INFLUENCE OF DIGITAL COMMUNICATION PLATFORMS ON UPTAKE OF FINANCIAL SERVICES AND DAIRY PRODUCTION TECHNOLOGIES IN UASIN GISHU, KENYA

BY

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DECLARATION AND APPROVAL

This thesis is my original work and has not been submitted for award of a degree in any other University.

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DEDICATION

This thesis is dedicated to my loving mother Mrs. Lucy Naimasia for her big dreams and ambitions for me and my siblings, my son Jason Lemashon for always cheering me up when the going got tough, my lovely wife Mrs. Diana Naimasia for being the best friend in the whole world and to God who granted me the strength and well-being during this study.

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LIST OF ABBREVIATIONS AND ACRONYMS

ACCI	African Center for Competitive Intelligence
ASCU	Agricultural Sector Coordination Unit
CCK	Communications Commission of Kenya
CRM	Customer Relationship Management
DVD	Digital Video Disk
FAO	Food and Agriculture Organization
FFD	Farmer Field Days
FFS	Farmer Field Schools
FHH	Female Headed Households
FSP	Financial Service Providers
GDP	Gross Domestic Product
GOK	Government of Kenya
IFC	International Finance Corporation
JICA	Japan International Cooperation Agency
MHH	Male Headed Households
MOALF	Ministry of Agriculture, Livestock and Fisheries
NGO	Non-Government Organization
SMS	Short Message Service
TAM	Technology Acceptance Model
TV	Television
USA	United States of America
WFP	World Food Program

ABSTRACT

Dairy farming in Kenya was introduced in mid-1950's during the colonial era. Today the sector accounts for 14% of the Agricultural Gross Domestic Product and is dominated by smallholders who are characterized by subsistence production on small farms of about 0.5 to 2 ha and low levels of application of technology. With increasing pressure on productive agricultural land from human settlement and industrialization, growth in the dairy sector is expected to come from application of new technologies. Research has shown that productivity in smallholder farms can be significantly increased through adoption of better feeding and breeding technologies however, only 20% of the smallholder farmers use these technologies a situation attributed to many factors including inadequate extensions services and low capital levels due to limited access to agricultural credit. The public extension system in Kenya's dairy sector is generally inefficient due to underfunding and limited staff capacity. Furthermore, financial service providers (FSP) only lend less than 5% of their loan book to the agricultural sector which limits ability of farmers to afford high upfront cost required for adoption of new technologies. The potential for application of digital technologies have been identified in the agricultural sector and special efforts to drive investment in digital technologies have been initiated to ensure the sector is running efficiently, markets are well supplied, and consumers are able to access affordable and nutritious food.

This study therefore sought to evaluate how digital communication platforms can be utilized to influencing adoption of dairy production technologies and uptake of financial services in dairy farming. The study was conducted in three villages in Kapseret Sub-County of Uasin Gishu County, using two technologies i.e., mobile phone short message service (SMS) and video mediated learning (VML). 120 participants were randomly allocated into three groups of 40 farmers each and trained using VML for Group 1, SMS for Group 2 and a combination of VML and SMS in Group 3. In the results, the study found that 67% of the respondents depend on agriculture for their livelihoods while 50% kept livestock for milk production. Furthermore, 89% of farmers interviewed had access to mobile phones and 57% of had access to video viewing equipment. The study observed a general increase in adoption of dairy technologies from an average of 38% before the study to 53% after the study across all the study groups. The study found the highest uptake of financial services and dairy production technologies in the combined VML and SMS groups, with an adoption rate of 56% and 67% respectively. Further analysis revealed a strong association between farmer's socioeconomic factors like age (r=-0.560), gender

(r=-0.573), farming experience (r=-0.635), and education level (r=0.570) and utilization of digital platforms for accessing information on dairy production technologies and financial services.

The study concluded that digital communication platforms like videos and mobile telephone SMS are effective in stimulating uptake of important technologies and services while better results are seen when they are combined and used in a complementary manner. This study highlights the potential of modern ICT tools for agricultural extension and communication in the Kenyan dairy sector and recommends how they can be utilized by the Kenyan government and relevant stakeholders to improve the smallholder milk productivity.

CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

The importance of Agriculture in Africa cannot be underplayed as it contributes to the continent's evolving income, population wellbeing, and urbanization dynamics which is the reason why the Maputo Declaration on Agriculture and Food Security was endorsed by majority of the countries (CTA, 2016). The declaration sought to reduce Africa's dependents on food imports valued in excess of 35 billion dollars by dedicating at least 10 percent of public spending towards the agricultural sector (Africa Progress Panel, 2014). The sector in Kenya is attributed to growth in many areas of the economy, food security which in the end contributes to poverty reduction. The dairy sector which is estimated to form the single greatest contribution within the agricultural sector contributing 14 percent to the sector's Gross Domestic Product (GDP) and less than 4 percent of the total GDP for the country (Nassiuma & Nyoike, 2014). Projections by GoK & UNDP (2013) indicate that the economic growth brought about by agriculture is two times effective in the fight against poverty when compared to other sectors.

Commercial dairy farming was introduced in Kenya early in the twentieth century during Africa's settlement and colonization by Europeans and was only adopted by indigenous Kenyans in the mid-1950s driven by policy reforms in the Swynnerton Plan which aimed to intensify expansion of commercial agricultural production in order to create land holdings large enough to provide sufficient food, enable alternate husbandry and bring in cashflows for Africans (MOALF, 2017). Shortly after independence in 1963, dairy cattle which were owned by European settlers were taken over by the Government and introduced to Kenyans through co-operatives. However, beneficiaries had limited knowledge and ability to keep many dairy livestock introducing the need for extension service. Inefficient agricultural extension systems and low staff capacity led to subsistence production happening on small farms of between 1 and 7.5 acres which are characterized by limited application of productivity enhancing technologies (World Bank & CIAT, 2015). Smallholder farmers are estimated to be more than 1.8 million in Kenya while each is only able to keep between two and five dairy cows with an average yield of 5kgs per day (FAO, 2015). In Kenya, there are two generally recognized dairy cow feeding systems which are one zero-grazing, where dairy cows are enclosed in stalls and second is open grazing where dairy animals are allowed to roam free in pursuit of feed. The type of selection is motivated by the aspiration to

enhance optimal utilization of land which is a limited factor and the desire of maximizing on milk output (Mutavi, 2018).

The increasing pressure on available land from industrialization and human settlement is an indication that growth in performance of the agricultural sectors it will no longer be sustainable to rely on expanding land under production to increase farm productivity. This is therefore an indication that improved technologies can be important drivers for the current and future development in Kenya's dairy sector (ILRI, 2011). The last two decades has seen introduction of new technologies for fodder production and breeding these being important factors in the pursuit of productivity increase and make up a significant proportion of dairy production costs estimated at between 55 to 70 percent (Odero-Waitituh, 2017). Any increase in productivity in dairy farming is therefore depended on the availability of high quality feeds, the type of animal breed and production system (Kibiego, et al., 2015). However, FAO (2015) explains that less than 20 percent of smallholder dairy farmers practice improved practices in feeding and breeding and this proportion is expected to decline as a result of high production costs compared to milk prices offered by the market. This situation is attributed to many factors including inadequate extension services and low capital levels due to the rising livestock keeping costs relative to prices paid by the market and limited access to financial services. Making extension and financial services accessible, are some of the recommended interventions to shift the subsistence production method to commercial dairy production along with smallholder farmers joining groups and co-operatives leading to more farmers' accessing better milk prices and quality inputs.

As a public and private service agricultural extension is expected to deliver relevant information to enable farmers make informed decisions at their farms (Al-Zahrani, et al., 2016). The long-term effect of extension services is to influence behavior change among target farmers leading to better farming decisions such as adoption of high yielding technologies resulting in desirable outcomes including higher farm productivity, increased farm income and ultimately improved household livelihoods (Mwololo, et al., 2018). Smallholder farmers have potential to increase milk production in their farms by 16 percent by optimal utilization of resources available to them and adoption of new production technologies, while they can bring down the cost of producing 4 percent without affecting milk output (Mugambi, et al., 2015). However, the delivery methods for information on dairy production technologies and agricultural financial services have for years

been through oral & face to face interactions with either individual farmers at their farms or in group meetings. This approach is currently only able to reach a small portion of smallholder farmers and is ridded by high cost of operations limiting the transformation of subsistence farming to commercial agriculture.

Agricultural extension needs for farmers have evolved over time, from largely being based on production and technology transfer to marketing and agri-business management in a bid to increase farm income (Kahan, 2013). The structural adjustment programmes (SAPs) in Kenya which were fronted by the World Bank and IMF among other things recommended that the state reduces its budget allocations to agricultural extension services and direct support to the dairy value chain such as artificial insemination and funding of veterinary clinical services (IFAD, 2016). There was a general assumption that these changes would create opportunities for the private sector to invest and self-regulate its provision of such services, but since the sector was not developed enough and lacked incentives for private players the restructuring led to a deterioration of quality and limited access of these agricultural services (ASCU, 2012).

Inaccessibility to information on agricultural credit especially for dairy smallholder farmers and especially women has limited the range of activities, the type of improved practices used and the scale of operations that a dairy farmer can adopt on his farm (Alila & Atieno, 2006). However, several banks and MFIs are cautious about agricultural sector finance. The general belief for non-inclusion of the agricultural sector is financial policy priorities, is the perception that smallholders and agribusiness SMEs are of high risk due to unstructured markets and the high dependence on naturally occurring factors like rain (Maganja & Agai, 2017).

Just like all sectors in our economy, players in extension service provision continue to explore new approaches to overcome limitations of traditional approaches that are reliant on face to face interactions in delivering advisory services (Marwa, et al., 2020). There are many potential applications for information and communication technology (ICTs) tools that can transform livelihoods of farmers and accelerate economic activities in agriculture sector yielding benefits in the economy and environment (Duncombe, 2012). In its report, the World Bank (2018) explains that modern Information Communication and Technologies (ICTs) such as Video and SMS offer exceptional potential to deliver important agribusiness information in a personalized and timely fashion thus contributing to food security, poverty alleviation and transforming rural livelihoods.

Furthermore, multiple information users and value chain actors in the agricultural sector are continually identifying intersection points between information and communication tools and the information gap in agricultural sector which has become valuable opportunities to exploits in order to tackle some of the global challenges such as youth unemployment and food security (CTA, 2016).

Major developments in development, access and utilization of video content such as pico display projectors with storage and solar charging capabilities and snowballing of mobile phone adoption in rural areas have made it easier and much affordable to create access to audio visual content (Van Campenhout et al., 2017). For developing and underdeveloped countries majority of whom are in Africa, tools that have the ability to mimic real life experiences appears to have better ability to deliver information intendent for development purposes. This is the reason why use of recorded videos of training by extension officers and demonstration of success by lead farmers have been effective in dissemination of information, skills, and knowledge among low literacy populations (Wright, et al., 2016). For low budget farmer support initiatives, video appears to be the most appropriate approach to transfer important information from experts on agricultural production technologies while maintaining the quality of information (Asamoah & David, 2011).

The wide presence of mobile telephony networks in Kenya offers a unique opportunity for rural populations to access information that has the potential to transform their livelihoods (Lung'ahi, 2014). The popularity of mobile phones is developing countries is fueled by the need for communication, mobile money transfer, messaging and networking such as WhatsApp, Email, Facebook and Twitter. In Kenya the ownership of mobile phones is estimated to have exceeded the 100 percent mark (CAK, 2018), meaning that all adults in Kenya own or have access to a basic mobile handset. Messages transmitted through SMS can therefore reach virtually all of the estimated 3.5 million small scale farmers in Kenya. This level of cell phone penetration makes mobile phone a potential 'mass media' tool for transmission of important information to smallholder farmers.

1.2 Statement of the Problem

Agricultural extension service provision have changed after the top down approach traditionally used to a demand driven exercise for transfer of information, knowledge, and skills for sustainable agriculture. For the dairy sector, an important factor to consider is the suitability of the available

extension approaches to sufficiently address the different farmer information needs and demographics such as the poverty level, farm size, gender and age (Lung'ahi, 2014).

Despite keeping livestock breeds with high dairy production potential, smallholder dairy farmers are not able to achieve a fact attributed to traditional livestock keeping methods of production, poor breeding technologies, poor nutrition, poor housing condition, inferior health care and services, and low capital investment (IGAD, 2016). Many modern breeding technologies in dairy farming such as artificial insemination (AI), sexed semen (SS) and embryo transfer (ET), now exists and can positively impact herd genetics and reproductive performance (Khanal & Gillespie, 2013). Furthermore, financial service providers have designed products and services to enable farmers access agricultural credit to cover high upfront cost for adoption of dairy production technologies and acquisition of farm assets. However, such production technologies and agricultural financial services have lower uptake rates in Kenya's dairy sector especially among smallholder farmers in rural areas (Wambugu, et al., 2011).

Institution based promotion efforts of improved dairy technologies inform of extension and marketing services have been made by different organizations including farmer co-operatives, Food and Agriculture Organization (FAO), Heifer international, Government ministry and Financial service providers like Juhudi Kilimo in a bid to increase agricultural productivity. However, the rate of adoption of the promoted technologies have been declining without significant uptake. Advancement in ICT is being fronted as the most promising avenue to effectively reach and effectively transfer knowledge on production technologies in the agricultural sector. However, currently digital tools are being utilized seldomly in areas such as in financial inclusion and general communication, while their potential for agricultural extension has been explored and studied less (Van Campenhout, et al., 2017).

There is no sufficient documented research in the study of modern tools that can be utilized for agricultural extension, factors influencing the overall adoption and intensity of adoption of dairy technologies, the characterization of dairy technology information supply and level of adoption by small holder farmers. The limited availability of literature fails to address the ever-widening gap between agricultural research and adoption of new technologies by smallholder farmers. At the same time, there are limited studies on the potential of modern ICT tools like video and SMS to complement other extension approaches like VVC, FFS, T&V or F2F to improve access to

information and adoption of technologies in the small scale agriculture sector in Kenya. This study explored whether digital platforms are viable tools for elaborate and less costly agricultural extension service provision and communication support for smallholder farmers in the dairy sub-sector.

1.3 Broad Objective

The goal of the study was to analyze factors that influence acceptance and use of digital communication platforms and determine the effectiveness such platforms on the stimulating the uptake of financial services and dairy production technologies in smallholder farming.

1.4 The specific Objectives

1. To assess factors influencing access and acceptance of digital platforms used for communication and agricultural extension small holder dairy farmers in Uasin Ngishu county.
2. Evaluate the rate of uptake of financial services and dairy production technologies among small holder farmers in Uasin Ngishu county.

1.5 Research Questions

A series of testable research questions can be developed from this proposed research model, as shown below:

i. What factors influence access, acceptance and use of digital communication platforms among smallholder dairy farmers?
ii. How do digital communication platforms like mobile phone influence the rate of uptake of financial services and dairy production farming technologies among smallholder farmers?

1.6 Assumption of the Study

The researcher considered the following assumptions in the study:

i. Farmers in the study areas are rational human beings and will therefore make decisions that will enable them improve livestock productivity.

ii. Farmer's perception and socio-economic demographics influence the choice of the channel of receiving information.
iii. Smallholder farmers are unable to acquire new dairy technologies in their farms because of the lack of a source of capital.

1.7 Justification of the Study

Many global developments today are proposing solutions to the challenges facing the agricultural sector. This is especially observed where information technology like mobile phones and video technologies are challenging age old practices by introducing more cost effective avenues of reaching rural populations (Chen, 2018). These modern channels can be powerful communication avenues that can prove to be effective in promoting agriculture and development agenda over wide geographies even in remote areas. However, majority of research done on use of ICTs in Kenya have been in communication and financial services provision while their potential for use in the agriculture sector for agricultural extension has not been sufficiently covered. This study evaluates factors that influence access and utilization of ICT tools by smallholder farmers for accessing agricultural information and goes ahead to analyze the impact of the information on uptake of financial services for investment in dairy technologies that positively impact production.

There is no sufficient documented research in the study on how modern communication tools can be utilized for agricultural extension, on factors influencing the overall adoption and intensity of adoption of dairy technologies, the characterization of dairy technology information supply and level of adoption by small holder farmers. This study therefore seeks to contribute to the research on utilization of the ICT revolution especially in agricultural extension services and dissemination of important information to farmers like weather forecast, market information financial services. This study takes an experimental approach that compares results from multiple digital communication to determine whether digital platforms are viable alternatives to the more sophisticated, and hence costlier, approaches for dissemination extension services to farmer. More specifically, by this research investigating the effectiveness of digital platforms in the adoption of dairy farming practices and financial services among farmers, actors in dairy value chains who include Government, Financial service providers and development organizations will get insights of how technology can be utilized to increase reach of farmer advisory programs and accelerate uptake of agricultural financial products and services. Findings from this study will be valuable to

policy makers and regulators in the larger agricultural sector in understanding and building effective strategies for utilizing ICT platforms in dissemination of important services to farmers like provision of weather information, management of input subsidies and market linkages. This will enable them to generate long-term gains in boosting farm productivity, increase predictability of yield and contribute to resilience of smallholder farmers to emerging issues such as climate change (FAO,2015).

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

Having explored the importance and potential for information technology tools in agricultural extension and financial services, in the following section, the thesis reviewed past literature on agricultural extension, developments and application of ICT in agricultural extension and agricultural lending.

2.2 Theoretical Review

The four actors of production being land, labor, capital and entrepreneurship stand to have better returns when the information needs of farmers which can range from information on production technologies, value addition and market access (Mittal & Mehar, 2015). Farmers have a variety of sources where they can access information and knowledge to support their farming spanning from their peer farmers, public extension agents, agents of input provider and their own discovery at their farms (Aker, 2011). It is clear that access to important information by farmers is not proportionate and the gap is wider for smallholders who have limited resources to afford the cost of access. Modern channels of transmitting agricultural Information can range from agricultural training centers, professional experts who provide extension services for pay, newspaper pull outs, Radio and TV programs however the inability of these not being available across all levels of production becoming an impediment to uptake of production technologies in developing countries (Okello, 2014). To address these challenges, research and marketing institutions have embraced the ICT tools to bring about social and economic development by creating an enabling environment to reach farmers and other stakeholders with improved technologies (UNCTAD, 2007).

Theories that have been used to describe the acceptance of technology have the following factors in common they are the perception, attitude, believes of the users and the actual utilization of system (Drew and Alharbi, 2014). Theories such as Diffusion of Innovations Theory (DIT) which was put in use in 1960, the Unified Theory of Acceptance and Use of Technology (UTAUT) which was built from the study and improvement of the three versions of the Technology Acceptance

Model (TAM) and the Theory of Planned Behavior (TPB) have been proposed to explain consumers' acceptance of new technologies and their intention to use (Lai, 2017).

In this study, constructs of the Unified Theory of Acceptance and Use of Technology (UTAUT) were used. This theory was formulated as the "User acceptance of information technology: Towards a unified view" and was aimed at explaining the initial objectives of the user of an information system and their subsequent utilization of the system. The UTAUT theory was created through a process of review and merging of the concepts of the eight versions of TAM that were previously used in research to describe utilization behavior of users on an information system. Later in a study by Venkatesh et al. (2003) trying to validate the theory arrived at the conclusion that it was able to explain the behavior variation in 70 percent of intent to use behavior and in actual use in accounted for 50 percent. The TAM shown in Figure 1 is one of the most successful measurement for ICT usage among practitioners and academics. This theory was first used by (Davis, 1989) to identify factors that determined acceptance of computer systems across a range

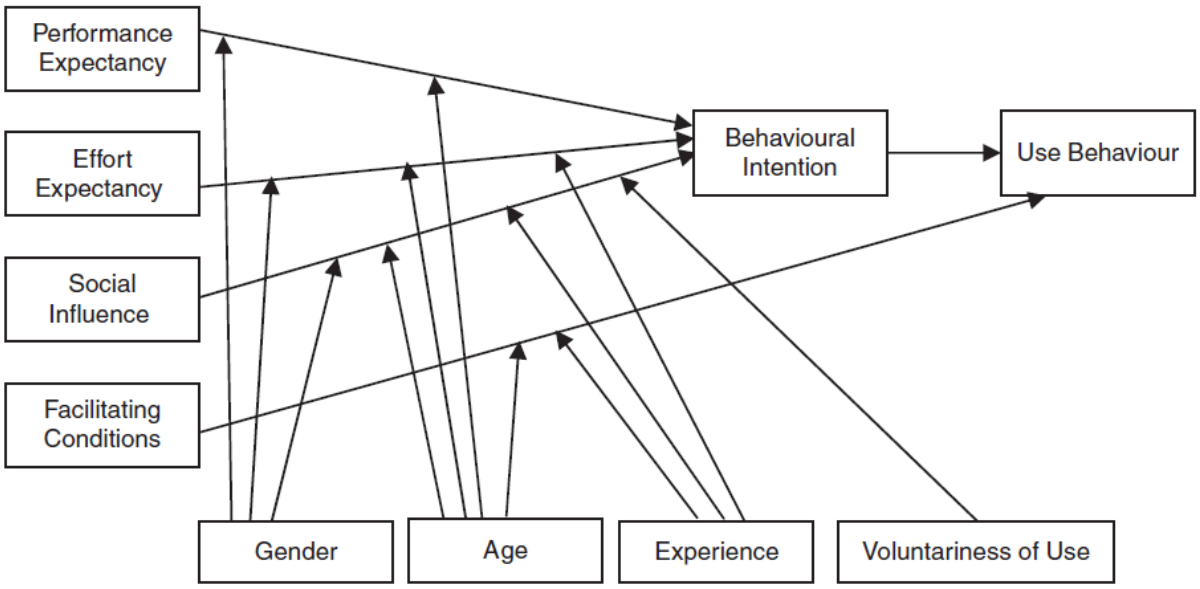

Figure 1. The Unified theory of Acceptance and Use of Technology by Venkatesh et al. (2003)

of computer systems and end user populations. The TAM theory seeks to predict the behavior of people towards computers and their acceptance by measuring their objectives, personal perception like attitudes, subjective norms, supposed usefulness, perceived usefulness, recognized ease of use, and other relatable variables. The theory has three models with the latest one the TAM 3 presenting a comprehensive nomothetic network of the attributes of users of computer system

adoption Venkatesh and Bala, (2008) using the four determinants of perceived usefulness and perceived ease of use which include the individual differences, system characteristics, social influence, and facilitating conditions.

The UTAUT theory puts forward four forecasters of the behavioral intention of the user which are performance expectancy, effort expectancy, social influence and facilitating conditions. The theory pursues to predict acceptance and measure intention the of computer systems by people who are intended to utilize or derive benefits from the technologies. Furthermore, the theory seeks to explain people's attributes such as attitudes, relatable variables, and subjective norms (Lai, 2017). This study considered the farmer as both a system user and a learner and constructs from the theory were tested with regard to the adoption of digital platforms as agricultural extension approaches.

2.3 Trends in Agricultural Extension

The Green revolution led to modernization of farming practices in the twentieth century particularly in the Asian continent, the results were observed in substantial improvement in agricultural yields, national production, and food security (Rehima, 2013). The yield increase of the agricultural sector in countries like Brazil and the United States of America (USA) have been on a constant rise since the 20th century, however the case in developing countries is different, farm productivity is on a declining trend a scenario brought about by deteriorating soil fertility, scarcity of water and climate change. The difference between the two circumstances in the agricultural sector is the effectiveness of a country translating agricultural research into applicable solutions to important challenges. An example is in the many solutions that have been fronted in livestock breeds, new seed varieties, fertilizers, and farming systems whose uptake remains very low especially among smallholder farmers in rural areas of developing countries (Radhakrishna & Thompson, 2006). In his report, Van den Berg (2007) highlighted a variety of factors that constrained the green revolution in Africa and other continents among them limited access to extension services and high capital investment required for adoption of new technologies. Extension service providers can become important agents of change necessary in the transformation of farming that utilizes traditional methods into progressive and profitable agriculture. This transformation is essential especially in the global drive to ensure food security, job creation and poverty reduction (ASCU, 2012).

To match varying extension needs by farmers, Muyanga & Jayne (2006) reported that many extension service provision models and approaches have been adopted over many years in Kenya albeit in varying success rates. Some of the extension approaches implemented include the training and visit (T&V) approach developed in 1979 by the world bank, the farmer field schools (FFS) which emphasized on discovery learning and problem solving, farmer-to-farmer (F2F) which provide opportunities for peer farmers to exchanges knowledge and Video Mediated Learning (VML) which utilized expert made videos to pass important information to farmers. Currently there are different actors driving extension services in Kenya including the Government, international development organizations and the private sector. Even though the Government remains the major driver in delivery of extension services its budget priorities are in remuneration for employees and operational expenses for the concerned ministry, there are however plans to create incentives for private sector actors to tap on their entrepreneurial drive to stimulate their active participation in provision of extension services and leave the Government to play a regulatory role (ASCU, 2012).

Innovation in agricultural extension which is being accelerated by a global push for revolutionizing the approaches put in place for provision of public and private extension services in developing countries. Additional knowledge requirements by farmers are developing as the world enters into an era of globalization, it is of essence for agricultural extension service providers to adopt more robust and innovative approaches (Qamar, 2005). There is also a recent shift in the model in which agricultural extension is delivered different from the common trickle down of research and production technologies to a farmer driven commercial model. This have stimulated entrepreneurship from private sector and funding from Government and international organizations like FAO and the World Bank for the development and experimentation of new technology assisted extension models (Asamoah & David, 2011). Modern Information ICT tools and platforms confer extraordinary potential in the delivery of extension services to small holder farmers opening up links to new market opportunities, and therefore contributing in the fight against food insecurity and poverty in rural communities. (Mukhebi, et al., 2008).

2.4. Agricultural Extension Approaches in Kenya

The term extension refers to provision of instructions and other services that are needed to transform the way resources are utilized for improvement of agricultural livelihoods of rural

households (Muyanga & Jayne, 2008). There are numerous agricultural extension models experimented and implemented driven by the need to improve fortunes of farmers however, the current extension services in Kenya have been labeled as unproductive which is one of the factors blamed for the dismal growth and low adoption of technologies in the agricultural sector (Chimoita, 2014, GoK, 2014). According to FAO (2013), extension services if properly designed and implemented will be better placed to improve agricultural productivity. Extension is an ongoing process where useful information is transferred to people and then assisting those people to acquire the necessary knowledge, attitudes and skills to this information or technology for improvement of their quality of life (JICA, 2008)

Several Government programs have tried to surmount hurdles related to the delivery of information that impact the adoption production technologies however, such interventions have not borne expected impact which have been blamed on the limited scale of implementation and sustainability. The fast adoption of mobile phones across less developed countries provide exceptional prospects for facilitation of important information to farmers in a bid to tap on the strength of emerging communication platforms for provision of extension services (Aker, 2011). However, ICT driven programs have also been decried for their complexity, high set-up costs, limitation of access and affordability among low income households (Anderson & Feder, 2007).

In agriculture, there is a demarcation separating the role of research and extension whereas the formers are expected to focus on development of useful knowledge inform of innovations while the later focuses on transfer and adoption. While organization involved in agricultural research often receive support inform of funding there is need for a robust extension system to provide backstopping in order to effectively serve the needs of farming households. The many existing delivery methods for agricultural extension have for years been through face to face interactions between farmers and extension agents sometimes these interactions are accompanied by on farm demonstrations activities where new production technologies are applied for improved results to be appreciated. The success of extension approaches that rely of oral and face time between participants depends on many factors including accessibility of skilled trainers and availability of resources to cover operational and overheads expenses, these have proved to be in short supply in developing countries in Africa (Farm Radio International, 2009).

2.5. Improved Feeding and Breeding Technologies in Kenya

The demand for fresh milk and value-added milk products in East Africa has recently increased due to a growing population and an increase in disposable income among middle income earners. The supply of milk by farmers in the region is not sufficient to meet this growing demand, some of proposed interventions to bridge this gap is by improving the capacity of farmers to produce more milk. Due to limited access to resources such as land, the most appropriate support that smallholder farmers need is on ways they can increase milk production which is a factor of good breeds, livestock management and proper feeding.

Research covering several facets in the area of dairy livestock feeds and feeding especially during the dry season of the year when feed is in low supply adversely affecting dairy livestock growth and reproduction. Options for feeding that have been recommended include production and utilization of high quality hay and crop residues like wheat and rice straws combined with interventions like fermentation and protein supplementation which are strategic in ensuring animals derived maximum nutrients from dry forages subsequently enhancing productivity. Additionally, Artificial Insemination services which were first introduced in Kenya in 1945 have been hailed for its ability to introduce high quality breed traits while avoiding challenges of using a Bull however, its use is not on the rise due to many constraints including high cost and limited know how among majority of dairy farmers (Okeyo et al., 2009). According to Baltenweck et al. (2014), despite considerable growth AI services by private and public players its uptake is low with the latest studies on breeding indicating that many farmers who initially used AI service are turning back to using natural breeding with. Provided the significance of AI as an affordable and sustainable breeding option, its sluggish adoption has serious repercussions on the success of the dairy sector (M'Ikiugu, et al., 2015). Therefore, it is important to put forward cost friendly and sustainable interventions that illustrate the benefits of AI and support access to information to aid in the process of choosing the most appropriate genetic material for dairy herds (Lawrence, et al., 2015).

2.6. Analysis of Existing Digital Platforms and Information and Communication Technology (ICT)

The proliferation of ICT platforms that have numerous applications in the agricultural sector poses numerous opportunities for the sector such as in the dissemination of important information on production technologies. (Aker, 2011), This study will explore the potential of tailored text messages about best practices to influence farmers make informed decisions on prices, diversification of their produce, and access to inputs leading to increased incomes. Major benefits can be derived by beneficial application of ICTs found through the internet and mobile telephony. According to statistics from the Communications Authority of Kenya (2018) mobile phones penetration in the country stands at 78 per cent which means that most adults in Kenya own at least a basic mobile handset. Messages transmitted through SMS can therefore reach virtually all of the estimated 3.5 million small scale farmers. This level of cell phone penetration makes mobile phone a potential 'mass media' in Kenya.

The use of video in agricultural programs funded by Kenya's development partners has grown in popularity because of its ease of use, flexibility, and standardized information delivery mechanism of training. (Van Mele, 2011). Images in videos have been lauded as powerful motivators for behavior change and use of real people in videos do assist in elimination of utilization hurdles for illiterate people (Lie & Mandler, 2009). In majority of the use cases for videos, evaluation of the intervention has not been done in the context of the complementarity or total replacement of traditional extension approaches (Gurumurthy & Chami, 2016). This study will examine the acceptability of locally created videos and tailored SMS text as educational materials among smallholder farmers and extension officers.

As the use of mobile phones proliferates throughout the world, development practitioners have increasingly considered using mobile phone technology to reach their target audience. It is important to evaluate the effectiveness of these programs in complementing or substituting for alternative training programs. It is also important to determine the types of programs for which the text messages are most effective (Travis, 2015). Short Messaging Services (SMS) is a text component in mobile phones and websites that is utilize for communication but with a limitation of a maximum of 160 characters. The SMS-based services can offer farmers a timely source of

information, for example they will not have to wait for newspapers to publish price information a day after the price is reported (Lung'ahi, 2014).

Greater access to information help farmers makes informed decisions on prices, diversification of their produce, and access to inputs leading to increased incomes. The basic assumption being that video and mobile phone-based interventions can be a poverty alleviation tool that enables smallholder farmers to increase their yields and eventually facilitate consumers to access nutritious diets at affordable prices.

2.6.1 Existing Digital Platforms

Access Agriculture is an international NGO started in 2012 by two media companies, Agro-Insight (Belgium) and Country wise Communication (UK) which develops, mass multiply and disseminate short agricultural training videos about 10 -15 minutes long in collaboration with more than 200 communication professionals across the globe. The platform is designed for use by staff and agents working in agricultural research, input manufacturers and agents of producer organizations (FAO, 2019). The use of digital technology c reates ease of access to the training materials virtually anywhere anytime making it an effective tool for promoting agricultural enterprise tool across all value chains worldwide especially among young people who have developed a negative view of agriculture (CTA, 2014). Despite having a wide library of quality audio-visual training materials its usage is constrained to areas of high speed internet, require facilitation by experts and the audience need to have considerable literacy level.

Twiga Foods Ltd is a mobile-based business-to-business marketplace platform that offtakes farm produce fresh from farmers and processed food items from processors for distribution to vendors in urban centers at affordable prices. The company has pack houses where farm produce and processed food items are cleaned and repackaged and uses a cashless enterprise management platform to connect to their network of over 14,000 registered farmers and 8,000 vendors in urban areas. The platform is accessible through a website and mobile phone application. Like any other produce off taker, Twiga requires farmers to undergo a rigorous registration process and enter into contractual agreement with the company to stick to specific crop and production capacity, quality and food safety standards. The use of a digital platform has enabled Twiga to build efficient logistics, reduce post-harvest loss, and pay farmers more while delivering to consumers for less. In turn, this has enabled them to offer guaranteed access to market for high value locally consumed

fruit and vegetables. It has also enabled provision of quality agronomy and farm management support to farmers to ensure high yield and high-quality production.

Seeds of Gold started as a pull out Magazine in the Saturday Nation Newspaper of the Nation Media Group produced in Collaboration with Egerton University for the purpose of educating Farmers on Best Farming Practices. Seeds of Gold have grown to have a TV show aired once every week and a YouTube channel where practical information is shared. It demonstrates through success stories and informational articles how adopting agricultural technologies and implementing good farming practices can be profitable for smallholder farmers (Eyrich, 2014). Some of its limitations include the fact the magazine and videos are only accessible through a website or bought with the newspaper creating access and affordability challenges. It is also done in English, discriminating against audience category with lower literacy and low understanding of English language which is where most smallholder farmers fall.

2.7 Modern Agricultural Credit and Financial Services

More than 2.5 billion people globally directly depend on smallholder farming for their livelihoods (Varangis, 2020) while in sub-Saharan Africa the dairy sub-Sector is rapidly expanding with majority of the expansion happening in east Africa which accounts for 85% of the regions dairy cow population (Deka, et al., 2019). Furthermore, dairy farming in Kenya accounts for livelihoods for more than 2 million households and is dominated by smallholder farmers (IFAD, 2016). Although smallholders dominate milk production in Kenya, their efforts to increase production is constrained by among other things poor access to credit facilities (Mutavi, et al., 2016). This is attributed due to inability to provided collateral needed for bank loans climate impact and the limited knowledge of the banks on agricultural value chains lending (Kembe, et al., 2008, USAID,2009).

The definition for agricultural lending includes multiple credit instruments utilized to finance investments and transactions in agricultural value chains. The type of financing is determined by the nature of investment or transaction needs for a specific farmer or farmer group, which is defined by value chain activities like planting, harvesting, and marketing cycles (GTZ & FAO, 2014). In its report on agricultural finance (FAO, 2017) found that smallholder farmers without access to credit, have no choice but to continue farming without the benefit of improved dairy

practices, access to accurate and timely information. Financial service providers in Kenya have advanced a disproportionately lower proportion of their outstanding loan books to the agricultural sector estimated at less than 1% this is a far cry from the sector's contribution to the county's GDP. The World Bank (2018) in its report proposes access to agricultural credit services as critical in unlocking capital necessary for improving productivity, smooth out farm cash flows, facilitate better entry to markets and enable superior risk management (Worldbank, 2018).

Majority of Financial Service Providers in Kenya have at least one product targeting dairy farmers mainly for purchase of dairy animals, farm inputs like seeds for fodder, animal feeds, equipment, setting up housing structures, paying for labor and farm overheads and invoice discounting (Sibiko & Qaim, 2017). However, many rural households have not benefitted from a agricultural loan facility a fact ascribed to limited information about the credit facilities, lack of collateral and credit history, low borrowing capacity and fear (Wilkes et al, 2018). Therefore, without a financial history and tangible collateral, many rural smallholder farmers are unable to demonstrate their creditworthiness to secure loans from mainstream financial institutions however, Microfinance institutions like Juhudi Kilimo, a microfinance institution which provides financial services and training to smallholder farmers in Kenya. They are at the forefront of bringing to market new ways of managing credit risk in agricultural financing unlocking the much needed capital to enable investment in dairy farming. The microfinance has developed financial products which are coupled with insurance and training in an effort to de-risk smallholder farmers. The institution has also have set up digital platforms where farmers can take up loans for dairy farming and access information on new technologies that maximize production including modern breeding, farm equipment, herd management and record keeping.

2.8 Conceptual Framework

This section seeks to conceptualize how the study answer the research questions and is derived from the theories described in the previous section.

The conceptual framework illustrated in Figure 2. presents the variables in the study and how they are interrelated to enhance adoption and utilization of digital communication platforms for accessing extension and financial services. According to McBride & Daberkow (2003), ability of farmers to access relevant information on technologies that has potential to positively impact their

farm production determines the rate of adoption. Therefore, acceptance of digital platforms that enhance access to information dairy production technologies and financial services by farmers can have far reaching benefits. This conceptual framework is based on predictors of farmer's acceptance of digital communication platforms. The first one is the performance expectancy which covers notions such as perceived usefulness, motivating factors, fit for the need, relative advantage, and expected result. The second predictor is effort expectancy which addresses the perception of apparent complexity and comfort of using the digital platforms. The study is based on assumptions that the farmer's intention is to increase dairy productivity and they can describe their intentions and expectations.

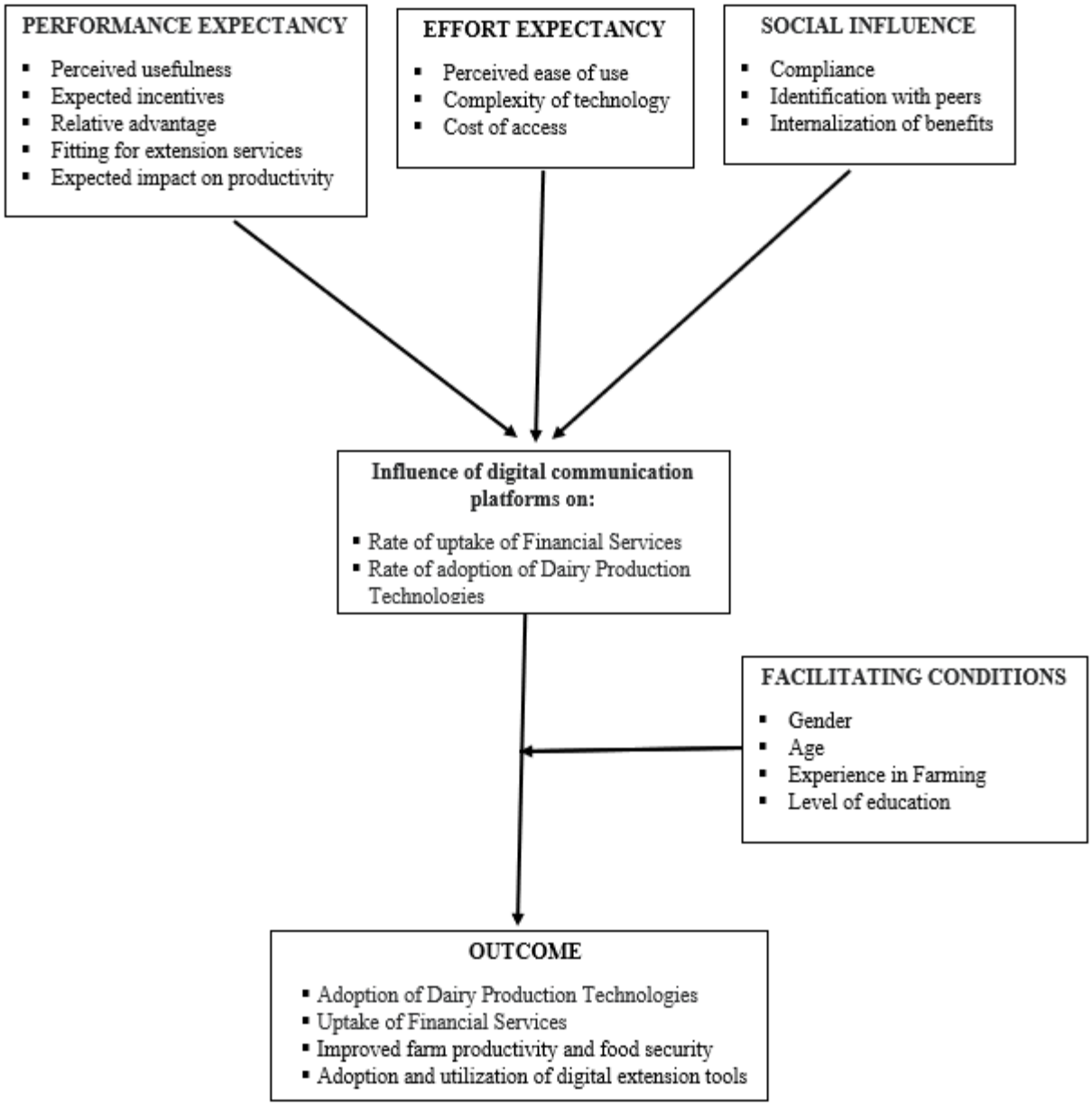

Figure 2. Conceptual Framework

CHAPTER THREE
METHODOLOGY

3.1 Introduction

The chapter introduces the methodology utilized by the study, the research design, description of the population, sample determination and the sampling procedure. Furthermore this chapter describes instruments used in the study and describes their cogency and reliability, the data collection procedures, data analysis techniques and ethical considerations during the study are also discussed.

3.2 Study Area

The study area for the research was Kapseret Sub-County one of the five administrative units of Uasin Gishu County with an estimated area of 300.8 square kilometers. As illustrated in Figure 2.2, Kapseret is located 10 km to the South West of Eldoret Town along Eldoret-Kisumu road and covers a land area of 3,345 km2. It is located in the Kenyan rift valley, which is part of the Great Rift Valley which (GoK, 2014). The country has Trans Nzoia County bordering in the north, Elgeyo Marakwet County to the east, Baringo County to the southeast, Kericho County to the south, Nandi County to the southwest and Kakamega County to the northwest (MoALF. 2017). Uasin Gishu county geolocation is found between longitudes 34 degrees 50‟ east and 35 degrees 37‟ West and latitudes 0 degrees 03‟ South and 0 degrees 55‟ North. It experiences temperatures range of 7 degrees Celsius to 29 degrees Celsius high and has reliable bimodal rainfall patterns with the average rainfall ranging between 900mm to 1,200mm occurring in two distinct peaks in May and October with intermittent dry periods between November and February (GoK & UNDP, 2013).

Agriculture is the mainstay of Uasin Gishu county with the average farm size being between 2 and 10 acres characterized by red loam soils, red clay soils, brown clay soils and brown loam soils which is capable of supporting a wide range of crop and livestock enterprises (GoK, 2013). The major crops grown in the county maize, beans, wheat, sunflower, and potatoes while the livestock include dairy farming, beef cattle, poultry, sheep, goats, pigs, beekeeping, rabbit farming and fish farming (MoALF. 2017). The population is estimated at 132,624 and largely practices agriculture with horticulture and dairy sectors being prominent (NG-CDF, 2019). Small holder farmers are

organized in Cooperatives for marketing of farm produce with the largest dairy cooperative being Lelchego Dairy Cooperative Society which serves milk demand all the way to Kakamega and Kisumu (Media, 2018).

Figure 3. *Map of Uasin Gishu County (GoK, 2019)*

3.3 Sample Size Determination and Sampling Procedure

The study adopted a descriptive research design recommended by Mugenda & Mugenda (2003) to describe characteristics on participants, data collected through questionnaires, events, perceptions and behaviors. The sampling frame comprised of 1,547 smallholder farmers who have been recruited and trained by Juhudi Kilimo on microfinance services like savings, loans, insurance and agricultural training from Uasin Gishu County. The study used the improved Kothari (2010) formulae to arrive at a sample of 120 farmers was achieved as illustrated in Equation 1 and 2.

$$n = \frac{Z^2.p.q.N}{e^{2(N-1)}+Z^2.p.q}$$.....Equation 1

Where:

n = sample size,
z = standard variate at a given confidence level,
p = sample proportion of successes,
q =1-p,
N = Size of population,
e = acceptable error (precision)
Hence, the most conservative number of farmers to be interviewed was:

$$(n) = \frac{1.96^2(0.5)(0.5).(1,547)}{0.05^2\,(1,547-1)+1.96^2.(0.5)(0.5)}$$= 120.37.....Equation 2

n= 120

The study area was purposively selected as the study area because Juhudi Kilimo microfinance had the highest lending activities for agricultural lending and had conducted a recent marketing drive to recruit more clients in the area. The study employed the multistage sampling technique to arrive at the 120 participants of the study. In the first stage, the microfinance provided a heterogeneous list of farmers recruited in Uasin Gishu county and generated the sampling frame of 1,547 farmers living in 3 villages in Kapseret sub-County. In the second stage, Systemic random sampling was used to arrive at the farmers to participate in the study where every 13th farmer in the list provided by the microfinance was selected to make up the list of 120 participants for the study. The constant factor was calculated by dividing the population of 1,547 with the sample size of 120. In the third stage, the farmers were then randomly allocated into 3 study groups of 40 farmers each who were then subjected to three different training approaches.

The first group (Video) being subjected to video mediated learning clips on improved dairy farming technologies followed by high level focus group discussion facilitated by the extension officer in Village A in Ngeria area. A series of 5 video clips were obtained from a digital media library produced by Juhudi Kilimo in conjunction with the Human Geographic media program in digital extension project entitled ‘Mbinu Mpya za Ukulima’. These video clips included (i) Hydroponics feed production (ii) Farm Equipment (iii) Dairy Cow Breeding with AI (iv) Dry Matter Feeding (v) Calf Rearing. Videos were displayed from a large TV set to four groups of 10 individuals each. Each clip was between 5 to 8 minutes long.

The second group of 40 farmers in village B in Simat Area met an extension officer who first explained the five topics and the mode of receiving the advice. This meeting was organized in Simat centre. The farmers received on their mobile phones messages sourced from *i*-cow covering topics on (i) Hydroponics feed production (ii) Farm Equipment (iii) Dairy Cow Breeding with AI (iv) Dry Matter Feeding (v) Calf Rearing. The farmers received three messages every week with advice on improved dairy farming practices for three months.

The third group of 40 farmers in village C in Kipkenyo Area met an extension officer who first explained the five topics and the mode of receiving the advice. This meeting was organized in Kipkenyo centre where 5 to 8 minutes long videos were shown. The title of the five videos were (i) Hydroponics feed production (ii) Farm Equipment (iii) Dairy Cow Breeding with AI (iv) Dry Matter Feeding (v) Calf Rearing. Videos were displayed from a large TV set to four groups of 10 individuals each. After viewing the videos, farmers later received messages on their mobile phones sourced from *i*-cow covering the same topics for three months.

Three months after training that is January to March 2019, a pre-tested survey was deployed to collect information on the implementation of disseminated dairy production technologies among the project participants. Primary data were collected with the help of enumerators through interview guide to enable clarification and probing of the respondent for accurate answers. Secondary data was obtained from loan and savings schedules from the microfinance institution.

Table 3.1: Data Collection Framework

Objectives	Activities	Variables	Data collection tool	Sample size *(Number of Farmers)*
Objective 1	Survey	Age, land size, occupation, herd size, ownership of digital tools	Questionnaire and Focus Group Discussion	120
Objective 2	Video Mediated Learning	These video clips included (i) Hydroponics feed production (ii) Farm Equipment (iii) Dairy Cow Breeding with AI (iv) Dry Matter Feeding (v) Calf Rearing.	1. Video watching 2. Farmer group discussion	40
Objective 3	Text Messages on Mobile phone	Text messages on technologies such as hydroponics fodder production, A.I technology, new farm equipment and dry matter breeding	1. Text Messages 2. Farmer group discussion	40

3.4 Data Sources and Analysis

To address the first objective, a pre-tested questionnaire was utilized to collect baseline information from the participants at the beginning of the study the data included personal traits such as age, gender, education level, ownership of dairy cows, farmer's occupation, ownership of a phone, a radio & a TV. At the same time information on institutional factors such as membership to co-operative societies, participation in farmer training events and access to credit and savings services was also collected. An end-line questionnaire was administered at the end of 3 months to get data on ownership of dairy cows, milk production, implemented technologies and responses on perception and attitude were captured on a Likert scale and findings were presented through frequencies, pie-charts, graphs and percentages.

To address the second objective, data on implementation of dairy production technologies was collected in the baseline and end-line surveys while secondary was retrieved from the microfinance institution's loan management system on the number of farmers who put savings and took credit

for dairy farming and for implementing technologies trained about in the study, the loan and savings account balances were also recorded.

Secondary information on farm tenancy, quantity of milk produced, loans applied for and purpose of the loan was acquired from the microfinance customer relationship management system. The collected data was then subjected to descriptive statistic and binary regression analysis to determine factors that influence the uptake of credit services for investment in dairy farming technologies disseminated during training process. Data was analyzed using thw Statistical Package for Social Sciences (SPSS version 20) into frequencies and percentages inform of tables and graphs. The significant differences and degree of association between variables were determined using the Pearson's Moment Correlation Test.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socio-economic Characteristics of Smallholder Dairy Farmers

Table 4.1 presents socio-economic characteristics of the smallholder farmers who participated in the study. Data from this study revealed that, in the 120 sampled farmers, 87 percent were women and women headed households (FHH) accounted for 32 percent. This pattern is not far off from data collected by the Kenya Bureau of Statistics in 2009 which reported female-headed households in rural areas at 34 percent. These findings are attributed to the fact that women form most of the membership of self-help groups commonly referred to as Chama in Kenya as a result of the communal nature of womenfolk however, fewer of them are heads their households. These findings are further supported by the ongoing efforts to enable more women to access financial services to accelerate the growth of the agricultural sector in a bid to promote equal opportunities for women and men in societies a phenomenon referred to as the affirmative action (FAO, 2017). In their study Mueller et al., (2019) also attributed similar findings to the high tendency of the youth in African especially men to seek formal jobs in urban areas compared to adults and young women which explains why more women than men are members of rural self-help groups.

Furthermore, the age disaggregation showed that an average of 65 percent of the participants were above the age of 45 years and only 20 percent of the respondents were below the age of 35 years. This is an indication that even though farming is increasingly seen as offering attractive investment opportunities for the youth, majority of the smallholders are senior citizens. This is in line with a report by CTA (2014), which sought to identify employment and income generating opportunities for young people. It suggests that young people, are increasingly viewing the agriculture as an avenue to put in good use their talents and acquired skills while generating sustainable incomes. Respondents in the mobile technology group had a mean average age of 53 years, while in Video mediated group had a mean average age of 54 years and those in the combined mobile and video mediated group had a mean average age of 52 years. According to Ali, (2016), the age of a system user is a determinant of their behaviors towards computer systems and eventually their utilization in everyday life including in solving agricultural challenges. The age of the farmer is also related to their experience in farming which therefore becomes an important factor when considering the choice of channel for use in agricultural extension.

In addition, literacy levels affect the ability of farmers to utilize information transmitted through digital channels of extension. The study found that all respondents have received some level of education with 41 percent of total respondents having achieved education levels of secondary school and higher. This means that majority of farmers have the requisite literacy level to read and understand information disseminated through digital platforms. These results agree with a study by Harvest Plus (2012) which found that most rural farmers are literate and can read and comprehend information disseminated in the digital platforms regarding dairy cattle farming activities.

Table 4.1: The Socio-economic Characteristics of Smallholders

Characteristics		Pooled Data %	Mobile technology %	Video mediated technology %	Video & Mobile combined %
Age	≤25 years	9	9	8	10
	26-35 years	11	12	10	11
	36-45 years	15	23	20	21
	46-55 years	45	43	47	45
	≥56 years	20	19	21	20
Gender	Male	13	14	11	13
	Female	87	86	89	87
Education Level	Lower Primary	21	30	28	28
	Upper primary	38	20	22	23
	Secondary School	23	13	20	19
	Certificate	10	27	20	16
	Diploma	8	10	10	14

N=120 Farmers

4.2 Occupational and Institutional Factors of Smallholder Dairy Farmers

Table 4.2 presents occupational and institutional factors of the sampled smallholders. The study results show an average of 69 percent of the respondents depend on farming as one of the sources of food and income. In various study groups, 67 percent of respondents in mobile technology group, 69 percent in the video mediated technology group and 50 percent of the respondents in combined mobile and video mediated group reported that they rely on farming as a significant contributor to their source of livelihood along with other occupations. However, an average of

only 29 percent depends on agriculture alone as an economic activity and food source this seems to indicate that a significant number of farmers tend to supplement their income through off farm income generating activities like employment and other types of businesses. Despite research showing that farming is the most effective route to reduce poverty in rural areas, poor prices and high dependence on seasonal rains makes this difficult to attain in Kenya therefore as new job opportunities come up in other sectors of the economy, farmers are encouraged to diversify their income sources or even exit agriculture entirely (Kirui, Okello, Nyikal, & Njiraini, 2013). Even with these insights, agriculture development is still one of the most transformative interventions Governments and development organizations are implementing.

The results also show that an average of 52 percent of farmers have an average landholding equal to or less than 5 acres. This is indicative of a high disaggregation of agricultural land in rural areas a phenomenon attributed to high population growth in rural areas resulting in decline in farm productivity, total household income, and asset wealth (Jayne & Muyanga, 2012). Furthermore, an average of 45 percent of farmers in the study reported being members of producer co-operative societies and as a result were able to market their farm produce while 55 percent reported that though they did not have membership to producer groups, still were able to sell their milk to local unstructured markets. These outcomes agree with a study by Muriuki (2011) which found that more than fifty percent of milk in Kenya, is marketed through informal (unlicensed) channels. The benefits that farmers earn through co-operative intervention is highlighted by FAO (2012) as better leverage of economies of scale, better access to agricultural extension and better marketing capabilities.

Findings from the study also showed that female farmers have higher access to training materials on agriculture accounting for 67 percent. The study also established that information technology is available and has been utilized by farmers in rural areas to access extension and market information, albeit in varying rates. An average of 30% of the total respondents from all the groups cited radio as the most common source of information on dairy farming followed by newspaper (17%). Digital media trails traditional channels of agricultural information transmission as follows Television (16%), Mobile Phone (13%) and Videos (12%). Similar results were found by Fielding and Ninsiima (2012) in their discussion brief noting that numerous people especially smallholder

farmers are adopting simple communication ICT tools that have capabilities of being used for accessing agricultural information albeit not comparable to conventional sources.

Table 4.2: Occupation and Institutional factors

Characteristics		Mobile Technology %	Video Mediated Technology %	Video & Mobile Combined %
Occupation	Formal Employment	17	20	23
	Farmer	30	29	27
	Businessperson	16	20	16
	Farmer + Employed	23	26	21
	Farmer + Business	14	23	13
Access to and use of digital platforms				
Mobile Phone	Yes	89	96	95
	No	11	4	5
Television	Yes	47	67	59
	No	53	33	41
Internet	Yes	13	15	14
	No	87	85	86
Practice Dairy Farming	Yes	61	60	62
	No	39	40	38
Member to Co-operative	Yes	46	47	45
	No	54	53	55
Land holding	≤5 Acres	50	58	49
	6-10 Acres	17	19	18
	11-15 Acres	20	21	21
	>15 Acres	13	12	12
N=120				

4.3 Household Characteristics

As illustrated in Table 4.3, the average household membership for farmers in Mobile technology group was 5.07 while the average household size for farmers in the video mediated group is 5.16 persons per household and that of farmers in the combined digital and video mediated group was 5.32 persons per household. The average years of experience for participants in the Mobile technology group was 8.15 while the mean number of years for farmers in the video group was 9.07 and that of farmers in the combined Mobile technology and video mediated group is 8.73 as illustrated in Table 4.3. Further disaggregation shows that male farmers have more experience in dairy farming due to their relatively easier access to capital and new technologies with an average

of 10.70 years of experience, compared to their women counterparts whose average years of experience in farming standing at 9.3 years.

The mean land ownership for all respondents in the study was 2.54 acres. Breaking this further by study group, the average land ownership for respondents in the mobile technology group was 1.78 and the mean land size among respondents in the video mediated group was 3.13 acres while the mean land size among the respondents in the combined mobile and video mediated group was 2.73. An average of 52 percent of all farmers own land of less than 2 ha which implies that majority of farmers in the study areas were smallholder in nature and are more likely to practice intensive dairy farming in a bid to maximize output from a unit of land. Such findings agree with a study by Campenhout, et al. (2017), who found that the small land size available to smallholder farmer opens them to opportunities of sustainable intensification of production and the application of newly discovered production improving technologies.

Table 4.3 Household Landholding, Household Membership and Experience in Farming

Variable	Average	Std. deviation
Land holding		
Mobile technology	1.78	0.7
Video mediated technology	3.13	1.74
Combined Group	2.73	3.13
Household Membership		
Mobile technology	5.07	1.47
Video mediated technology	5.16	1.65
Combined Group	5.32	1.76
Experience in Farming		
Mobile technology	8.15	1.13
Video mediated technology	9.07	1.20
Combined Group	8.73	1.07
N=120		

4.4 Access and Use of Agricultural Information among Dairy Smallholders

Table 4.4 illustrates a needs assessment of farmers who participated in the study. The study found that 86 percent of the farmers in the study were interested to learn about breeding, 82 percent

wanted information on feed production and 80 percent were interested on information about value addition. with an average of 20 percent. These results reveal the most important problems facing smallholder farmers can be alleviated by access to information. It is an indication that information about practices that lead to protecting livestock, and generation of more incomes from farm produce are highly sought after. Similar findings were found by Wilson, et al. (2014) who alluded that farmers are more interested to learn about technologies and practices that have demonstrable financial benefits to their livelihoods.

Table 4.4: Information of Interest to Smallholder Dairy Farmers

Topic	Pooled Data%	Mobile technology %	Video mediated technology %	Combined Mobile and Video group %
Breeding	86	83	90	85
Value addition	80	77	83	79
Feed Production	82	83	83	81
Marketing	79	83	73	81
Disease Management	71	73	70	72

N=120 Farmers

4.5 Influence of Video Mediated Learning on Uptake of Financial Services and Dairy Farming Technologies among Smallholder Farmers

As illustrated in Table 4.5, An analysis of responses on the Likert scale found that, 60 percent of farmers were positive that dairy technologies transmitted through videos were easy to apply at their farms. A similar finding was reported by Okello et al. (2012) who in their research on how ICT contributes to commercialization of smallholder agriculture found that digital communication platforms like videos are valuable tools for precise diffusion of standardized knowledge from a professional resource to low-literacy communities like smallholders. For example, in a situation where there are insufficient resources to higher professional trainers to facilitate multiple training activities digital communication platforms can provide effective alternatives for dissemination of the same knowledge at a fraction of the cost.

Table 4.5: Ease of Understanding and Application of Dairy Technologies Learnt from Videos

Characteristics	Understanding Information %	Application of best practices%
Positive	60	62
Neutral	19	23
Negative	21	15

N=40 Farmers

Where they are done professionally and necessary equipment are available to view, video mediated learning has proven to exceedingly successful in sharing valuable information for agricultural development. Furthermore, Woodard (2012) in his study found that multimedia, such as video, provide fantastic prospects for transmitting individualized information small holder farmers at scale.

4.5.1 Influence of Videos on Adoption of Financial Services and Dairy Technologies

Figure 4.1 presents the rate of adoption of new technologies. There was a significant improvement in the number of farmers who kept dairy livestock after the study from 38 percent to 53 percent before the study. These results indicate that adoption of new dairy technologies as a result of training through videos is associated with a higher uptake of agricultural credit services by smallholders. When information on access to finance was embedded into agricultural extension videos, it significantly increases farmers knowledge on the economic benefits of dairy enterprises and as a result, they gain information on how they can access agricultural credit for investment in their dairy farms. Abate et al (2012) found comparable findings in Ethiopia and reported that videos with information relevant to famers needs and featuring successful lead farmers stimulate a change in behavior by constructively influencing their decisions at their farms.

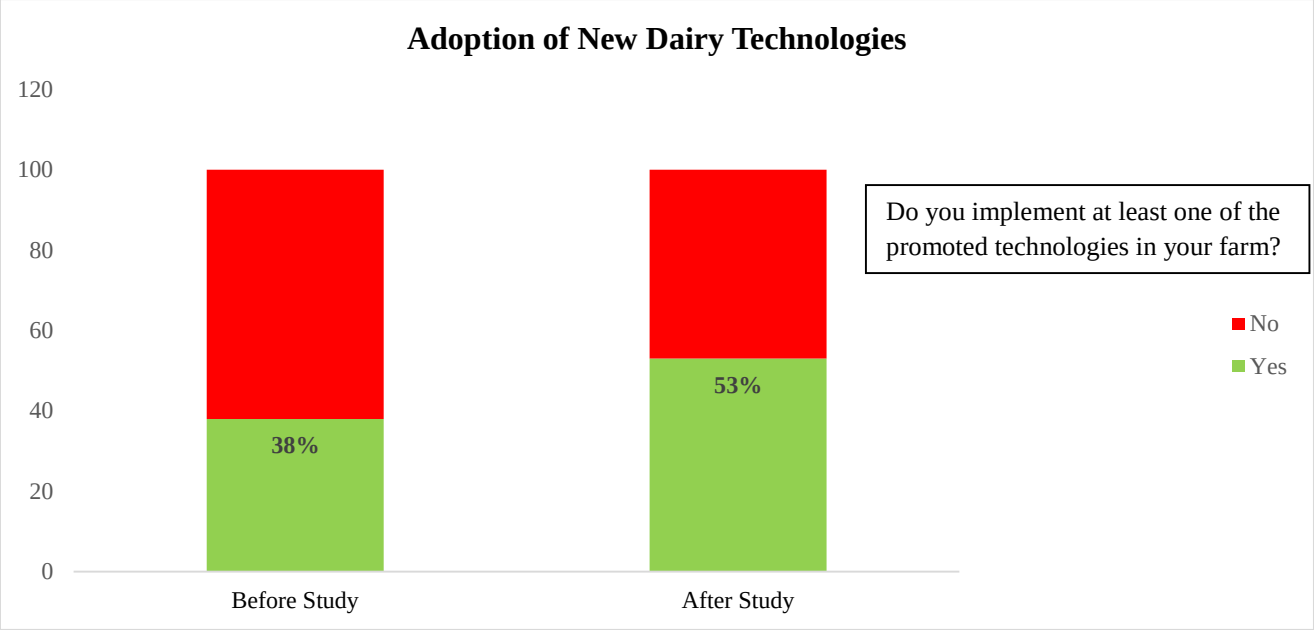

Figure 4.1 Influence of Video Mediated learning on adoption of New Dairy Technologies

Figure 4.2 further illustrates that uptake of financial services increased from 49 percent before the study to 52 percent after the study. This scenario is expounded by the reality that, farmers can readily access financial services from multiple sources however, utilization for improving agricultural enterprises like adopting dairy technologies is low. Many smallholder farmers lack access to information on appropriate financial services to upscale their farming enterprises (Walukano et al, 2017). Therefore, advisory coupled with financial services unlocks their potential of agricultural credit to expand their farming activities.

4.5.2 The Correlation between Socio-economic Factors and adoption of the Financial Services

As illustrated in Table 4.6.1, the study found in the combined mobile and video technology group a negative correlation (r=-0.497, p=0.03) when the respondents age is tested against the uptake of financial services. This finding means that the uptake of financial services reduces as the age of the smallholder farmer increase. In comparison, a significantly higher negative correlation was observed in the correlation between level of education of smallholders (r=-.259, p=0.000) and the uptake of financial services for dairy farming purposes. Compared to the other study groups, the correlation between education level, age and uptake of financial services is much lower. The study finds that Farmers with higher education level do not prefer to uptake financial services for dairy

farming purposes. Even though farmers who have acquired a higher than basic level of education, are expected to understand the educational content transmitted through digital channels and utilize in making rational decisions, they often choose to invest borrowed capital in other investment purposes.

Furthermore, the study found a positive correlation ($r=0.613$, $p=0.00$) between farmer experience in farming and uptake in financial services. The correlation was slightly lower ($r=0.582$, $p=0.00$) in the video mediated technology and in the Mobile technology group ($r=-0.553$, $p=0.00$). Farmers with more experience in dairy farming understand the technology needs of their enterprise and tend to have a higher confidence to take up credit therefore the higher likelihood of taking up financial services. The fact that a higher correlation is seen in the combined mobile and video learning technologies group is an indication of the effectiveness of the experiment.

In addition, further analysis reveals that respondents who are members of co-operative societies have a less likelihood to take up financial services from other financial institutions illustrated by the negative correlation between the membership in co-operatives and uptake of financial services in all study groups. Similar findings were reported by Wilkes et al (2018) who found that although formal financial institutions are prevalent in developing countries, a big percentage of dairy farmers have not attempted to apply for credit at any of the mainstream financial service providers sighting barriers including the thinking of not needing a loan, dread of losing properties, limited ability to pay a loan, lacking security and inadequate of credit rating.

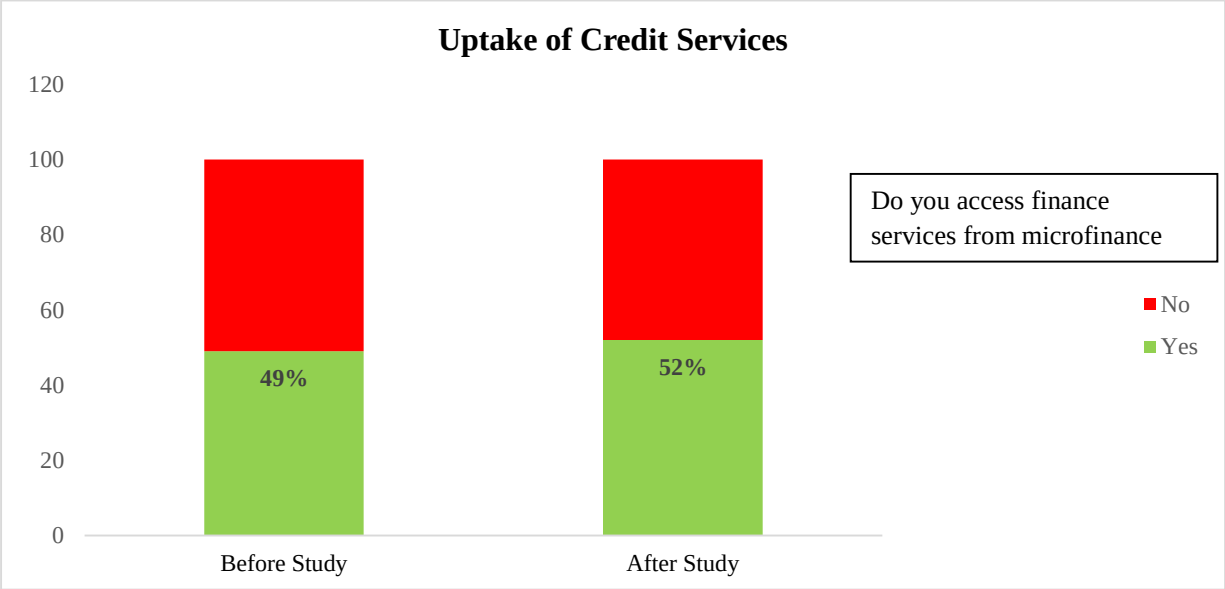

Figure 4.2: Influence of Video Mediated Learning on Uptake of Financial Services

Table 4.6.1: Relationship between Socio-economic Factors and the adoption of Financial Services

	Financial Services Uptake	Gender	Age	Education Level	Land Ownership	Experience in Farming	Membership to co-operatives
Mobile Technology	Correlation (r)	-0.160	-.560**	-.371**	-.091	.553**	-.417**
	P=Value	.098	.000	.001	.348	.000	.000
Video mediated Technology	Correlation (r)	-.126	-.485**	-.283**	-.083	.582**	-.425**
	P=Value	.083	.075	.000	.275	.000	.003
Combined Mobile and Video group	Correlation (r)	-.185	-.497**	-.259**	-.075	.613**	-.472**
	P=Value	.067	.003	.000	.320	.000	.000

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

4.5.3 The Relationship between Socio-economic Factors and Adoption of Digital Communication Platforms

The correlation analysis as shown in Table 4.6.2 between the uptake of dairy technologies and gender reveals a stronger positive correlation in the combined mobile and video technology group (r=0.573, p=0.094) compared to the video mediated technology group (r=0.526, p=0.080) and the

mobile technology group (r=0.512, p=0.091) groups revealing that men were more likely to take up dairy technologies promoted through digital channels compared to women. In their report titled GSMA Connected Women, Rowntree et al (2019) found that the digital gender gap extends beyond just ownership and access and identifies that there is a wider gender gap in the use of digital services, which widens further for mobile internet-based services.

In addition, the study found a positive correlation between uptake of digital technologies and education level of the respondents. The combined mobile and video technology group (r=0.604, p=0.009) among the three study groups demonstrating that farmers who have attained higher education levels have a higher ability to comprehend and actualize advice received through digital platforms. The correlation was (r=0.597, p=0.013) in the video mediated group and (r=0.508, p=0.026) mobile technology group. Furthermore, the study observed a negative correlation when the experience in farming of the respondents is tested against use of digital communication platforms. Of the three study groups, the farmers in the combined mobile technology group had a lower negative correlation (r=0.420, p=0.091) signifying that farmers with more years of experience in farming exhibit a lower uptake of digital technologies while the combined mobile and video technologies group had the lowest negative correlation (r=0.359, p=0.073). Similar findings were arrived at by UNESCO (2017) on their case study in Guatemala found that younger farmers tend to have attained higher education levels and as a result have no problem utilizing digital technology platforms however, they do not have the field experience to understand the challenges and limitations like their older counterparts who have low literacy levels.

Furthermore, the study found that the correlation between membership to co-operatives and uptake of digital technologies is significantly positive across all study groups. The highest correlation being the combined mobile and video technologies group (r=0.480, p=0.958) and the lowest being the mobile technology group illustrating that farmers who are members of co-operatives are able to take up technologies more easily though at low rate. As explained by Wilkes, et al. (2018), dairy co-operatives that provide superior services to farmers by way of their in-house extension departments can lead to lower interest in alternative extension channels such ad digital extension platforms.

Table 4.6.2: Relationship Between Socio-economic Factors and Adoption of Digital Communication Platforms

	Financial Services Uptake	Gender	Age	Education Level	Land Ownership	Experience in Farming	Membership to co-operatives
Mobile Technology	**Correlation (r)**	.512	.241	.508	.205	-.420	.309
	P=Value	.100	.050	.026	.204	.100	.267
Video mediated Technology	**Correlation (r)**	.526	-.069	.597	.071	-.327	.434
	P=Value	.100	.050	.013	.664	.050	.410
Combined Mobile and Video group	**Correlation (r)**	.573	.166	.604*	.036	-.359	.480
	P=Value	.100	.010	.009	.826	.100	.958

*. Correlation significance level at 0.05 in a 2-tailed

4.6 Evaluating how Mobile Phone Technology Influence Uptake of Financial Services and Dairy Farming Technologies among Smallholders

Mobile communications technology has the advantage of offering a cheaper way of transmitting expertise and innovations to remote areas, disseminating learning and technical courses and empowering rural communities to negotiate better prices for agricultural produce (Okello, et al., 2014). The study found that 92 percent of all participants owns a cell phone which reiterates the findings of Okello, et al. (2012) which alluded the growing dependence of rural households on mobile phones for communication and access to financial services unlocks potential for transmission of information that can be beneficial to agricultural development. A report by Kanwar & Daniel (2009) further reported a phenomenon popularity of mobile phones in farming households and uncovered a fantastic opportunity for the ICT tool to make knowledge dissemination possible amongst farmers. Therefore, the mobile phone opens a new opportunity for dissemination of agricultural information and new technologies in a much more efficient way.

4.7.1 Ease of Understanding and Application of Dairy Technologies Learnt from SMS

Table 4.7 presents a measurement of farmers' opinion on the information they received through digital means. Results showed that 46 percent of the respondents in the SMS group found the information on dairy best practices and new technologies they received during the study period to be easy to understand and to apply at their farms. That is 23 percent agreed and 23 percent strongly agreed to the statement. Masuki, et al. (2011) reported similar findings in his study which reported that information sent through mobile phones to farmers can be used to time farm operations, like

breeding, feed planting, harvesting, storage and market information on price. At the same time, farmers also seem to attach a level of importance by obtaining information faster than neighbors. The perception of the farmers to the channel through which information is distributed is important in ensuring uptake of promoted information. In their study Okello, et al. (2014) concluded that mobile phones could transmit important to farmers for better allocation of production factors like land and capital. This study confirms the fact that clarity in information transmitted to farmers on value chain related areas such as market prices, improve their negotiating power and enhance their competitiveness.

Table 4.7: Ease of Understanding and Application of Dairy Information Received in SMS

Characteristics	Understanding Information %	Application of best practices %
Positive	46	44
Not Sure	20	25
Negative	33	31

N=40

4.7.2 Influence of mobile phone platforms on adoption of loans and dairy technologies

In this study we tested the reminder effect of specially designed text messages (SMS) send to farmers' mobile phones. 44 percent of respondents in the SMS group reported that they implemented some of the practices advocated for in the text messages as illustrated in figure 4. These results agree with a similar study by (Travis, 2015) which found that text messages when used as reminders are effective in encouraging the adoption of agricultural best practices that maybe complex, and for which no separate investment is required. On the same note, it is important to appreciate that SMS has various limiting factors to its effectiveness as a channel for distributing actionable information including literacy level of farmers, inability to demonstrate and messages are restricted to 160 characters. These characteristics make this channel more effective when used to complement other extension methods like video and farmer field school. This agree with sentiments by Toyoma (2020) that there is a developing comprehension of the potential ICT tools have in broadcasting important information while informing research on the intention and competences of the individuals targeted to utilize them.

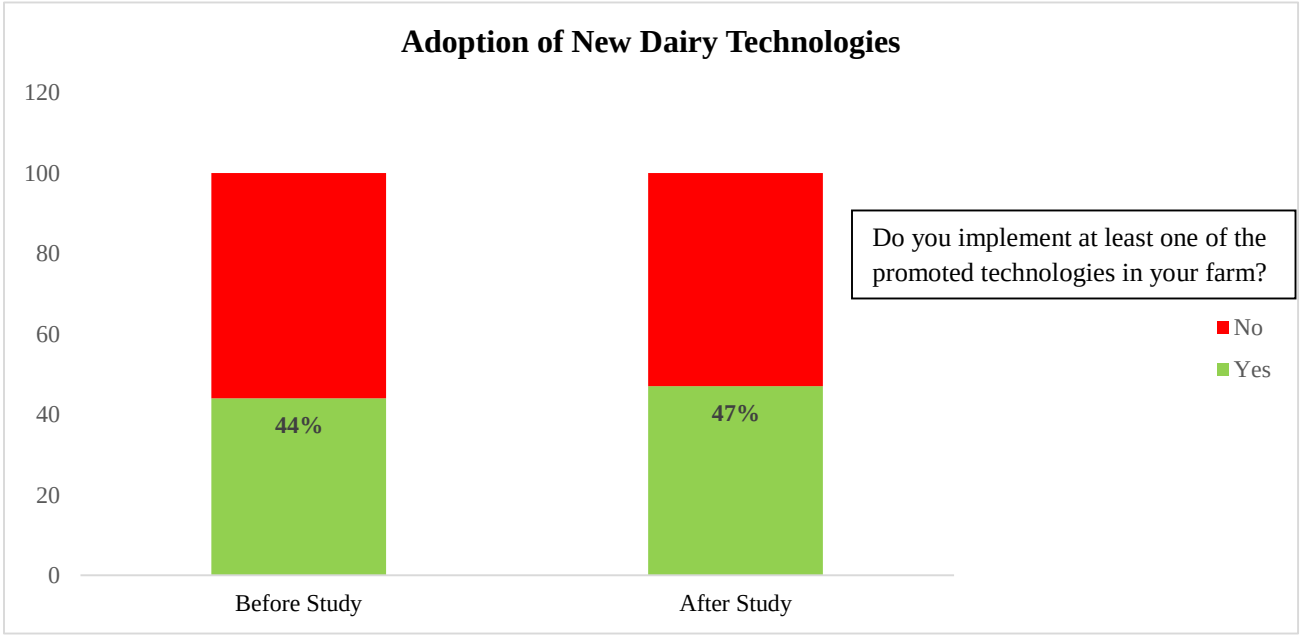

Figure 4.3: Influence of mobile SMS on adoption of Dairy Technologies

Uptake of modern dairy technologies and practices by small holder farmers is helped by availability of financial services. In this study the percentage of farmers taking up loans to invest in dairy farming increased from 47 percent to 53 percent in the mobile technology group. This is an indication that access to financial services has much more effect in motivating adoption of technologies by smallholder farmers compared to access to information. This serves to illustrate

that despite how exciting a new technology could be farmers still need capital to be able to implement at their farms.

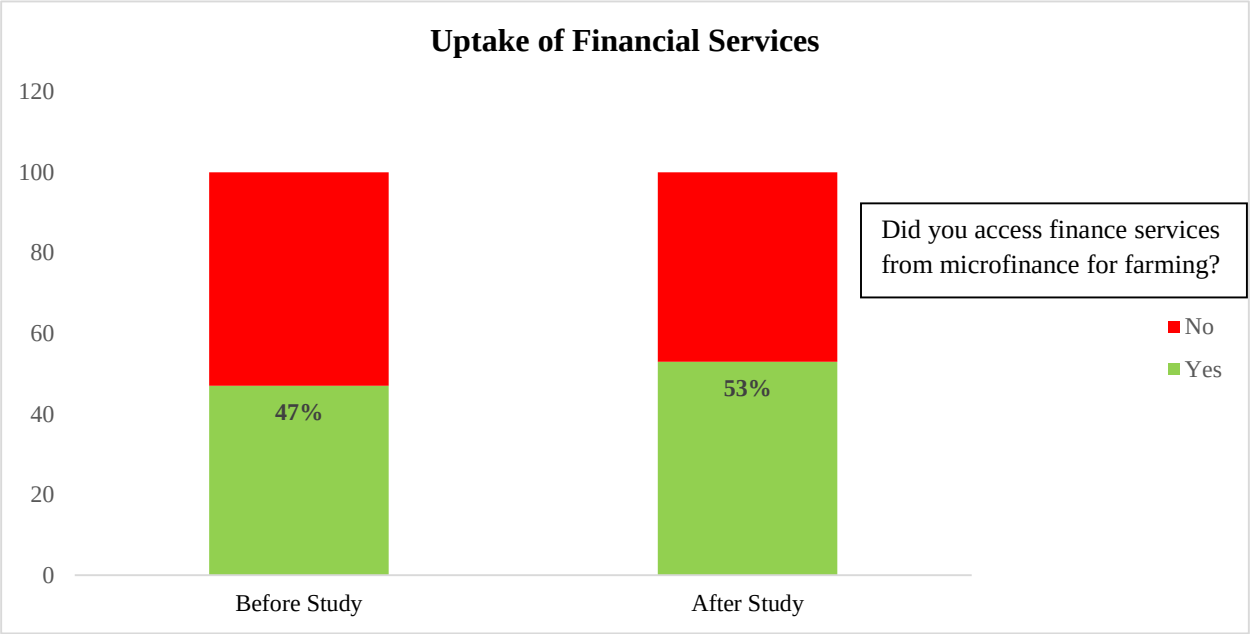

Figure 4.4: Influence of mobile SMS on uptake of Financial Services

CHAPTER FIVE
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter depicts a discussion of the key findings of the study aligned to the main objective and explains out the conclusion and recommendations for future research.

5.2 Summary

For every new technology, the attitude of the intended users on its usefulness and ease-of-use determines the level rejection or acceptance. As alluded in the Theory of Change, the perception of individuals on the usefulness of an ICT system and the ease of use does determine whether they will more easily adopt it when compared to others of the contrary opinion. As the debate on how best to provide smallholder farmers with the appropriate information continues, the study sought to address two main objectives, which were:

i. Assess factors that influence uptake of financial services and dairy technologies among small holder dairy farmers.
ii. Evaluate the influence of digital platforms on the uptake of financial services and dairy technologies by smallholder dairy farmers.

i. Assessment of factors that influence uptake of financial services and dairy technologies among small holder dairy farmers.

The study found that socio-economic factors like Age, Gender, Education have significant effect on how digital platforms are utilized to access agricultural information. Key to note is that older farmers were less likely to take up digital extension technologies and new farming technologies. This is believed to be because of the risk averse nature of the older generation compared to their younger counterparts. However, this may pose to be a challenge given that the mean age of farmers in the study were 54 years old which means digital interventions in extension can compound rather than remove existing challenges in agricultural sector. Furthermore, male famers and participants of who have a level of education higher than primary school level will readily to take up digital extension services. Being a member of a co-operative society make one less likely to take up alternative extension and financial services like digital platforms because they already get extension and finance services traditionally offered by most co-operative societies.

ii. **Evaluate the influence of digital platforms on the uptake of financial services and dairy technologies by smallholder dairy farmers.**

Digital technology has significantly affected practically all sectors of the economy, and agriculture is no exception. This study has determined that digital technologies when used in agricultural extension significantly lead uptake of new technologies and financial services. Mobile technology and video mediated learning both are both effective in extension however the highest uptake in financial services and dairy technologies is observed when both technologies are combined, where farmers watch videos on new technologies then received mobile phone messages occasionally during implementation of the learned technologies.

It should be noted that technology can only address some, and not all, of the barriers faced by farmers therefore this study finds that the role of government is pivotal in supporting innovations in the extension system to enable proliferation of digital platforms supporting extension. It should ensure that extension institutions and organizations developing digital extension content and infrastructure are incentivized with necessary support such as rural infrastructure, expansion of the grid and research. In so doing, farmers will develop positive attitude towards non tradition extension channels and make access to information possible in an affordable and sustainable way.

5.3 Conclusions

Assessment of factors that influence uptake of financial services and dairy technologies among small holder dairy farmers.

Farmers aim to increase their production by putting into practice new farming practices. As many studies have indicated, the onset of digital technologies has created new and more affordable opportunities for passing down information on dairy production technologies and financial services to farmers in rural areas.

It was concluded that personal traits of the participants like gender, age, education, farmer experience and membership to co-operative significantly influenced and contributed to the uptake of financial services and dairy technologies among smallholder farmers.

Evaluate the influence of digital platforms on the uptake of financial services and dairy technologies by smallholder dairy farmers.

It is a known fact that conventional, face-to-face agricultural extension works. Unfortunately, these face-to-face approaches require resources that no public or private extension program can sustain. This study concluded that concluded that mobile phones technology combined with video mediated learning are able to achieve significant uptake of improved dairy technologies and financial services among the farmers. Therefore, digitally enabled extension can be used to effectively communicate information that is beneficial to farmers with significant levels of success.

5.4 Recommendations and Policy Implications

i. Assessment factors that influence uptake of financial services and dairy technologies among small holder dairy farmers.

The study found that socio-economic characteristics and institutional factors attributed to dairy farmers have an association with uptake of agricultural training delivered through digital platforms. This serves to demonstrate that while digital technology can alleviate some limitations and challenges facing traditional face to face agricultural extension service provision, actual use of the platforms and implementation of training transmitted is dependent on their perception and ability of the farmers to comprehend the training.

This study makes recommendations to policy makers and extension service practitioners in the national and county government to carryout assessment and analysis of important attributes of target farmers to advice the choice of digital platform to adopt for facilitating agricultural training programs. Further, they should seek to explore ways to use digital platforms to complement traditional or other modern agricultural extension approaches in order to achieve optimal results and make provision of the service sustainable.

ii. Evaluate the influence of digital platforms on the uptake of financial services and dairy technologies by smallholder dairy farmers.

The study determined that training delivered through two digital platforms that is Video Mediated Technology and Mobile phone SMS, are able to stimulate uptake of dairy technologies and agricultural credit among farmers albeit in varying rates. This demonstrates the effectiveness of digital tools when it comes to dissemination of important agricultural information to smallholder farmers.

This study recommends to Government, development and private organizations providing extension support to smallholder farmers to explore the application of digital tools like mobile

phone text messages and video either for use as standalone training and information dissemination platforms or in a complementary manner with other digital platforms and extension approaches.

5.5 Recommendation for Further Research

By virtue of farmers being an excessive rural population, owning small farm sizes and using inefficient farm management practices, one of the most important tools to help overcome their challenges is to reform extension service delivery in Kenya. Further research needs to be undertaken to establish the cost benefit analysis of digital platforms as channels for extension service delivery and the level of complementarity of different tools available for institutions and organizations to exploit.

Further research should be designed to investigate institutional arrangements and technical competences required for digital extension technologies to thrive in Kenya. While attempting to answer questions on whether digital tools or services that are cost-effective, work best for reaching women and youth, give farmers a voice, or can be sustained and scaled organizationally and financially. This will pave way for effective integration of technologies in extension service delivery and guarantee more sustainable implementation at county government level.

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Appendix I: Farmers Questionnaire (Baseline)
Date. _____Questionnaire No. _____

Section A: General Characteristics

This questionnaire is part of a research which aims at understanding the effectiveness of videos and Text messages in dissemination of agricultural information and technologies and uptake of financial services among small holder farmers in Uasin Ngishu county.

1.1. Name of respondent (At least two names) _____

1.2. Gender: Male [1] Female [2]

1.3. Family position: [1] House Hold head [2] Spouse to the House Hold Head [3] Child <18 years [4] Relative [5] Other (specify) _____

1.4. Age in years: [1] ≤25 years [2] 26-35 years [3] 36-45 years [4] 46-55 years [5] ≥56 years

1.5. Education level: [1] Lower Primary [2] Upper primary [3] Secondary School [4] Certificate [5] Diploma [6] Degree [7] Postgraduate

1.6. Occupation: [1] Formal Employment [2] Farmer [3] Business Person [4] Employed + Farmer [5] Farmer + Business

1.7. Do you own a Mobile Phone? [1] Yes [2] No

1.8. Do you own a Television set [1] Yes [2] No

1.9. Do you own a DvD player [1] Yes [2] No

1.10. What is the size of your farm

[1] ≤5 Acres [2] 6-10 Acres [3] 11-15 Acres [4] >15 Acres

1.11. Do you keep livestock for commercial milk production

[1] Yes [2] No

1.12. If Yes, what livestock do you keep for milk production

[1] Cattle [2] Goats [3] Sheep [4] Other_____

Section B: Farmer access to agricultural extension approaches and methods

		Tick the one that applies to the farmer
2.1	Do you supply milk to a milk cooperative society	[_] 1= Yes [_] 2= No
2.2	Do you receive the following training services from the cooperative/Ministry of Agriculture	[_] 1= Yes [_] 2= No - A.I Services [_] 1= Yes [_] 2= No – Feed production [_] 1= Yes [_] 2= No - Health Management [_] 1= Yes [_] 2= No - Value Addition [_] 1= Yes [_] 2= No – Farm Demonstration
2.3	Do you get support or visits from extension agents	[_] 1= Yes [_] 2= No
2.4	You have access dairy farming information from the following sources	[_] 1= [_] 2= No – Radio [_] 1= [_] 2= No – Television [_] 1= [_] 2= No -Brochures [_] 1= [_] 2= No -Newspapers [_] 1= [_] 2= No – Mobile Phone messages [_] 1= [_] 2= No – Organizational visits [_] 1= [_] 2= No – Video Disks
2.5	Have you ever attended a field day where Dairy farming is discussed	[_] 1= Yes [_] 2= No
2.6	What areas interested/fascinated you most on dairy farming	[1] Feed Production [2] Disease Management [3] Breeding [4] Value addition [5] Marketing

Section C. Farmer Socio economic factors

3.1	How do you reach your market	[1] By foot [2] Bicycle

		[3] Motorbike [4] Matatu
3.2	What is type of land tenure for the land under dairy farming	[1] Own Title deed [2] Leased [3] Inherited Land (Family title) [4] Community Land [5] Other _____
3.3	How many family members do you have in your house hold?	[1] 1-3 Members [2] 4-6 Members [3] 7-9 Members [4] >10 Members
3.4	How many milk producing livestock do you keep in your farm?	[1] 1-3 [2] 4-6 [3] 7-9 [4] >10
3.5	How much milk do you get from your dairy animals per day in Litres	[1] <5 [2] 6-10 [3] 11-15 [4] 16-20 [5] >20
3.6	What is the source of Labour in your farm	[1] Family [2] Hired/Wage [3] Permanent [4] Others (specify) _____
3.7	What is the source of your farming capital	[1] Own Savings [2] Family [3] Microfinance/Bank [4] NGO [5] Chama [6] Inheritance [7] Government subsidy
3.8	Why did you join Juhudi Microfinance	[1] Loans [2] Savings
3.9	If 3.8 is [1] Loans, what do you intend to use the loan for	[1] Livestock Farming [2] Crop Farming [3] Working Capital [4] Farm Equipment [5] Other

Appendix II: Farmers Questionnaire (Endline)

Date. _____Questionnaire No. _____

Section A: General Characteristics

This questionnaire is part of a research which aims at understanding the effectiveness of videos and Text messages in dissemination of agricultural information and technologies and uptake of financial services among small holder farmers in Uasin Ngishu county.

4.0 Name of respondent (At least two names) _____

4.1 Which service did you receive during the experiment period?

[1] SMS Messages [2] Video [3] None

2. Section B: Farmer use of agricultural information derived from Video and SMS

		Tick the one that applies to the farmer
4.2	Did you keep livestock for Milk before the experiment period?	[_] 1= Yes [_] 2= No
4.3	Did you acquire any livestock for Milk during or after the experiment period?	[_] 1= Yes [_] 2= No
4.4	If Yes, did you seek capital from Microfinance or Bank to acquire new livestock	[_] 1= Yes [_] 2= No [_] 3= NA
4.5	If Yes, how much capital did you borrow from the Microfinance or Bank	[1] ≤10,000 [2] 10,001 – 20,000 [3] 20,001 – 30,000 [4] 30,001 - 40,000 [5] 40,001 – 50,000 [6] >50,000 [7] = NA
4.6	How Easy was the process of getting the Loan from Microfinance/Bank	[1] Very Easy [2] Easy [3] Moderate [4] Difficult

		[5] Very difficult [6] = NA
4.7	How many milk producing livestock do you keep in your farm?	[1] 1-3 [2] 4-6 [3] 7-9 [4] >10
4.8	How much milk do you get from your dairy animals per day in Litres	[1] <5 [2] 6-10 [3] 11-15 [4] 16-20 [5] >20
4.9	Where do you sell your milk	[1] Dairy Co-operative [2] Local Market [3] Don't sell

3. Section C: Ease of understanding agricultural information derived from Video and SMS and access of financial services

		Choose one
5.1	Information received from SMS messages was easy to understand and practice	[1] Strongly Disagree [2] Disagree [3] Moderate [4] Agree [5] Strongly Agree [6] NA
5.2	I find SMS as the most preferred channel above all others to receive agricultural advice for my farm	[1] Strongly Disagree [2] Disagree [3] Moderate [4] Agree [5] Strongly Agree [6] NA
5.3	Information in videos seen was easy to understand and practice	[1] Strongly Disagree [2] Disagree [3] Moderate [4] Agree [5] Strongly Agree [6] NA

5.4	I find Videos as the most preferred channel above all others to receive agricultural advice for my farm	[1] Strongly Disagree [2] Disagree [3] Moderate [4] Agree [5] Strongly Agree [6] NA
5.5	My livestock production has increased as a result of advice I got from SMS/Videos	[1] Strongly Disagree [2] Disagree [3] Moderate [4] Agree [5] Strongly Agree
5.6	My livestock health has improved as a result of advice I got from SMS/Videos	[1] Strongly Disagree [2] Disagree [3] Moderate [4] Agree [5] Strongly Agree
5.7	Access to capital (Loan) from Microfinance/Bank was easy	[1] Strongly Disagree [2] Disagree [3] Moderate [4] Agree [5] Strongly Agree