acting as a reference. The insights from this study can help mobile phone developers on how best to serve an unserved market in the rural areas not yet penetrated.

The findings of the study will aid policy makers in the counties and national governments on better mobile phone adoption practices and faster diffusion rates. The findings will also help stakeholders in the mobile telephony and agricultural sectors of the economy in reaching a wider underserved population of farmers and greater country population. The researcher is expected to benefit through the communication and writing skills to be gained by the time of completion of the research project.

This study will also provide a clear picture of the role that mobile phone technologies play in various marketing functions including distribution, product development and innovation. It will also show ways that adoption of mobile technologies has impacted dairy farming and agriculture and is continually doing the same for marketing and market research.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter will evaluate the theories guiding this study and the importance of mobile phone technologies along with the adoption and diffusion of these tools. It will also review the dairy industry. The literature is from various researchers, scholars and authors.

2.2 Theoretical Review

The following theories will be discussed for the purpose of this research; namely the diffusion of innovations theory; technology acceptance model; theory of planned behaviour; and unified theory of acceptance and use of technology (UTAUT) model.

2.2.1 Diffusion of Innovation Theory

The theory seeks to explore why, how and at what rate new ideas and in this case technology spread through cultures. Diffusion is explained as the process by which an innovation is communicated through certain channels over time among the participants in a social system. Thus diffusion is explained as ‘a special type of communication concerned with the spread of messages that are perceived as new ideas (Rogers, 2003). An innovation is ‘an idea, practice or object that is perceived as new by an individual or other unit of adoption. The characteristics of an innovation, as perceived by the members of a social system, determine its rate of adoption (Rogers, 1995). Innovations may also be classified based on their impact on behaviour and social structure into continuous, dynamically continuous and discontinuous products or innovations (Robertson, 1971). Technological innovations fall into the discontinuous innovation category and thus they can be regarded to as knowledge intensive innovations. This is because the knowledge needed for technological innovation comprehension is possibly contingent on aspects of technology (Moore, 1999).

Technology consists of both a hardware and software component, with the hardware embodying the technology as a material or physical object (in this case, mobile handsets, hand-held devices such as PDAs, tablets). Software on the other hand is the information base used (for example, Symbian and Java for Nokia phone handsets or Android for smart devices). Though the latter is less observable than the hardware, they should both be

considered when being researched for a study such as is intended here (Rogers, 1995). There are four main elements which influence the spread of a new idea; the innovation itself, communication channels, time and a social system. This process is dependent on human capital and the innovation must be widely adopted to be identified as sustainable. Within the rate of adoption, the innovation reaches critical mass as identified by the categories of adopters: innovators, early adopters, early majority, late majority and laggards (Rogers, 1995).

Relating this to adoption of mobile technology in agriculture, it is expected that the technology is technically and culturally appropriate while the problem of adoption is one of asymmetric information and high search cost (Feder and Slade, 1984; Shampine, 1998; Smale *et al*, 1994). The adoption of a technology can be measured by 'the timing and extent of new technology utilization by individuals' (Sunding and Zilberman, 2001). In this study the consideration will be on adoption and diffusion of mobile technology among dairy farmers. The timing of adoption and diffusion can be split into three levels, i.e. the decision process a dairy farmer whether or not to adopt a technology, the innovativeness of the farmer in terms of when to adopt the diffusion process and the rate at which is adopted in the system (Rogers, 2003). The extent of adoption will be measured by the usage rate, number of dairy farmers using the technologies, the change in amount of milk produced and processed, the amount paid among other items to be measured by the research tool.

2.2.2 Theory of Reasoned Action

The theory proposes that a person's actual behaviour can be determined by considering their prior intention along with the beliefs that the person has for the given behaviour. The intention that a person has prior to an actual behaviour is referred to as the behavioural intention of that person and is defined as a measure of one's intention to perform a behaviour (Fishbein and Ajzen, 1971). This theory has four constructs that a user has in actual behaviour since behavioural intention is positively influenced by beliefs, attitudes, subjective norms and normative beliefs. Attitude according to this theory is defined as a person's positive or negative feelings about performing the actual behaviour, suggesting that the attitude of a person towards a behaviour can be measured by considering the sum of the product of all relevant beliefs about consequences of performing that behaviour.

The subjective norm associated with a behaviour is also described as the person's perception that most people who are important to him or her think he/she should or should not perform the behaviour. Thus subjective norm can be determined by considering the sum of the product of a person's normative beliefs (Fishbein and Ajzen, 1971, 1980). Normative beliefs are identified as the perceived expectations of other individuals or groups and one's motivation to comply. This theory though suggests that attitudes and norms are not weighted equally in predicting behaviour. Depending on the individual and the situation faced, these factors may have different effects on the behavioural intention, thus a weight is associated with each of these factors in the predictive formula of the theory (Fishbein and Ajzen,1980) (Miller (2005).

2.2.3 Social Judgement Theory

The theory assumes that people assimilate new information about attitude objects in the light of what they already know or feel. The initial attitude acts as a point of reference, and the new information is categorized in terms of the existing standard. People contrast in terms of the information they will find acceptable or unacceptable. They form latitudes of acceptance and rejection around an attitude standard. This is the case with mobile phone technologies, once people adopted a technology, they either formed a latitude of accepting or rejecting it. Ideas that fall within latitude will be favourably received while those falling outside the zone will not.

Messages that fall within the latitude of acceptance tend to be seen as more consistent with one's position than they actually are. This process is called an assimilation effect. On the other hand, messages that fall within the latitude of rejection tend to be seen as even further from one's position that they actually are, resulting in a contrast effect. A consumer or farmer in this case accepts fewer ideas that are removed from his or her own position and tends to oppose even mildly divergent position.

2.2.4 Technology Acceptance Model

This model is an extension of the Theory of Reasoned Action (Fishbein and Ajzen, 1980). It proposes to explain why users accept or reject and use a technology. It suggests that when consumers or users are presented with a new technology, there are a number of factors which influence their decision on how and when they will use it explained by the

following two constructs; Perceived usefulness – defined as ‘ the degree to which an individual believes that using a particular system would enhance his or her job performance; Perceived ease-of-use – outlined as ‘the degree to which a person believes that using a particular system would be free from physical and mental effort (Davis, 1989).

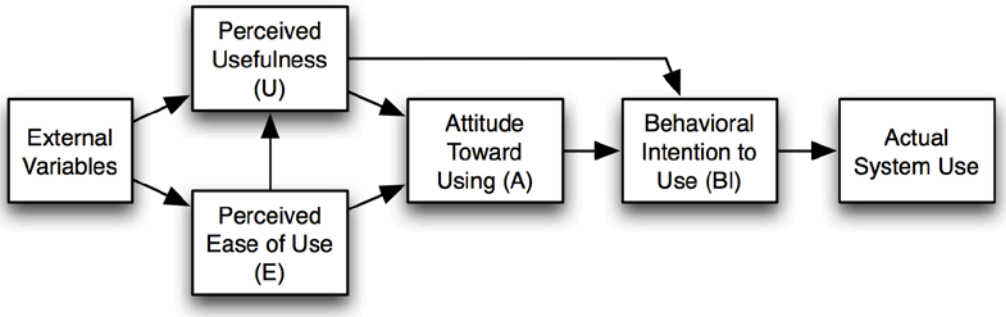


Figure 1: Technology Acceptance Model

According to the theory, an individual’s use of a technology is influenced directly or indirectly by the user’s behavioural intentions, attitude, perceived usefulness of the system and perceived ease of the system. It also suggests that external factors affect intention and actual use through mediated efforts on both perceived usefulness and perceived ease of use (Davis, Bagozzi and Warshaw, 1989).

2.2.4 Unified Theory of Acceptance and Use of Technology (UTAUT) Model

This is a model to describe user acceptance of information technology. It aims to explain user intentions of an information system and subsequent usage behaviour (Venkatesh et al, 2003). It holds that the following four constructs; effort expectancy, performance expectancy, social influence and facilitating conditions; are direct determinants of usage intention and behaviour. The model suggests that gender, age, experience and voluntariness are posited to mediate the impact of the four constructs on usage intention and behaviour. The theory holds that the four key constructs are direct determinants of usage intention and behaviour. Gender, age, experience, and voluntariness of use are posited to mediate the impact of the four key constructs on usage intention and behaviour. Many user acceptance models with different determinants exist to measure the user agreement of information systems which is an important factor to indicate a system

success or failure. These models have been widely tested to predict user acceptance. No comprehensive instrument to measure the variety of perceptions of information technology innovations had existed until the UTAUT model attempted to review and compare the existing user acceptance models with an ultimate goal to develop a unified theory of technology acceptance by integrating every major parallel aspect of user acceptance determinants from those models (Venkatesh et al. 2003 and Sundarajev, 2009). The key constructs of performance expectancy, effort expectancy, social influence and facilitating conditions can be applied to this study. This makes UTUAT a more relevant model to this study as compared to TAM.

2.3 Types and the Uses of Mobile Technology in Agriculture in Kenya

Mobile technologies in review for this study will include cell phones, smartphones, tablets, hand-held devices, PDAs and computing devices. Mobile devices have been used to perform weather monitoring from remote areas. This is through a solar-powered wireless network from the fields to local users through WLAN and to remote users via the cellular network and the Internet (Gichamba and Lukandu, 2012). Mobile technologies have been used for geo-referenced environmental monitoring (Vivoni and Camilli, 2003). This was through a wireless prototype system to acquire, store, display and transmit real-time geo-referenced environmental data between multiple field teams and remote locations. SMS applications have been adopted too. Farmers use these applications to interact with experts and systems to receive weather updates, information on best practices on sectors of agriculture. An SMS service that brings information on demand and supply to farmers and extensions workers has been developed in Uganda (Hellstrom, 2010).

In Kenya, **Kilimo Salama** - Swahili for ‘Safe Agriculture’- is an initiative by Syngenta Foundation for Sustainable Agriculture in partnership with UAP Insurance and Safaricom Limited to support farmers in dealing with weather risks by developing and piloting agricultural micro-insurance products (Webb, 2010; Aker and Mbiti, 2010). Kenya Farmers Helpline is another form of mobile platform that has had an impact on farmers. Through a call centre, farmers are able to interact and talk with agricultural experts from across the country on various agricultural issues (Murray, 2010). NLMIS is also an enterprise created for pastoralists and cattle traders in Kenya to access market trends on

cattle and dairy farming. This is from the now defunct Ministry of Livestock, currently housed under the Ministry of Agriculture (Mwangi, 2010). **Angaza Kilimo** is web-based and text-messaging system developed by FarmChem-a Kenyan agricultural input company in partnership with ICT4D and USAID in 2010. It targets existing and potential customers by giving them tips on farming and strategies to help them increase their yields and profits. It also allows farmers to give feedback on products and identify farmer field days near them. It helps locate the nearest authorized retailer, updates on new products and ordering of products directly to their nearest dealer. Distributors can also access the system to place orders directly from FarmChem. By 2012, the system had 50,000 registered farmers and other individuals with access to useful information on inputs and production (FarmChem Kenya and USAID, 2012).

Kenya Agricultural Commodity Exchange developed a text-messaging service **SMS Sokoni** in partnership with mobile services provider, Safaricom. This helps farmers across the country to access up-to-date and reliable market information on prices and commodity offers at an affordable rate via mobile. In 2006, average monthly usage stood at 1,273 and by 2008, the usage had increased to 24,716 users. This indicates the potential of such solutions and the usefulness in accessing market information and linkage systems. **M-Farm** is a mobile subscription service aiming to improve the agricultural sector in Kenya by connecting farmers through peer-to-peer collaboration to improve market information and enhance learning opportunities. The application offers price information, ways for farmers to sell their crops collectively and to buy farm inputs together by use of their mobile phone or through the website (Donovan, 2013). **i-Cow** is another mobile service that helps dairy farmers to track their animals on breeding, nutrition, milk production efficiency among other dairy best practices. It also assists access animal health specialists and extension service on the nearest veterinarian or artificial insemination specialist through text messaging or the Web. The application also has a platform where farmers can trade livestock and related products on their phones (Macharia, 2013). According to a GSMA 2013 report, Kenya leads other countries in Africa in developing and deploying mobile agricultural services. By December 2013, there were 17 such services compared to 5 in Uganda, 4 in Ghana, 3 in Senegal and Zambia respectively. This shows the potential in mobile technologies in changing and affecting agricultural practices in the country.

There is existing available data in Kenya to support the adoption of mobile phone technologies in agriculture. The data focuses more on credit access using the mobile while others have focussed on diffusion of animal rearing with initiatives like Kuza Biashara (ICT Authority, 2012). In addition, there are proposals to set up an electronic animal monitoring system to provide end-to-end data on farm animal produce (ICT Authority White Paper 2014). However other studies in Swaziland and Bangladesh were used to understand the role and factors that lead to adoption of mobile technologies. Empirical data from these studies demonstrates the existence of agricultural market information systems and the use of mobile phones by farmers in Bangladesh. Evidence also demonstrates the existence of persistent poverty traps which lead to lower adoption rates of technologies in under-developed countries (Mulford, 2013).

Summary

The studies aforementioned have covered different aspects of mobile telephony and adoptability of the technologies. This is captured by the tool of data collection in this study. Aspects such as how mobile technologies have helped improve productivity, act as a source of information and aided in payment models are captured unlike previous studies.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

The chapter defined the proposed research method to be used in conducting the study. This included the research design, target population, sampling design and procedures, data collection and techniques for analysing data.

3.2 Research Design

A research design is a blueprint for conducting a study with maximum control over factors that may interfere with the validity of the findings (Burns and Grove, 2003). This research used the descriptive research design which involved acquiring information about one or more groups of people about their characteristics, opinions, attitudes and previous as well as current experiences. This design was concerned with finding out who, what, when, which, where and how of a phenomenon (Cooper, R. and Schindler, S. 2008).

3.3 Population of the Study

The population of importance for the study comprised of Kenyan adult males and females engaging in smallholder dairy farming within Limuru Sub-County. A target population is described as a complete set of individual cases with some common characteristics to which researchers want to generalize the results of the study (Mugenda and Mugenda, 2003). The Sub-County is composed of 5 county assembly wards and population as follows; Bibirioni, Limuru Central, Limuru East, Ndeiya and Ngecha Tigoni with a total population of 131,132 (Kenya National Census, 2009). The sub-county was the area of interest due to the concentration of dairy farmers. The area also has active co-operative societies and milk processors who provided additional information to assist data availed by the respondents.

3.4 Sample Design

The sample was identified using a stratified random sampling method. However to identify and capture the individual farmers or households, sampling was done in two phases. The first was proportional, that is according to the number of farmers in a given cluster or stratum, then random sampling was undertaken within that stratum. Survey strata was dependent on the administrative boundaries of the sub-county. These identified the random sample of farmer households.

A sample of 125 was proposed for this study, divided according to the number of farmer households proportionate to the population in each of the 5 county wards. Rosco (1975) proposes a rule of thumb for determining a sample size and posits that a sample size of 30 - 500 is appropriate for most academic researches. Within these limits (30 to 500), the use of a sample about 10% size of parent population is recommended. The primary tool for collecting data was the questionnaire. The respondents were selected through sample sizes weighted by household estimates extrapolated from the 2009 census figures. Households were selected using to a random sampling procedure using transects between randomly selected landmarks in each sample community (Staal & Baltenweck, 2002). The Table below represents the Sample Representation in the 5 assembly wards in the Sub-County;

NAME OF ASSEMBLY WARD	**POPULATION (Kenya National Population Census, 2009)**	**% of Total Population**	**Sample**
Bibirioni	21,202	16%	20
Limuru Central	31,211	24%	30
Ndeiya	26,387	20%	25
Limuru East	28,348	22%	27
Ngecha Tigoni	23,984	18%	23
TOTAL	**131,132**	**100%**	**125**

Table 1: Population of Limuru Sub-County (Kenya Census, 2009) and Proposed Sample

3.5 Data Collection

The farmer household respondents were accessed in the farms within the divisions or constituencies (strata) through household questionnaire administration (see appendix 2). The primary data was collected using structured questionnaires, administered to the respondents per stratum comprising of Kenyan male and female adults who were accessed in their farms and through their respective co-operative societies and milk processors. Administration of questionnaires was through both drop and pick method as well as one-on-one interviews.

The questionnaire was divided into four sections; with section I consisting of general information about the respondents, section II, III and IV consisting of questions relating to the dairy farming, mobile technologies and their applicability and attitudes and behaviour towards the technologies in dairy farming and related services.

3.6 Data Analysis

Data collected was analysed using both descriptive and inferential indicators. Descriptive indicators included frequencies, percentages, means and standard deviation. They were used to describe the socio-economic characteristics of smallholder farmers. Descriptive statistics enable meaningful description of a distribution of scores or measurements using a few indices or statistics. Measures of central tendency yield the expected score or measure from a group of scores in a study (Mugenda and Mugenda, 2003). Tables and figures were used to illustrate trends especially performance indicators such as the size of the herd or number of animals, milk production and income levels.

It provided profiles of the dairy farmers on ownership or access to mobile phones and related services, frequency of use of the phones and mobile services, rating of usefulness of these services, supplementary services such as mobile money and insurance among others. Borg (1996) proposes that a descriptive research design is a logical and valuable way of looking at the world. Measures of variability, such as standard deviation, inform the analyst about the distribution. Frequency distribution showed a record of the number of times a score or record of the number appears. The analysis tool explained the variables, codes and the data items. The SPSS program was used to analyse the data and output presented in form of tables, pie charts and bar graphs as well as analyse the factors that are seen to affect the adoption of mobile phone technologies.

3.7 Summary

The area of study offered a glimpse of the dairy farming industry. It also offered a good spread of usage of mobile phone technologies. The area has fair penetration of mobile network. The sample picked was representative of the population. The data collection tool was tested and adapted to the study. The data was adequate enough for analysis and reporting.

CHAPTER FOUR: DATA ANALYSIS

4.1 Introduction

Data analysis was guided by the research objectives presented in chapter one. The report contains tables directly related to the research objectives which were primarily on the existence, adoption and flow of mobile technologies in the dairy industry. SPSS was also instrumental in the analysis especially in attempting to find the correlation between demographics and variables of study.

4.1.1 Response Rate

The reverted questionnaires were cleaned, edited and coded. Out of the 125 questionnaires distributed 2 were not returned; 3 were incomplete allowing for 5 new interviews in the respective areas thus leading to a response rate of 100% good enough to facilitate data analysis. The success rate in questionnaire response was aided by explaining to participants the importance of the study and assuring them of confidentiality and benefit of the findings. The researcher deemed the response rate adequate and sufficient for the study and for the purpose of data analysis.

4.2 General Farmer Information

The information collected from the questionnaires consisted of demographic characteristics of respondents, financial status and mobile phone technologies adoptability.

4.2.1 Sample Demographics

The demographic characteristics of respondents are discussed and analysed in details as marital status, age in years, gender, respondent’s occupation, household expenditure and highest level of education.

Table 4.1 Marital Status of the Respondents

Marital Status	Frequency	Percent
Married	76	60%
Single	47	38%
Divorced	1	1%
Widowed	1	1%
Total	**125**	**100%**

Table 2: Marital Status

Source: Author (2015)

Majority of those sampled were married 72 with a percentage of 60% followed by the single ones at 51 respondents contributing 38% while only 1 person each was divorced and widowed at an approximate percentage of 1% respectively.

Table 4.2 Age of the Respondents

Age (in Years)	Frequency	Percent
19-29	74	59%
30-39	24	19%
40-49	14	11.5%
50-59	9	10.5%
Total	**125**	**100%**

Table 3: Age Bracket

Source: Author (2015)

A fair majority of the respondents interviewed, 59% were in the age bracket of 19 - 29 years followed by those in the age bracket of 30 - 39 years at 19% then 40 -49 years at 11.5% with the final 10.5% aged between 50-59 years. The analysis shows that most of the respondents were single giving an indication of the youthful population in the county.

Table 4.3 Gender

Gender	Frequency	Percent
Male	94	75%
Female	31	25%
Total	**125**	**100%**

Table 4: Gender Source: Author (2015)

75% of the respondents were male and 25% of the respondents were female, implying that there were more males in the study area.

Table 4.4 Employment Status

Employment Status	Frequency	Percent
Full-time	39	31.2%
Business	27	21.6%
Student	23	18.4%
Part-time	20	16%
Retired/Unemployed	15	12%
Government	1	0.8%
Total	**125**	**100%**

Table 5: Employment Status

Source: Author (2015)

31.2% of the respondents were employed full-time, while 21.6% were in business. Students comprised of 18.4% of the sample while part-timers were 16% and those retired or unemployed were 12%. Government employees was at 0.8%.

Table 4.5 Household Monthly Income

Household Income per Month (in	Frequency	Percentage
Below 15,000	75	60%
15,001 - 50,000	32	26%
50,001 – 85,000	12	9.6%
85,001 – 120,000	5	4%
More than 120,000	1	0.4%
Total	**125**	**100%**

Table 6: Household's Head Income

Source: Author (2015)

A fair proportion of the respondents at 60% indicated that they earn a monthly income of below KES 15000 followed by those between KES 15001 and 50000 at 26%. Those earning between KES 50001 and 85000 were at 9.6% of the respondents. 4% of the respondents were said to earn between KES 85001 and 120000. Only 0.4% or 1 respondent of the total sample earned more than KES 120,000.

Table 4.6 Level of Education

Education attainment	Frequency	Percentage
College/University	91	72.8%
Secondary	23	18.4%
Primary	6	4.8%
Post-graduate	4	3.2%
Self-taught	1	0.8%
Total	**125**	**100%**

Table 7: Level of Education

Source: Author (2015)

From the sample, 72.8% of the respondents have attended college or university; 18.4% secondary; 4.8% primary school while 3.2% have attained post-graduate qualifications and only 0.8% were self-taught.

Table 4.7 General Farmer Information per Assembly Ward

The demographic characteristics of respondents were discussed and analyzed in terms of marital status, age in years, gender, respondent's occupation, household income and highest level of education then cross tabulated with respect to the five assembly wards used for the study.

Limuru County: Summary of Assembly Wards and their Percentages						
		Limuru Central	**Limuru East**	**Ndeiya**	**Ngecha Tigoni**	**Bibirioni**
Marital Status	Married	57%	48%	72%	74%	35%
	Single	40%	48%	28%	26%	65%
	Divorced	-	4%	-	-	-
	Widowed	3%	-	-	-	-
Age	19-29 yrs	63%	67%	40%	43%	80%
	30-39 yrs	30%	26%	36%	35%	20%
	40-49 yrs	7%	4%	8%	4%	-
	50-59 yrs	-	4%	16%	17%	-
Gender	Male	80%	48%	48%	48%	65%
	Female	20%	52%	52%	52%	35%

Occupation	Full-time	37%	30%	32%	30%	25%
	Business	23%	19%	24%	22%	20%
	Student	17%	19%	12%	26%	35%
	Part-time	20%	7%	16%	13%	10%
	Retired/Unemployed	3%	22%	16%	9%	10%
	Government	-	4%	-	-	-
Household Income per Month	Below KES 15000	60%	56%	60%	57%	65%
	KES.15001-50000	30%	37%	16%	13%	35%
	KES.50001-85000	10%	4%	16%	22%	-
	KES.85001-12000	-	-	8%	9%	-
	Over KES.120000	-	4%	-	-	-
Education	College/University	67%	78%	68%	78%	75%
	Secondary	23%	19%	24%	5%	5%
	Primary	10%	-	4%	17%	10%
	Post-Graduate	-	-	4%	-	10%
	Self-taught	-	4%	-	-	-

Table 8: Summary of Assembly Wards

Ngecha Tigoni and Ndeiya had the highest population 74% and 72% respectively of those married and the rest 26% and 28% being single in the two sub-counties; this was followed by Limuru Central 57% and Limuru East at 48% while Bibirioni had 65% singles. On age groups the most predominant age group across all sub-counties was 19 - 29 years with Bibirioni having the highest 80% hence clarifying the reason for high percentage of those who were single. Limuru Central and Bibirioni had the highest percentage of male respondents at 80% and 65% respectively. Limuru East, Ndeiya and Ngecha Tigoni had 52% each of their respondents being female. 37% of the respondents in Limuru Central were in full employment while 32% in Ndeiya were fully employed, 30% of those in Limuru East too. 65% of households in Bibirioni earn than KShs. 15,000 in a month while 60% in Limuru Central and Ndeiya also earn below KShs.15000 in a month. The highest level of education for majority of the respondents was a college certificate or university degree showing high levels of literacy in the constituencies particularly in Limuru East and Ngecha Tigoni where 78% were college certificate or university degree holders followed by Bibirioni 75%, with Ndeiya and Limuru Central having respectively 68% and 67% of their respondents respectively graduating from a college or university.

4.3 Dairy Farming – Ownership, Milk Production, Commercial Activities and Related Activities

This information was collected to confirm the ownership of dairy animals, types of dairy animals, length of time farmer has been in dairy farming and what type of dairy farming they practice. The information will also show amount of milk produced, where milk produced is sold and earnings from the same.

Table 4.8: Animal Ownership

Number of Animals	Frequency	Percentage
Between 1- 5 animals	93	74.4%
6 -10 animals	23	18.4%
11 -15 animals	3	2.4%
16-20 animals	-	-
More than 20 animals	6	4.8%
Total	**125**	**100%**

Table 9: Animal Ownership

From the data collected, the highest number of respondents kept between 1 to 5 animals at 74.4%, 18.4% of the respondents kept between 6-10 animals while 4.8% have more than 20 animals and 2.4% have 11 to 15 animals.

Table 4.9 Types of Dairy Animals

Type of Animal	Frequency	Percentage
Cows	111	88.8%
Goats	9	7.2%
Others	3	2.4%
Sheep	2	1.6%

Table 10: Type of Dairy Animal

A large majority of the respondents' rear cows for dairy farming at 88.8%, while 7.2% kept goats, 1.6 reared sheep while 2.4% kept other animals.

Figure: Number of Years Engaged in Dairy Farming

Figure 2: Number of years in Dairy Farming

Majority of the respondents interviewed indicated engaging in dairy farming for between 3 to 6 years at 54.4%, with another 30.4% having started dairy farming less than 3 years ago. 7.2% have done dairy farming for between 6 to 9 years.

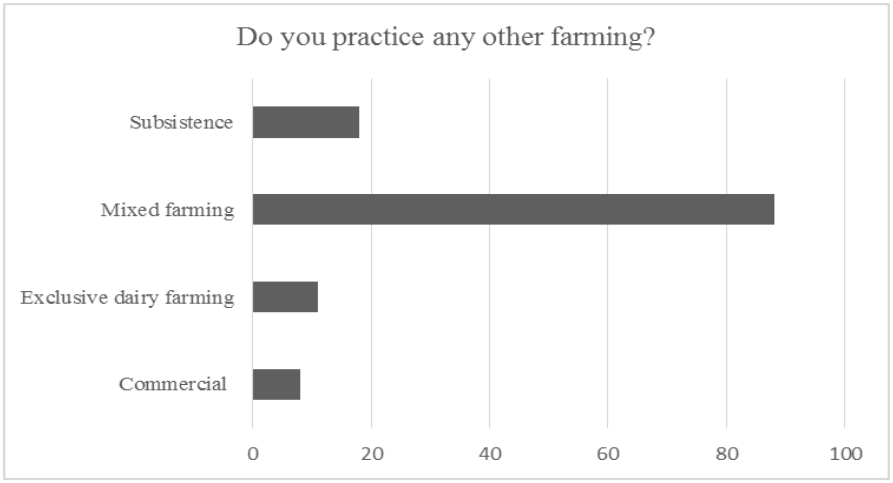
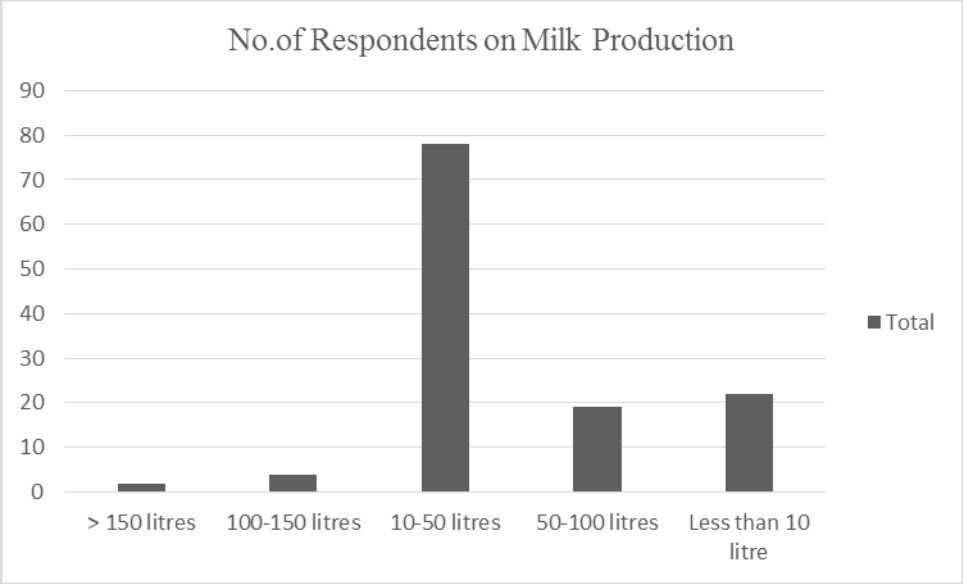


Figure 3: Farming practises including Dairy Farming

From the figure and data collected, 70.4% of the respondents indicated engaging in mixed farming, 14.4% are in subsistence farming while 8.8% exclusively keep dairy animals with the remaining 6.4% being in commercial farming.

Figure: Total Milk Production of all Dairy Animals



From the data collected, 62.4% of the respondents indicated producing a total of 10 to 50 litres per day. 17.6% produce less than 10 litres, with 15.2% producing 50 to 100 litres of milk per day from their farms.

4.5 Mobile Phone Technologies – Attitudinal and Behavioral Measurement

4.5.1 Mobile Phone Technologies Adoptability

The data collected from the respondents indicated all of them owned a mobile phone of one kind. 54.4% of the respondents owned a smartphone with 45.6% owning a feature phone. However only 72.8% of the respondents use the mobile phone or related applications for dairy farming and related activities such as veterinary services, payments and dairy farming education. 57.6% of the respondents indicated using a mobile phone or application in the last 12 months.

Table 5.0 Mobile Phone Applications Usage

Mobile Phone Application	Frequency	Percentage
Kilimo Salama	35	41%
i-Cow	30	35%
SMSSokotext	14	16%
m-Farm	6	7%
TOTAL	**85**	**100%**

Table 11: Mobile Phone Applications

From table 5.0 above, 84 respondents had used a mobile phone application of one kind or another. 41% of the respondents using mobile phone applications had used Kilimo Salama, 35% used i-Cow, 16% used SMSSokotext meaning only 7% used m-Farm for their dairy farming practices.

4.5.2 Mobile Phone Technologies Attitudes and Behaviour

The study also sought to gauge the respondents' attitudes towards mobile phone technologies which includes feelings towards their current uses and future adoption. The study used semantic differential scale and Likert scale to establish the attitudes and behaviours of different attributes regarding mobile phone technology. From the responses a majority of the respondents indicated that they had positive feelings by the number of percentages based on the specific questions asked.

Using Factor Analysis, the findings of the study were as follows;

Table 5.1: Factor Analysis of Mobile Phone Technology Adoption Components

	Factor/Component	Description
1.	**Necessity:**	The mobile phone is important in my dairy farming
2.	**Innovations:**	The mobile phone has changed the way I practice dairy farming
3.	**Information:**	Mobile phone technologies provide relevant information relating to dairy farming
4.	**Productivity:**	Mobile phone technologies have helped me increase the produce from the dairy animals
5.	**Savings:**	Mobile phone technologies have helped save costs of dairy farming operations
6.	**Affordability:**	Mobile phone technologies are expensive to use
7.	**Penetration:**	I intend to use a mobile phone technology in the next 6 months
8.	**Reliability:**	I will always use a mobile phone technology
9.	**Relevance:**	Using mobile phone technologies makes no difference in my dairy farming

Table 12: Factor Analysis of Adoption Components

Using answers given by the respondents on the Likert scale component of the questionnaire, a factor analysis was undertaken and is postulated in two tables starting with the table above. The study revealed that four of the nine factors had an over 50% explanatory power in the respondents' decision to adopt mobile phone technologies. These four factors were namely innovations, reliability, penetration and relevance, were the dominant reasons given for the decision to acquire mobile phone technologies, as shown in table 5.2 below. To a large extent, the adoption of mobile phone technologies by the dairy farmers in Limuru was driven by the innovations made in mobile phone technologies which changed the way they practice their dairy farming for the better. The farmers were also of the view that mobile phone technologies were reliable and as such they would continue to use and adopt them in the foreseeable future. This would ensure penetration of these technologies in the dairy farming sector.

Table 5.2: Total Variance of Components Explained

Total Variance Explained

Factor/ Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
Innovations	3.972	44.131	44.131	1.265	14.054	14.054
Reliability	1.169	12.989	57.121	1.131	12.570	26.625
Penetration	.985	10.944	68.065	1.062	11.795	38.420
Relevance	.829	9.212	77.277	1.058	11.761	50.180
Information	.645	7.163	84.440	1.045	11.608	61.788
Affordability	.504	5.604	90.044	1.039	11.545	73.333
Necessity	.484	5.380	95.424	1.022	11.360	84.692
Productivity	.262	2.912	98.335	1.019	11.325	96.017
Savings	.150	1.665	100.000	.358	3.983	100.000

Extraction Method: Principal Component Analysis.

Table 13: Component Analysis

However there was also a sizeable number of respondents who were of the view that the use of mobile phone technologies did not make much different in their dairy farming. This is evidenced in the fact that 74% of the respondents were engaged in mixed farming thus giving the likelihood that they adopted mobile phone technologies to a greater extent for the crop husbandry as opposed to animal husbandry.

4.6 Summary and Discussion of Findings

The findings indicated those sampled were largely male at 75% and were married (60%) showing they have households and dependents. Their age bracket was between 19-29 years at 59% showing that they are fairly youthful with a monthly income of below KSh. 15000 signifying little or no disposable income. From the sample findings it does indicate that the respondents have mobile phones whether they are basic feature phones or smartphones which are slightly more expensive and adaptable to mobile phone applications. The outcomes also point to the use of mobile phone technologies in improving their farming – be it dairy farming or mixed farming as respondents indicated they do. A larger percentage of those respondents using mobile phone applications were using them for animal health services and information on improving the animals they own. It is still yet to be seen what impact mobile phone technologies have in the

marketing and more commercial aspects of dairy farming. From the study, the adoption of mobile phone technologies by the dairy farmers in Limuru was driven by the innovations made in mobile phone technologies as indicated by the factor analysis variance of 44%. Reliability was also a major factor in adoption of the technologies due to the ease of relaying and obtaining information by mobile phone. Penetration is the third main factor indicating the mobile telephony penetration across the county.

CHAPTER FIVE

SUMMARY AND CONCLUSIONS

5.1 Introduction

This chapter summarizes the major findings of the study, conclusions, limitations of the study and recommendations for further research. The overall objective of the study was to determine existence, adoption and flow of mobile phone technologies in the dairy industry. Specific objectives were to establish the proportion of farmers engaging in dairy farming who have adopted mobile phone technologies, investigate the factors that affect the adoption of these technologies as well as determine the constraint and challenges facing dairy farmers in adopting the mobile phone technologies.

5.2 Summary of Findings

The study findings do establish and indicate the existence of mobile phone technologies in the dairy farming industry. These technologies range from animal health services, to general dairy farming information as well as those that help marketing and selling of dairy products. The respondents did also indicate using the mobile phone for basic services such as calling veterinary and extensions service officers. They also use mobile money services from their respective mobile network providers to be able to facilitate their farming operations. The findings noted that 75% of all respondents were male. The data also indicated that 60% of the respondents were married showing the role of farming in most households. Indicative from the findings was the fact that 72.8% of the respondents had education level of college or university level. Over 85% of the respondents indicated engaging in dairy farming of cows with the other 15% keeping goats and sheep. This is due to the amount of milk produced which was recorded at mainly between 5-20 litres per animal per day at 58.4%.

The study was able to determine the factors that affect mobile phone technologies adoption with innovations being the most important influence. Answering to the statement, ‘The mobile phone has changed the way I practice dairy farming’, 83% of the respondents agreed that the technologies will have an impact in their dairy farming. Other

factors seen determining the adoption include reliability, penetration, relevance and information. 81.6% of the respondents either agreed or strongly agreed that mobile phone technologies provide relevant information relating to dairy farming. It is also noted that 100% of the respondents from the sample had mobile phones of one or another type. Some of the constraints for adopting mobile phones were identified as income levels meaning less of disposable income to buy innovative mobile phone handsets. This is evidenced from the income levels of the respondents with 60% of them indicating an income of less than KSh. 15000 per month. The type of phone as well as the lack of extension and dairy information platforms offered by the mobile network providers. While some mobile networks have a mobile technology of one or the other type, others do not have any mobile application or information portal for farmers. Interestingly 58.8% of the respondents reported owning a smartphone showing that there is an opportunity for those willing to develop mobile applications and appeal to such farmers. This can be corroborated by the data which indicates that 59% of all respondents were between the ages of 19 -29 years.

The study indicated that dairy farmers would look to adopt mobile phone technologies to look at animal health, payment schemes as well as milk sales and general information. This is shown from the data where 30% each of the respondents answered in the affirmative of intending to use mobile phone technologies for both animal health and payment systems. The data showed that respondents would like mobile applications developed for animal health (28.8%), general dairy farming information (24%) as well as milk production improvement practices (24%) respectively. The findings also saw that 68% of the respondents are using one form of mobile application such as Kilimo Salama, i-Cow, SMSSokotext or m-Farm to get information or improve their agricultural practice.

5.3 Conclusions

The study concludes that the adoption of mobile phone technologies in Limuru Sub-county is influenced by the innovation around the technologies, their reliability, penetration, relevance and information offered. Other factors shown to influence this adoption include; affordability, necessity, productivity and savings. The findings also show that there is a significant level of usage of mobile phone applications such as Kilimo Salama, i-Cow, SMSSokotext as well as m-Farm to source for information on dairy farming as well as on general agricultural practices. The study also found a high

penetration of mobile telephony within the county showing that there is a huge potential for mobile phone technologies currently in use or intended to be developed in future.

5.4 Recommendations for Policy, Theory and Practice

The researcher recommends that innovators and technology enthusiasts still have a largely untapped market in mobile phone technology development. From mobile applications that maybe embedded in the operating systems of mobile phones to services that maybe prescribed using short text codes or USSDs. From the study it is indicative that a large number of farmers do intend to use these technologies once availed and customized to suit their farming needs. These needs include animal health, milk production and milk sales, insurance, marketing and selling as well as general dairy farming information. With regards to factors influencing the adoption of mobile phone technologies, it can be noted that how innovative a technology is remains as the most important consideration by farmers in adopting them. The other major factors include reliability given that most farmers would prefer a reliable technology, penetration or how widespread it is in its location, relevance and information. It is important to note that there are mobile phone technologies already in existence but there seems to be a void that these technologies have not filled for Limuru Sub-County farmers.

It is important to note too to mobile phone technology firms which either develop hardware (the handsets and related gadgets) as well as mobile network providers that they can partner with innovative developers of mobile technologies who can leverage on their brand names or network coverage to be able to provide additional information on the same. This is the case with i-Cow which leveraged its relationship with one of the mobile network providers to be able to appeal to a larger number of farmers in the sub-county and across the country too. Milk processing firms should capitalize and incorporate some of these mobile technologies which farmers can learn or adopt through their networks. These can be from the extension services offered – veterinary and vaccines; milk collection and delivery; milk processing and marketing and finally selling of the final processed products. Milk processors such as Brookside Milk, Kenya Co-operative Creameries as well as Githunguri Dairies each operate within the area of study and have some amount of influence in the way farmers adopt and use different products and services. Savings and Credit Co-operative Societies would also be used to facilitate the adoption of mobile technologies through innovative financial products and tools such as

animal health insurance services and payment services to the dairy farmers. The Dairy Board of Kenya had proposed the development of eDairy (2010), an innovative application in ICT proposed to help achieve self-sufficiency in national milk production. This was meant to minimize cost and time while improving on efficiency. This innovation would have both the web and mobile technology using online and SMS services to lure young and seasoned dairy farmers in using the application. Development and deployment of such an innovation to sub-counties such as Limuru would realize the quick adoption of mobile technologies.

5.5 Recommendations for Further Study

Certain that a large majority of respondents in Limuru Sub-county do show the adoptability of mobile phone technologies, it is recommended that use of these technologies be widely spread across the wards in the sub-county. The adoption could be largely driven by innovation, reliable services and applications, resourceful and helpful sources of up-to-date information. Also given that initially the study was limited to dairy and animal husbandry, there is an indication that farmers in food and cash crop farming are using mobile applications for improving their produce and selling practices. Additional studies can be done to establish factors that are aiding in use of mobile phone technologies in crop farming more than is the case in dairy farming. Comparative studies on the adoption of mobile phone technologies in animal husbandry and crop farming can be done to determine which one has a higher adoption rate than the other and why.

5.6 Limitations of the Study

One major limitation of the study was accessing the right person to respond to the questionnaire. This was due to the fact that most of them were either employed full-time or part-time and are not exclusively dairy farmers. Still on the respondents, a number of them did not have proper records such as the amount of milk produced or sold which would be used to verify the changes in milk productivity from the time they started using mobile phone technologies to the current state. The researcher had also intended to carry out a mobile survey to validate the data given from the questionnaire but this proved futile due to time constraints and the size of sample intended for the study from each of the wards.

REFERENCES:

Adongo, M.J (2013), The Role played by Mobile Phone Communication in Diffusion of Dairy Goats Rearing in Kitui County, Kenya. University of Nairobi

Ajzen, I. and Fishbein, M. (1980), Understanding Attitudes and Predicting Social Behaviour. Englewood Cliffs, NJ: Prentice Hall

Ajzen, I. (1985), From Intentions to Actions: A Theory of Planned Behaviour. In J.Kuhl and J. Beckmann (Eds), Action Control: From Cognition to Behaviour. New York; Springer-Verlag.

Aker C. Jenny. (2010), Dial "A" for Agriculture: Using Information and Communication Technologies for Agricultural Extension in Developing Countries. Tufts University

Aker, J. (2010). Information from markets near and far: Mobile phones and agricultural markets in Niger. *American Economic Journal*: Applied Economics, 2, 46-59

Aker, J. and Mbiti, I. (2010). Mobile phones and economic development in Africa. *Journal of Economic Perspectives*. 24(3): 207-32

Angaza Mkulima: Customer relationship management and agricultural information. Farmchem Kenya, 2012. http://www.angazamkulima.com

American Marketing Association. Resource library, Electronic document Retrieved from https://www.ama.org/publications/MarketingNews/Pages/your-mobile-moments-are-shrinking.aspx

Bhattacherjee. A (2001). Understanding Information Systems Continuance: an Expectation-Confirmation Model. *MIS Quarterly 25(3), 351-370*

Bhattacherjee. A and Premkumar, G (2004). Understanding Changes in Belief and Attitude toward Information Technology Usage: A Theoretical Model and Longitudinal Test. *MIS Quarterly 28* (2*), 229-254*

Bolarinwa, K.K., and Oyeyinka, R.A (2011). Use of Cell Phone by Farmers and its Implication on Farmers "Production Capacity in Oyo State, Nigeria"

Boyd, Jr. H. Westfall, R. and Stasch, S. (2004), Marketing Research. 7th Ed. Richard D. Irwin Inc

Cooper, R.D. and Schindler, S.P (2008) Business Research Methods, McGraw-Hill

Communications Authority. Quarterly Sector Statistics Report, Q4 2013/14, April-June 2014

Crandall, A. Kenyan Farmers' Usage of Cell Phones: Calling preferred over SMS, published on i-Hub Research website: http://www.research.ihub.co.ke/pages/resources.php

Crossbow Technology (2004). Smart Dust/Mote Training. Paper presented at Crossbow Technology Seminar, San Francisco, California

Davis, F.D., R.P. Bagozzi, and P.R., Warshaw, "User Acceptance of Computer Technology: A Comparison of Two Theoretical Models," *Management Science, 35, 8 (1989), 982-1003*

Donner, J. (2008). Research approaches to mobile use in the Developing World: a Review of the Literature. *The Information Society 24 (3), 140-159.*

Feder, G. and Slade, R. (1984). The Acquisition of Information and the Adoption of New Technology, *American Journal of Agricultural Economics, 66 (3), pg. 312-320*

Ghandi, S., Mittal, S. & Tripathi, G. 2009. "The Impact of Mobiles on Agricultural Productivity." Paper prepared for Vodaphone, Indian Council for Research on International Economic Relations (ICRIER), New Delhi

Gichamba, A. and Lukandu, I. A (2012). A Model for Designing m-Agriculture Applications for Dairy Farming. *The African Journal of Information Systems Vol 4, Issue 4*

Granot Y, Ivorra A, Rubinsky B. (2008). A New Concept for Medical Imaging Centred on Cellular Phone Technology. PLoS ONE 3(4): e2075. doi:10.1371/journal.pone.0002075

GSMA, mAgri Airtel Kilimo Programme (2015)

GSMA, The Airtel Kilimo Case Study (2014)

Hellstrom, J. (2009). Mobile phones and good governance – challenges and the way forward. Stockholm University

Islam, Sirajul. M and Gronlund, A (2011). Factors influencing the Adoption of Mobile Phones among the Farmers in Bangladesh: Theories and Practices. *International Journal on Advances in ICT for Emerging Regions, pg 4-14*

ICT in Agriculture- Connecting Smallholders to Knowledge, Networks and Institutions, World Bank e-Sourcebook, Report 64605, (2011)

Kenya Census Report (2009)

Kenya National Dairy Masterplan – Volume 1 – A Situational Analysis of the Dairy Sub-Sector, Ministry of Livestock Development, (2010)

Kibera, F., and Waruinge, B.C. (1998), Fundamentals of Marketing: An African Perspective, Kenya Literature Bureau, Nairobi

"Kilimo Salama becomes ACRE, retrieved from http://www.syngentafoundation.org/index.cfm?pageID=562 on 2nd October, 2014

Kothari, C.R. (2004), Research Methodology. New Age International. New Delhi. India

Kotler, P. (2003), Marketing Management**.** 11th ed. Prentice Hall India

Kotler, P., and Kevin, L.K (2009), Marketing Management. 13 Ed. Pearson International Limited

Lee, W.; Burks, T and Schueller, J (2002). Silage yield monitoring system. *The American Society of Agriculture Engineers*, St. Joseph, Michigan

Levine, Ross (2005), "Finance and Growth: Theory and Evidence" in *Handbook of Economic Growth*, Eds: Philippe Aghion and Steve Durlauf, The Netherlands Elsvier Science, 2005

Moore, G. A. (1999). Crossing the chasm: Marketing and selling high-tech products to mainstream customers. New York: Harper Business.

Morawczynski, Olga and Mark Pickens. 2009. "Poor People Using Mobile Financial Services: Observations on Customer Usage and Impact from M-PESA" CGAP Brief Onlinehttp://www.cgap.org/gm/document-1.9.36723/BR_Poor_People_Using_Mobile_Financial_Services.pdf

Mugenda, O.M., and Mugenda, A.G., (2003), Readings in Research Methods: Quantitative and Qualitative Approaches. *African Centre for Technology Studies*

Mulford, Michael, R (2013). Smallholder Market Participation and Welfare Effects: Evidence from the Kenya Dairy Sector. *Cornell University*

Mureithi, Muriuki. 2004. "Kenya Telecommunications Sector Performance Review: 1999-2003" Research ICT Africa Report.

Muto, M. and Yamano, T. 2009. "The Impact of Mobile Phone Coverage Expansion on Market Participation: Panel Data Evidence from Uganda" World Development

Oliver, R.L (1980). A Cognitive Model of the Antecedents and Consequences of Satisfaction Decisions. *Journal of Marketing Research; 460-469*

Onkvisit, S.S. (2004), International Marketing, Analysis and Strategy. 4th Ed. Routledge, New York

Rogers, E. M. (1995). Diffusion of innovations. New York: The Free Press. (Original publication 1962)

Roscoe, J.T. (1975), Fundamentals Research Statistics for Behavioural Sciences. “What Sample Size is ‘Enough’ in Internet Survey Research”? *Interpersonal Computing and Technology: An electronic Journal for the 21st Century*

Schiffman G. Leon, Kanuk Lazar Leslie and Wisenblit Joseph (2010), Consumer Behavior. 10th Ed. Pearson Prentice Hall

Schindler, P.S. and Cooper, D.R. (2006), Business Research Methods, 9th Ed. Mc Graw Hill

Simelone, N (2011). An Assessment of the Role of Cooperatives in Smallholder Dairy Production and Marketing in Swaziland. *University of Pretoria*

Statistical Abstract (2014), Kenya National Bureau of Statistics

Statistical Abstract (2013), Kenya National Bureau of Statistics

Sunding, D. & Zilberman, D., 2001. The agricultural innovation process: Research and technology adoption in a changing agricultural sector. In B. L. Gardner & G. C. Rausser, eds. Handbook of Agricultural Economics. Oxford: Elsevier, pp. 207–261

The Policy Paper Series No.9, (2009). India: The Impact of Mobile Phones

Thorpe, W., H. G. Muriuki, A. Omore, M. O. Owango and S. Staal (2000). Development of small-holder dairying in Eastern Africa with particular reference to Kenya. A Paper prepared for the UZ/RVAU/DIAS/DANIDA-ENRECA Project Review Workshop, Harare, Zimbabwe.

Venkatesh, V., M.G. Morris, G.B. Davis and F.D. Davis, "User Acceptance of Information Technology: Toward a Unified View," *MIS Quarterly, 27, 3 (2003), 425-478*

Vivoni, E.R. and Camilli, R. (2003). Real-time streaming of Environmental Field Data, *Comput. Geosci 29, 457-468*

Webb, T. (2010). 3 Reasons why Mobile technology is helping farmers in Kenya. Retrieved September 18, 2014 from http://2010globalmarketing.wordpress.com/2010/07/23/3-reasons-why-mobile-technology-is-helping-farmers-in-kenya/

Zhou, T (2011). An Empirical Examination of Users’ Post-Adoption Behaviour of Mobile Services. Behaviour and Information Technology, 30 (2), 241-250

APPENDIX 1: LETTER OF INTRODUCTION

LETTER OF INTRODUCTION

University of Nairobi
School of Business
P.O Box 30197 - 00100
June 2015

Dear Respondent,

REF: REQUEST FOR RESEARCH ASSISTANCE IN DATA COLLECTION

Currently I am a postgraduate student at the University of Nairobi and as part of my academic work; I am required to undertake and submit a research project related to my field of study as part of fulfilment of the requirements for the post-graduate programme, M.Sc.-Marketing Research.

It's my humble request to fill the questions in the accompanying questionnaire to generate data required for this study. Information obtained will be used purely for academic purpose and will be held in strict confidence. Upon request, you will be provided with a copy of the final report for perusal. Your assistance and cooperation will be highly appreciated.

Yours Faithfully,

Richard Wanjohi

Post-Graduate Research Student

University of Nairobi

APPENDIX 2: SAMPLE QUESTIONNAIRE