2020

Determinants of digital technologies adoption among small scale farmers in Kenya - a case of Embu and Kirinyaga Counties.

Kiarie, Hussein
Strathmore Business School
Strathmore University

DETERMINANTS OF DIGITAL TECHNOLOGIES ADOPTION AMONG SMALL SCALE FARMERS IN KENYA. A CASE OF EMBU AND KIRINYAGA COUNTIES

HUSSEIN KIARIE

MBA 110513/2018

A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE OF MASTER OF BUSINESS ADMINISTRATION OF STRATHMORE UNIVERSITY

SEPTEMBER 2020

DECLARATION

I, Hussein Kiarie, declare that this project is my original work and has not been submitted for examination in any other institution.

HUSSEIN KIARIE

MBA 110513/2018

Sign: ……. **Date: ……**

Approval

This research project has been submitted for examination with my approval as the university supervisor

Dr.

Lecturer

Strathmore University

Sign: ……. **Date: ……**

ABSTRACT

Despite the fact that Kenya is a regional innovation hub with the increasing digitalization of the various sectors within the economy, the adoption of technology within the agriculture sector has not been at par with the rest of the economy. This study sought to examine the determinants of the adoption of digital technologies within the agriculture sector. The study sought to establish the effect of resource capability, managerial capability, extension services, and socioeconomic factors on digital technology adoption. The study was grounded on the technology organization and environmental framework. The study adopted a descriptive research design with the population of the study being drawn from Small-Scale commercial farms in Embu and Kirinyaga County. The sample population for the study was 387 participants with a quantitative research instrument being utilized in the study. The study adopted a drop and pick method in the data collection process. The collected research data was analyzed using descriptive and inferential statistics. The analyzed data was presented using tables, charts, and bar graphs. The research was able to obtain a 93% response rate. The results of the study showed that, to some extent, most of the farmers were utilizing the various technological farms in their day to day farming activities. The study concludes that 18.5% of changes in the adoption of agricultural technologies was determined by the, household income, household size, gender farmers age, farming experience, education of the farmer, level of resource capability, managerial capability, and access to extension services. The The research recommends that the government should enhance research and development, which will support the introduction of modern technologies. The study recommends that farmers should enhance their collaboration and pooling of resources to support their capacity to adopt new agricultural technologies.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

AgTech	Agriculture technology
GDP	Gross Domestic Product
ICT	Information Communication Technology
NACOSTI	National Commission for Science, Technology and Innovation
SME	Small and Medium Enterprises
TAM	Technology Adoption Model
TOE	Technology, Organization, and Environment

OPERATIONAL DEFINITION OF TERMS

Extension services This refers to all the set of actions by agricultural government organizations in an effort to support individuals engaging in agricultural activities (Ajayi & Solomon, 2017)

Resources capability This refers to the physical equipment, materials and financial support afforded to farmers to enable them to comfortably engage in agricultural activities (Beshir, Emana, Kassa, & Haji, 2012)

Small scale farmers These are farmers who engage in agriculture on small pieces of land whose size is not bigger than 5 acres, sometimes planting crops and rearing animals on the same piece of land (Ingabire, Yonggong, Pesha, & Hardi, 2018)

Technology Technology is a body of knowledge involved in the creation of methods, tools, and systems that are used by human beings in the various industries, art, and science to create efficiency or simplify work (Kabunga, Dubois, & Qaim, 2012)

Technology adoption The decision by an individual or organization to acquire and incorporate new innovation into their system (Ogutu, Okello, & Otieno, 2014)

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

All world economies are dependent on their agricultural background to provide food to the population by providing food (World Bank, 2017). In Asia, the occurrence of the Green revolution largely caused farming practices to be modernized in the twentieth century (Frankel, 2015). The immediate results of the revolution were substantially improved agricultural yields and eventually elevated national food production and better food security (IFAD, 2011).Israel is the world's leading country in the agriculture technology (AgTech) sector despite only having 20 percent arable land and the rest being arid. There are more than 450 companies in the agri-tech sector, providing advanced data imaging, collection and analysis techniques, aerial technologies that have enhanced efficiency in farming and agricultural innovation (Leichman, 2019).

Small scale farmers are responsible for 80% of the food consumed in Asian and Sub-Saharan countries. African small-scale farmers occupy most of the land and are responsible for most crop and animal produce. It is, therefore, paramount that these small-scale farmers be empowered to ensure that the continent is able to keep up with the food demand, which most projections peg to double by 2050 (Committee on World Food Security, 2013). Agriculture is a key player in the economy of African countries, accounting for up to 40% of the total Gross Domestic Product (GDP) and up to 60% of export revenue (Altalb, Filipek, & Skowron, 2015). Most rural households in the region depend on agriculture as the main source of income. The agricultural sector has seen increasing attention, but it is worth noting that low levels of productivity has hampered its development, making it necessary to incorporate technology into farming systems so as to increase the level of production (Alia, Nakelse & Diagne, 2013).

A five-year report conducted on the agricultural sector indicated a gradual decline in the sector's growth from 5.4 percent in 2013 to around 1.6 percent in 2017. Similar to other African nations, the country's state of food insecurity is attributed to several factors: high production costs due to high farming inputs costs such as fertilizers, conflicts that cause displacement of families from agricultural areas, frequent droughts in some areas of the country, poor access to markets by the food producers, lack of modernization and poor integration of technology in the sector (Parliamentary Service Commission, 2018). In Kenya, agriculture is considered the main pillar of the economy. As of 2017, it was estimated to contribute 31.5 percent directly to the Gross Domestic Product (GDP) and accounted for over 50% of the country's exports

(Parliamentary Service Commission, 2018). Approximately 60% of the population is involved in the agricultural sector, making it the largest employer. Eighty percent of the rural area population is involved in agriculture and related activities as a source of their livelihood. The sector enjoys high priority attention from the government as it promotes its national development since it contributes 45 percent of government revenue (Food and Agriculture Organization , 2017).

Agricultural production in Kenya is low, just as can be noted in other developing countries. It is, therefore, important to increase agricultural productivity since it will; spur the growth of the economy, thus ensuring that the country realizes vision 2030, the country's plan to achieve universal living standards (Kipserem, Sulo, Chepngʻeno, & Korir, 2011). Increasing agricultural productivity can be achieved by developing new agricultural technology, which can then be disseminated to the farmers to improve their yields (Lopokoiyit, Onyango, & Kibett, 2013). Improving the level of quality sustainable agricultural production is mostly dependent on the willingness of the farmers to access, practice, and adopt new agricultural technologies and innovations which are in constant development and dissemination to interested farmers via research centers funded by the government and other private companies (Mashall & Miguel, 2014). Kenya's agricultural sector has been experiencing a rise in mobile farming applications that seek to solve common problems encountered by farmers. These mobile farming applications have helped in reducing information gaps facing farmers, such as variations in market prices and conditions, new farming technologies, fluctuations in weather patterns, and knowledge on where to buy farm inputs (Kadenyi, 2017).

The use of technology in irrigated food production presented an opportunity for farmers in irrigated food production areas to increase their yields through the uptake of the necessary information to increase their farm yields (Choudhury, Das, Sarmah, & Ahmed, 2018). Embu and Kirinyaga counties are at the forefront of Agriculture in the country. These counties possess fertile soil and good farming conditions. They are also heavily irrigated due to the massive rice production in the area. (Mwenzwa & Misati, 2014). With the presence of these conditions, there exist many small-scale farmers in the region. The study thus sought to find out whether these farmers have adopted the necessary technology and the determinants of these technologies.

1.1.1 Digital Technologies Adoption

Technology is defined as a body of knowledge involved in the creation of methods, tools, and systems for human application in various industries, art, science (Lamuka, 2015). The use of

technology is widespread across all industries and customized to suit the needs of the particular sector (Olwande, Smale, Mathenge, Place, & Mithofer, 2015). Agricultural technology (AgTech) plays a central focus in relation to food matters and refers to the production of machinery, systems that help in increasing efficiency during farming. Agricultural technologies are categorized into four main types; mechanical technology, biotechnology, and nanotechnology, biological and biochemical, and indigenous technology (Ozor & Urama, 2013).

Around different parts of the world, technology use involves a series of steps by which farmers or individuals become aware of the existence of new technology and over time, become increasingly aware of its usefulness and through effective usage, incorporate these systems into their daily use (Food and Agriculture Organization , 2017). It is therefore important to improve the ease of access to the internet since it is essential in unlocking the limitless possibilities of new and emergent digital technologies. It has been noted that internet usage has increased worldwide, but this is disproportionately in developed nations. This is because while half the world has access to the internet, only one in seven people use the internet in developing nations, (ITU, 2016) with huge disparities between rural and urban areas.

With digital technology adoption, every part of the agri-food chain has evolved. According to Droesch (2015), therein increased resource management through optimization, individualization, and intelligence adoption. The system is data-driven and works in a hyperconnected network of different technologies. It is now possible to trace valuable chains in the loop, and through information coordination, it is possible to accurately manage different fields, crops, and animals, each with their own optimal prescriptions. Through the digitalization of agricultural systems, farmers are able to become more productive since they can now anticipate and adapt to changes resulting from climate change leading to more reliable food security, profitability, and sustainability (Droesch, 2015).

Agricultural technologies are among the most effective tools available to small scale farmers both in the past and in modern times; technological change has been noted to be the key factor shaping agriculture in the last century (Wanyama, Obare, Owuor, & Wasilwa, 2013). Adeyemo (2012) found information communication technology (ICT) to be among the most effective solutions to issues arising within the agricultural industry, which include weak links in the market, poor management of information, low production levels, low income, and low levels of diversity. Langat et al. (2014) reported that due to slow rates of adoption, food security in

African countries would be at risk. Additionally, the economic empowerment initiatives put in place by government and non-governmental institutions to aid in the development of food generation practices are also impacted.

Kanchanatanee, Suwanno, and Jarernvongrayab (2014) looked into the factors that influence the intention of SMEs to use e-marketing tools to improve agricultural production based on the Technology Adoption Model (TAM) factors, which include attitude, perceived usefulness, and ease of use. Reardon, Chen, Minten and Adriano (2012) in countries like China, India, and Vietnam showed that 80% of farmers used mobile phones to connect with traders to estimate market demand and selling prices. In a study in the Philippines, Mariano, Villano, and Fleming (2012) note that farmer's education, government strategies, access to credit and extension services predicted the adoption of modern agricultural technologies. Kwama and Nyakweba (2015) investigated the factors that influence the adoption of electronic systems to market products by SMEs, focussing on the characteristics of the managers and the characteristics of the firm. The manager's gender, level of education and level of familiarity with computer systems were the key predictor factors. Akudugu, Guo and Dadzie (2012) examined the factors affecting the adoption of modern agricultural technologies and found out that socioeconomic factors, institutional effectiveness, access to credit, extension services, and expected benefits were key predictors. Ogutu, Okello and Otieno (2014) indicate that mobile phone usage has played a crucial task in the reduction of transaction costs in the agricultural sector.

Wanyama, Obare, Owuor, and Wasilwa (2013) pinions that enabling farmers to adopt emerging technologies would lead to an increase in farm productivity and household incomes, promoting food security and create new employment opportunities for the youth in the region. Mwangi and Kariuki (2015) studied the factors affecting the adoption of agricultural technology among smallholder farms and notes that technological factors, institutional factors, and economic factors were key determinants of adoption. The current study examined how the managerial capabilities, resource capabilities, extension services and government policies affect the adoption of digital technologies.

For the successful adoption of digital technologies, certain conditions and determinants must be available to ensure efficient digital technologies adoption in the agriculture and food sector. These conditions encompass technological infrastructure and connectivity (mobile subscriptions, network coverage, internet access, and electricity supply), affordability, educational attainment (literacy, ICT education), and institutional support. Access to digital

technology in rural and underdeveloped areas provides links between suppliers, farmers and other businesses operating in rural areas, enabling users to access talented workforce, build strategic partnerships, access training facilities, legal services and financial assistance in addition to reaching out to the major markets and customers who would not have been accessible due to geographical differences. The study focussed on five main digital technologies that have been designed for small scale farmers within Embu County. The technologies have been adopted to varying extent by the farmers; hence the study sought to examine how various factors influence the adoption of the technologies.

Table 1.1 Digital Technologies

Digital Technology	Usage within the Small-Scale agricultural farms
Kilimo Salama	Offers Agri-insurance to small-scale agriculture **farms**
Farm Weather	Offers daily weather forecasts to small-scale agriculture **farms**
Apollo App	Allows farmers to review and access farm inputs
DIGI Farm	Allows farmers to access credit and farm inputs
Smart Cow App	Allows farmers to monitor their expenditure and income among commercial farmers

The above digital technologies; kilimo salama, farm weather, Apollo app, Digi farm and Smart Cow app were developed and distributed to farmers within Embu and Kirinyaga Counties. To be able to clearly identify the factors determining the adoption of these technologies among the 12,000 farmers within the two countries; the study selected the farmers to participate in the research. This was expected to yield relevant information that helped in determining the relationship between resource capability, managerial capability, extension services, socioeconomic factors and adoption of digital technologies in small-scale farms.

1.1.1.1 Resource Capability

Resources are valuable sources of competitive advantage (Newbert, 2007). Organizations are expected to learn how to combine resources and to renew their core competencies (Ramachandran, 2011). Research has highlighted the importance of firms acquiring, developing, and maintaining differential bundles of resources and capabilities over time (Pavlou & El Sawy, 2011). According to Marshall and Miguel (2014), low adoption rates of modern agricultural technologies has also been positively linked to poor access of credit and loan facilities by farmers in the sense that the small-scale farmers often lack access to adequate

financial resources to meet the high required initial start-up cost required to acquire modern technology facilities. With the lack of the required resources, technology adoption may be a challenge to small scale farmers. This measure is therefore important to this study since it explains the availability and capability of necessary resources to aid in technology adoption

1.1.1.2 Managerial Capability

Graves and Thomas (2006), the expertise, management capacities and processes that firms possess in order to plan and implement programs and activities to achieve superior performance is known as managerial capability. The proper deployment of an organization's social, human and cognitive abilities in order to make use of its tangible and intangible resources involves managerial capability (Acquaah & Agyapong, 2015). Barney and Hesterley (2006) contend that managerial capability can be used in controlling and observing hierarchical frameworks for the basic execution of strategic activities in organizations for effective management. The absence of the basic or required managerial skills and capabilities may be a hindrance to technological adoption. The study sought to find out if managerial capability has an effect on technology adoption.

1.1.1.3 Extension Services

Christoplos (2010) notes that extension services can be defined as; organized systems that facilitate and enable farmers, other organizations, and those in the marketing of the agricultural products to access agricultural knowledge and information about the market and farming skills. Within the agricultural sector, the access to extension services focuses on the role played by government and private sector bodies that facilitate farmers and other stakeholders' access to knowledge, information, new technologies, development of technical and organizational factors geared towards improving their livelihoods and agricultural productivity (Masavi, Kiweu, & Kinyili, 2017). In the recent past agricultural extension services have shifted from production-oriented to technology transfer models geared towards the development of greater objectives such as improving farmer's livelihood, enhancing food and nutrition security, as well as the market-oriented and participatory approach (Chesang & Ayuma, 2016). When agricultural extension programs are well designed and effectively implemented, it has the capacity to improve agricultural productivity; increase food security, improve rural livelihoods, and propel pro-poor economic growth, especially among the smallholder farmers in African and Asia (FAO, 2015).

1.1.1.4 Socioeconomic Factors

The socioeconomic status of an individual is characterized by the social standing or class measured by indicators such as education, income, occupation, or a combination of them (APA, 2016). Sackett, Kuncel, Arneson, Cooper, and Waters (2009) indicate that the socioeconomic status of an individual encompasses aspects related to their social welfare and their economic and education standing in society. The main aspects of the socioeconomic status of an individual are; their education level, the heritage, occupational, personal beliefs, and income level (Ekber & Gökhan, 2013). Akudugu, Guo, and Dadzie (2012) found out that age, education level, income and household size were positively related to technology adoption in agricultural farms. The study sought to find out whether this is true for small scale farmers in Embu and Kirinyaga counties

1.2 Statement of the Problem

Despite Kenya being a regional innovation hub with the increasing digitalization of the various sectors within the economy, the adoption of technology within the agriculture sector has not at been par with the rest of the economy (Ndemo & Weiss, 2016). Droesch (2015) notes that low technology adoption by small-scale farmers has been the main hindrance to the realization of higher agricultural productivity. Integration of new technologies within the agriculture sector has the ability to disrupt the value chain and lead to efficiency, access to market-driven innovation, enterprise development, utilization of new farming techniques and climate-smart seeds (Mwangi & Kariuki, 2015; Eidt, Hickey, & Curtis, 2012). This has however not been achieved across small-scale farms in Kenya which continue to have abysmal productivity and technology adoption (Aura, 2016). There is lack of sufficient interrogation of digital technology adoption within small-scale farms hence the need for the current research to expand available evidence.

Tey and Brindal (2012) noted that lack of sufficient resources, poor managerial skills and government policy affected the adoption of agricultural technologies. Asiedu-Darko (2013) revealed that lack of extension services and personnel competencies affect technology adoption. Kinyanjui (2012) indicated that despite technologies having been disseminated, their adoption at the individual farm levels remains low, and productivity also continues to be low. Kabunga, Dubois and Qaim (2012) note that there was minimal adoption of biotechnology breeding programs in Central and Eastern Provinces despite increased dissemination of the programs. The above studies have indicated the extent to which digital technologies have not been fully integrated within small-scale farms. The current study sought to expand on the

available empirical evidence by analyzing the determinants of digital technologies in Kenya among selected small-scale farmers in Embu and Kirinyaga Counties in Kenya.

1.3 Objectives of the Study

The main aim of this research paper is to establish the determinants of digital technologies adoption among small scale farmers in Kenya

1.3.1 Specific Objectives

i. To establish the effect of resource capability on digital technology adoption among small scale farms in Kenya
ii. To examine the effect of managerial capability on digital technology adoption among small scale farms in Kenya
iii. To determine the effect of access to extension services on digital technology adoption among small scale farms in Kenya
iv. To establish the effect of socioeconomic factors on digital technology adoption among small scale farms in Kenya

1.4 Research Questions

i. What is the effect of resource capability on digital technology adoption among small scale farms in Kenya?
ii. What is the effect of managerial capability on digital technology adoption among small scale farms in Kenya?
iii. What is the effect of access to extension services on digital technology adoption among small scale farms in Kenya?
iv. What is the effect of socioeconomic factors on digital technology adoption among small scale farms in Kenya?

1.5 Scope of the Study

The research scope was geographically focussed on the 12,000 small scale farmers within Embu County and Kirinyaga County who have adopted modern technologies under the auspice of the National Irrigation Board, Embu, and Kirinyaga County Governments and group-based small-scale farmers association. The contextual scope of the research focussed on how various internal and external factors (resource capability, managerial capabilities, access to extension services, and socioeconomic) influence the adoption of modern digital technologies among small-scale farmers. The theoretical scope of the research was constrained to technology, organization, and ecological theory. The research scope was limited to a quantitative approach

using a structured research questionnaire. The unit of analysis of the research was small-scale farmers within the County government.

1.6 Significance of the Study

The agricultural sector is one of the key determinants of economic growth and development. The current study is anticipated to be of importance to various stakeholders within the sector. To the policymakers and field extension experts, the results of the research will be instrumental in designing new policies guided towards improving the modernization of the agriculture sectors. Further, the results of the research are expected to support new innovations and development of digital solutions specifically focussed on small scale farmers within the county. The results of the research further will be of importance to agricultural dealership firms and research and development centers in integrating technological solutions in their service provision. The findings will also help to bridge the knowledge gap and create a wealth of reference material that can be utilized in future research work.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The second chapter of the research focuses on a review of literature in line with the themes of the study. The chapter presented the various theories that anchored the research variables, the review of empirical studies, the summary of the research gaps as well as the conceptualization and operationalization of the research variables.

2.2 Theoretical Review

According to Wilson (2014), a theory is a set of correlated definitions, propositions, and ideas that present a systematic view of phenomena by indicating the relationship of variables with the intention of explaining or predicting the phenomena. The current study was based on the technology, organization and environment framework.

2.2.1 Technology, Organization, and Environment Framework

This framework was developed by Tornatzky, Fleischer, and Chakrabarti (1990) and is instrumental in the identification of three key aspects within an organization that influences its adoption and implementation of innovative technologies. These aspects may either be environmental, technological or organizational. The technological context refers to the internal and external technologies adopted by the specific organization including adopted practices, equipment and external technologies influencing processes and events within the firm (Oliveira & Martins, 2011).

The organizational context refers to descriptive measures about the organization, such as range, size, communication procedures, and managerial structure. Lastly, environmental context is the arena in which an enterprise conducts its business: its industry features and market structure, technology support and infrastructure, competitors, and dealings with the government (Oliveira & Martins, 2011). According to Angeles (2014), these external stakeholders can back or prevent new technology innovation. Conditions of the competitive environment and a frequently changing market, for example, compel firms to adopt and use the different forms of technology innovations. Government regulations are also are a useful tool that can be optimized to limit a firm's activities or to regulate the cost of production.

The TOE framework provides a critical framework that can be applied to study the adoption or incorporation of different forms of technological innovation. Hoti (2015) studied information system innovation adaption by small and medium enterprises being guided by the TOE model

while Chiu (2017) uses the framework to explore the critical factors for enterprises to adopt broadband mobile applications. The current study utilized this theory as it expounds on how technological context, organizational context, and environmental context of an enterprise can influence the process by which it adopts and implements innovative digital solutions. The technology factor context was denoted in this study by the resource capability among small-scale farmers to acquire the necessary infrastructure technologies and have technical skills and know-how. The organization factor context of the theory was relevant in underpinning how the managerial capability of the small-scale farmers can help determine their capacity to adopt new technologies. The environment context was relevant to this research as it informed on how access to extension services and the various socioeconomic factors can be integral in determining technology adoption.

2.3 Empirical Review

This section was instrumental in the review of previous empirical research papers with a focus on the various knowledge, contextual, and empirical gaps that the current research sought to solve in line with the objectives of the study.

2.3.1 Resource Capabilities and Digital Technology Adoption

According to FAO (2017), there are several digital technologies that have impacted small scale farmers positively. These Technologies support farmers to anticipate and respond to pest attacks, crop failures and climatic changes through timely weather-based agro-advisory messages. They include; Precision Agriculture (PA) which uses Guidance Systems during planting and fertilizer application leading to cost savings in terms of seed, fertilizer and tractor fuel, and can reduce working hours in the field. Variable Rate Technologies and drones (UAV) can also reduce water and pesticide use and reduce labor and resource costs. These are some of the capabilities that digital Technology can achieve efficiently (FAO, 2017).

Pierpaoli, Carli, Pignatti, and Canavari (2013) studied the drivers of precision agriculture technologies adoption. The study employed a literature review focusing on small-scale farmers in Italy. The research adopted both utility-based models and predictive models. The results indicate that innovation capability, human resource capacity and financial resources are key to the adoption of agriculture technologies. The study further indicates that competitive and contingent factors are key to the adoption of new technologies. The research was, however, not conducted within the Kenyan market; hence, the findings may not be replicative of the current study scope.

Beshir, Emana, Kassa, and Haji (2012) studied the determinants of chemical fertilizer technology adoption in Ethiopia. The study adopted a cross-sectional research design with both primary and secondary data being utilized. The results show that accessibility of credit services, the size of the land, access to home markets, proximity to sources and farm-inputs was key to fostering the adoption of new technologies. The study shows that increased utilization of new technologies improved food supply and productivity. The current research, however, relied on primary data in assessing the adoption of digital technologies.

Ingabire, Yonggong, Pesha, and Hardi (2018) examined the factors affecting the adoption of artificial insemination technology by small dairy farmers in Rwanda. The study adopted a descriptive research design with both structured questionnaires and in-depth interviews utilized in data collection. The results of the regression analysis indicate that the household income, access to financial credit and extension services had positive contributions to the adoption of artificial insemination technology. The study further indicates that farmers' knowledge and skills can predict the adoption of technologies. The study, however, focused only on Rwandan dairy farmers, while the current study focussed on all small-scale farmers in Embu and Kirinyaga County.

Baumüller (2015) studied the effect of technology application in Kenya. Digital transformation has the potential to deliver significant economic, social and environmental benefits and can be applied to improve the efficiency and functioning of agri-food systems. The use of mobile applications providing price information to farmers can reduce market distortions and help farmers to plan production processes. For example, the M-Farm application in Kenya led to farmers changing their cropping patterns and some reported receiving higher prices at the market as a result. The study focuses on technology application while the current study focuses on the factors affecting the adoption of digital technology.

Kinyangi (2014) studied the factors influencing the adoption of agricultural technology among smallholder farmers in Kakamega North sub-county, Kenya. The research adopted an exploratory research design with simple random sampling being utilized in selecting smallholder farms. Regression and correlation analyses were used to test levels of significance and strength of the relationship among study variables. The findings indicate there is a positive and significant correlation between capital availability and access to credit facilities and the adoption of agricultural technologies. The research further shows that farmer's training further

improved technology adoption. The research was, however, not focussed on small-scale farms in Embu and Kirinyaga County, which is the focus of the current study.

Aura (2016) explored the determinants of the adoption of integrated soil fertility management technologies in Kenya. The study adopted a descriptive research design with self-administered questionnaires being relied upon in the data collection. The study utilized both descriptive and inferential analysis. Findings show that labor capacity, off-farm income and **farms** size were significant determinants of adoption of integrated technologies. Findings show that there is a need for a more pro-poor focused approach to achieve sustainable soil fertility management among smallholder farmers. The research, however, failed to examine how government policies influence the adoption of technologies in small-scale farms.

2.3.2 Managerial Capabilities and Digital Technology Adoption

Cavallo, Ferrari, Bollani, and Coccia (2014) examined strategic management implications for the adoption of technological innovations in the agricultural tractor. The study focuses on smallholder farmers in Italy who have adopted tractors in their farming. The results of the analysis indicate that the user's attitude, years of activity within the firm and engagement with other stakeholders are key to technological innovations adoption. The study further shows that the adoption of new technologies has resulted in increased efficiency and safety in modern agriculture. The research utilized a qualitative approach, while the current study adopted a quantitative research approach.

Dehinenet, Mekonnen, Kidoido, Ashenafi, and Bleich (2014), in their study, focused on the factors influencing the adoption of dairy technology on smallholder dairy farmers in Ethiopia. The research sampled 384 farmers consisting of 192 adopters of daily technology and 192 non-adopters of technology. The findings of the research demonstrate that family size, farming experiences, accessibility of savings and auxiliary institutions, training on livestock rearing and off-farm activity participation are key to improving technology adoption. The research was, however, conducted within Ethiopian smallholder farms while current research examined Kenyan small-scale farmers.

Mwaura (2014) studied the effect of farmer group membership on agricultural technology adoption and crop productivity in Uganda. The study employed a descriptive research approach with descriptive and inferential statistics being adopted in the analysis. The findings indicated that group membership was positively associated with agricultural technology adoption. Results show that through group membership, farm owners were able to interact with other

individual and development agencies, which enhanced their decision making towards the integration of technologies in their farms. Findings further show that the adoption of agricultural technologies improved crop productivity. The study focuses on crop productivity, while current research examined the adoption of digital technologies in small-scale farms in Kenya.

Nato, Shauri, and Kadere (2016) sought to determine the influence of social capital on the adoption of agricultural production technologies. The research focused on the beneficiaries of the African Institute for capacity development training programs in Kenya. The research adopted a survey research design focusing on 120 respondents with structured research instruments being utilized. The results show that group involvement and social support significantly y influenced the adoption of appropriate agricultural production technologies. Findings also indicate that social networks, social trust and collective action do not significantly influence the adoption of agricultural technologies. The study further shows that capacity building programs are key to enhancing agriculture technology. The study, however, does not focus on environmental factors such as government policies and their effect on the adoption of modern technologies in the agriculture sector.

2.3.3 Access to Extension Services and Digital Technology Adoption

Uzonna and Qijie (2013) studied the effect of extension programs on the adoption of improved farm practices by farmers in Southern Turkey. The research adopted a descriptive research design with the quantitative approach being utilized in the data collection. The findings of the study indicate that the adoption of new technologies improved crop yield. The study further shows that timeliness in training, method of training significantly improved farm practices within the sampled farms. The study, however, failed to take into consideration the effect of internal factors such as resource and managerial capability on the adoption of digital technologies.

Altalb, Filipek, and Skowron (2015) conducted a study on the role of agricultural extension in the transfer and adoption of agricultural technologies. The study employed qualitative research with a literature review being adopted in the study. The results indicate that agricultural extension is a significant contributor to the adoption of modern agricultural techniques. The study shows that agricultural extension has fostered the transfer of knowledge, transportation of the products as well as enhancing effectiveness in productivity within farms. The study

focuses on the review of previous literature, while the current study utilized primary research data.

Ntshangase, Muroyiwa, and Sibanda (2018) examined farmers' perceptions and factors influencing the adoption of no-till conservation agriculture by small-scale farmers in KwaZulu-Natal Province. The study employed a quantitative cross-sectional design that sampled 185 small-scale farmers. Data analysis was done through descriptive and inferential statistics and econometric modeling using the logistic regression model. The results indicate that an increase in extension visits and farmer's perceptions were significantly associated with an increased likelihood of adopting no-till conservation agriculture. The study, however, fails to examine the adoption of modern digital technologies in agriculture.

Ajayi and Solomon (2017) investigated the effect of contractual extension terms and the socio-economic characteristics of Nigerian palm wine farmers on their adoption of innovative technology. The study employed a descriptive research design with multi-stage sampling being utilized in selectin 100 respondents. Findings were that most of the farmers were unaware of the existence of most of the available technologies which significantly impact their ability to become accepted and adopted. The results also indicate that 53% of the farmers had not been contacted by extension agents. The results show there are inadequate information, irregular extension contact and lack of frequent extension service offering within the country. The study focuses on small-scale farmers in Nigeria while the current study reviewed Kenyan farmer's adoption of modern technologies.

Okuthe (2014) examined the influence of institutional factors on the adoption of integrated natural resource management technologies by small scale farmers in South Western Kenya. The study employed an ex-post-facto survey design with both qualitative and quantitative research data being utilized. The findings of the study show that access to markets, mass media exposure and increased contact with extension officers was a key predictor of the adoption of integrated natural resource management technologies. The study indicates that strengthening social groupings among farmers results in increased adoption of technologies. The current study relied on quantitative data in examining the adoption of digital technologies in Embu and Kirinyaga County.

Omoro (2015) conducted an assessment of the extension staff farm visits frequency effect on greenhouse technology performance in small scale farms in Gusii Highlands, Kenya. The study adopted a survey research design with a sample of 276 respondents being considered in the

study. The findings indicate that the frequency of extension staff visits positively impacts the adoption of greenhouse technology. The results indicate there is a need for extension support in terms of staff capacity building, mobility, and employment to improve farmer coverage staff. The study was limited to extension services, while current research examined how other internal and environmental factors affect the adoption of digital technologies.

2.3.4 Socioeconomic Factors and Digital Technology Adoption

Mittal and Mehar (2016) studied the socio-economic factors affecting the adoption of modern information and communication technology by farmers in India. The study employed a multivariate Probit model with survey data being collected from 1,200 farmer households in India. The findings indicate that the farmer's age, education level and farmers' behavior were key factors in the selection of modern ICT applications in farming. The study further indicates that the formalization of farming processes and practices positively influence the adoption of new technologies. The study focused on households in India, while the current study focussed on small-scale farmers in Kenya.

Tey, Li, Bruwer, Abdullah, Brindal, and Darham (2017) examined the factors influencing the adoption of sustainable agricultural practices in developing countries. The study conducted a meta-analytic review of the previous 31 empirical studies focusing on sustainable agricultural practices in developing countries. The findings indicate that managerial factors are key to the adoption of sustainable agricultural practices. The study shows that human capital capacity, managerial skills, educational attainment and managerial tenure were predictors of positive adoption. The study relied on secondary data, while the current study collected primary data from small-scale farmers.

Choudhury, Das, Sarmah and Ahmed (2018) examined the influence of socio-economic factors on knowledge and technology adoption of sericulture farmers. The study adopted a quantitative approach in the examination and reveals that the education level, experience, farm size and continuous extension constantly positively influence the adoption of technology. The study notes that socioeconomic conditions are critical to the effective utilization of emerging agriculture technologies. The study is, however, not limited to the Kenyan agriculture sector, which is the focus of this study.

Ayoola (2012) conducted a study on the socio-economic determinants of the adoption of yam miniset technology in Nigeria. The study adopted a multi-stage sampling in selecting 120 farmers in collecting research data using structured interviews. The collected data were

analyzed using descriptive statistics and the Probit regression model. The results indicate that years of farming experience, availability of credit and improvement of resource utilization were key to the adoption of agriculture technologies. The study, however, focuses on the adoption of single technology while current research focusing on the various implementation of digital technologies among small-scale farmers in Kenya.

Bunde and Kibet (2016) examined the socio-economic factors influencing the adoption of modern beekeeping technologies in Baringo County, Kenya. The study adopted purposive sampling in gathering primary research data and relied on both descriptive and inferential analysis. The findings indicate that the gender of respondents, age, family size and the education level were significant predictors of beekeeping technology adoption. The study indicates that farm size and livestock hold did not significantly determine technology adoption within the households. The study only examined socioeconomic factors as a predictor of technology adoption within small-scale farmers.

Magugu, Feng, Huang and Ototo (2018) explored the socio-economic factors affecting agro-forestry technology adoption in Nyando, Kenya. The study adopted a survey research design with the unit of analysis being farmers in the process of adopting agroforestry technologies. The study indicates that farm size and higher education were positively related to the level of adoption. The study also indicates that increasing crop yield motivated farmers to accelerate the adoption of new technologies. The study also notes that access to information was key to the adoption process. The study, however, fails to examine how other factors, such as resource capability and access to extension services, influence the adoption of digital technologies.

2.4 Summary of Literature and Research Gaps

The availability of literature in technology adoption is dispersed across geographical areas and focuses on various contexts. The review of the studies has identified a number of research gaps that this study sought to solve.

Table 2.1 Research Gaps

Author	Title	Research Findings	Gap of Study	Focus of current study
Aura (2016)	Determinants of the adoption of integrated soil fertility management technologies in Kenya.	Findings show that labour capacity, off-farm income and firm size were significant determinants of adoption of integrated technologies	The research, however, failed to examine how government policies influence the adoption of technologies in small-scale farms	The current study examined how government extension services can be key digital technology adoption
Ingabire, Yonggong, Pesha, and Hardi (2018)	Factors affecting the adoption of artificial insemination technology by small dairy farmers in Rwanda	The study indicates that farmers knowledge and skills can predict the adoption of technologies	The study, however, focused only on dairy farmers	The current study focussed on all small-scale farmers in Embu and Kirinyaga County
Omoro (2015)	Assessment of the extension staff farm visits frequency effect on greenhouse technology performance in small scale farms Kenya	The findings indicate there is a positive relationship between extension staff visit frequency and greenhouse technology performance	The study was limited to extension services and technology adoption	The current research examined how resources, managerial, extension services and socioeconomic factors affect the adoption of

				digital technologies
Pierpaoli, Carli, Pignatti, and Canavari (2013)	Drivers of precision agriculture technologies adoption in Italy	The study indicates that competitive and contingent factors are key to the adoption of new technologies	The research was, however, not conducted within the Kenyan market; hence, the findings may not be replicative of the current study scope.	The current research focussed on small-scale farmers in Embu and Kirinyaga County
Tey, Li, Bruwer, Abdullah, Brindal and Darham (2017)	Factors influencing the adoption of sustainable agricultural practices in developing countries	The study shows that human capital capacity, managerial skills, educational attainment, and managerial tenure were predictors of positive adoption	The study relied on secondary data while the current study collected primary data from small-scale farmers	The currents study relied on primary data collected from farmers in Embu and Kirinyaga County

Source: Author (2020)

2.5 Conceptual Framework

A conceptual framework guides the researcher in determining the relationships between the research variables. However, it is crucial that one remains sceptical about the validity and reliability of these variables (Adams, Khan, Raeside, & White, 2007).

The conceptualization of the current research variables is shown below;

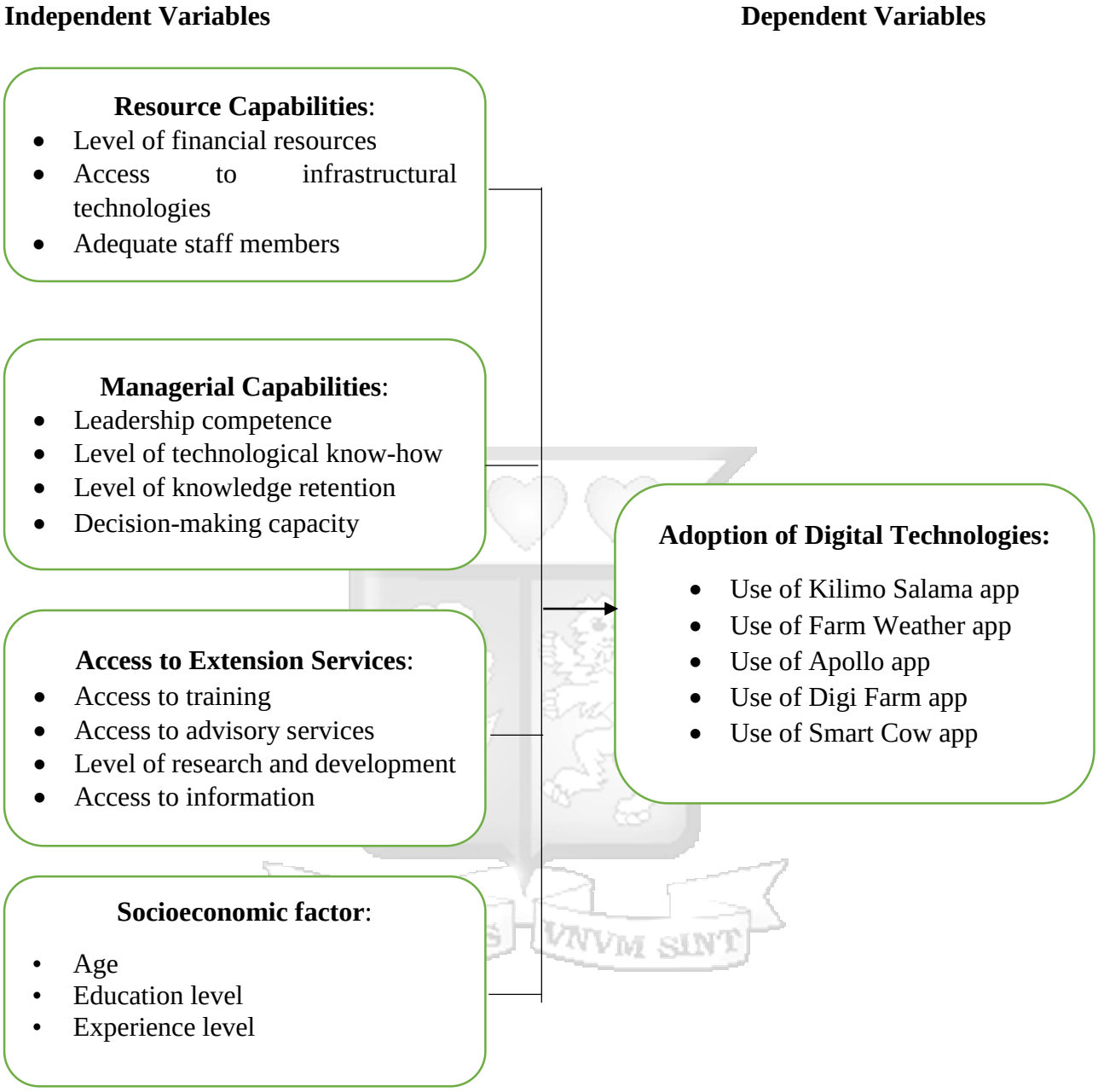

Figure 2.1 Conceptual Framework

The above conceptual framework hypothesizes the interaction between the various factors affecting the adoption of digital technologies among small scale farmers. The study examined the interaction between resource capabilities, managerial capabilities, access to extension services, government policy, and the adoption of new technologies.

Table 2.2 Operationalization of Research Variables

Variable	Indicators	Data collection tool	Data analysis	Sources
Resource Capabilities	• Level of financial resources • Access to infrastructural technologies • Adequate staff members	Structured questionnaire; 5-point Likert scale	Descriptive analysis and inferential analysis	Aura (2016)
Managerial Capabilities	• Leadership competence • Level of technological know-how • Level of knowledge retention • Decision-making capacity	Structured questionnaire; 5-point Likert scale	Descriptive analysis and inferential analysis	Ingabire, Yonggong, Pesha, and Hardi (2018)
Access to Extension Services	• Access to training • Access to advisory services • Level of research and development • Access to information	Structured questionnaire; 5-point Likert scale	Descriptive analysis and inferential analysis	Omoro (2015)
Socioeconomic factors	• Age • Education level • Experience level	Structured questionnaire;	Descriptive analysis and inferential analysis	Pierpaoli, Carli, Pignatti, and Canavari (2013)
Adoption of Digital Technologies	• Reduced Transaction cost • Easy Credit Access • Better information management • High Productivity	Structured questionnaire; 5-point Likert scale	Descriptive analysis and inferential analysis	Tey, Li, Bruwer, Abdullah, Brindal and Darham (2017)

2.6 Chapter Summary

This chapter consists of a review of both theoretical and empirical literature. The review of the study literature indicates that the integration of digital technology is critical to small scale farmers. The theoretical review of the adoption of technology indicates that managerial capabilities, resource capabilities, extension services and government policies are essential in directing growth within the agriculture industry. The study relied on the technology, organization and environment framework in examining the technology adoption within the agricultural industry in Kenya. The study further has reviewed several studies that have helped identify the various empirical gaps and methodological gaps that were utilized towards solving the research problem. Based on the work of the literature reviewed, the conceptual framework and operationalization of the variables are also presented.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The third chapter of the research discusses the various aspects of the research methodology that was applied in solving the research problem. The chapter outlined the research design, the target population, the sampling technique, and sample size, the data collection instruments and procedures, as well as the data analysis and presentation techniques.

3.2 Research Philosophy

Research philosophy describes the methodology to be followed by a researcher in collecting, sorting, analyzing the data necessary to obtain meaningful conclusions (Sekaran & Bougie, 2013). It is a viewpoint that is based on the set of shared assumptions, values, and concepts and practices which the researcher will utilize to affirm his hypothesis (Johnson & Christensen, 2019). The research adopted a positivism design. According to (Crowther & Lancaster, 2008) argue that as a general rule, positivist studies usually adopt a deductive approach where you can test to see if there is a relationship or link in a certain hypothesis. Positivism is associated with a self- understanding of scientific activity in which social science is independent of the reality it describes (Riley, 2007). The positivist paradigm asserts that real events can be observed empirically and explained with logical analysis (Kaboub, 2008). This philosophy was key in guiding this research study that was based on a quantitative approach in determining the association between digital technologies adoption and small-scale farmers in Kenya

3.3 Research Design

The research design is a specific plan or blueprint created to answer the research question and provision of variance control (Kothari, 2004). This study adopted a descriptive, cross-sectional survey research design in view of the research problem highlighted and was key in examining the cause and effect of the study variables. A cross-sectional survey examines associations between two variables (Creswell, 2007). A descriptive research design is suited for investigations that aim to report a change in direction. It aims to connect what happened with what is happening, thus enabling the researcher to determine the causative factor, taking into consideration the conditions and situations in which they naturally exist (Frankfort-Nachmias & Nachmias, 2008). It is specifically applicable in this study since it reports the relationship between variables without manipulation of the environment of the study.

3.4 Target Population

A population is defined as an entire set of individuals, cases, or objects with some common observable characteristics (Mugenda & Mugenda, 2003). The target population for the study was drawn from small-scale farmers within Embu County and Kirinyaga County. The unit of observation was the individual farm owners or the managers of the small-scale farms. According to the Embu and Kirinyaga Counties, respectively, the registered number of farmers in 2019 was 5,000 and 7000, respectively. The population of the research was the registered 12,000 farmers as shown below;

Table 3.1 Population of the Research

County	No of Farmers	Percentage of Farmers
Embu County	5,000	42%
Kirinyaga County	7,000	58%
Target Population	12,000	100%

Source: Embu County Government (2019); Kirinyaga County Government (2019)

3.5 Sampling Design and Sample Size

This study used a sampling frame of more than 12,000 registered small-scale farmers within Embu and Kirinyaga Counties. The sample is a subset of the population that the researcher uses to determine the current standing of the population (Field, 2009). The sample size for the research was calculated using the Yamane formula as shown below;

$$n = \frac{N}{1 + N(e^{2})}$$

Where: n is the sample size, *e* is the error term, and N is the total target population

N = 12,000

$$nf = \frac{12{,}000}{1+12{,}0000\ (.05*.05)} = 387 \text{ respondents}$$

The study applied a simple random sampling technique on all the counties when obtaining the sampling frame. This technique helps in the elimination of bias from the researcher in selecting the sample (Bordens & Abbot, 2003). The sample respondents were apportioned within the two counties as shown in the table below;

Table 3.2 Sample Respondents Distribution

County	Percentage of Farmers	Sample Respondents

Embu County	42%	42%*387 = 163
Kirinyaga County	58%	58%*387 = 224
Sample Respondents	**100%**	**387**

3.6 Data Collection Instruments and Procedures

The research relied predominantly rely on primary research data. The study utilized a structured research questionnaire to collect data. Kothari (2004) suggests that research questionnaires are free from the interviewer's bias and are in the respondents' own words. The study adopted Google forms in the collection of research data. The questionnaires were developed based on the objectives of the study after a review of the theoretical and empirical literature. Research questionnaires with a Likert scale of 1-5 were used. The questionnaires were ideal for inquiring sensitive information, especially when anonymity is to be assured (Kamaara, 2014). Before undertaking the research data collection, the study sought ethical clearance from the Strathmore Business School as well as seek a permit from the National Commission for Science Technology and Innovation.

3.7 Research Quality

The study further conducted a pre-test of the research instrument before the main research. This was carried out to remove any existing errors and introduce any changes in the research instruments (Kothari, 2004). Radhakrishna (2007) posits that 20% of the sample is sufficient for a pilot test. The study conducted the pilot test among 20% of the sample respondents.

3.7.1 Reliability Tests of Research Instrument

According to Cooper and Schindler (2014), reliability is the degree to which a measure gives consistent results. Kombo and Tromp (2006) suggest that reliability is a measure in which a research instrument produces dependable outcomes after repeated trials. According to Kothari (2012), an instrument is reliable if it yields consistent results over a period. The study adopted the Cronbach alpha in conducting the reliability testing of the study instrument.

Table 3.3 Reliability Statistics

Determinants of adoption of agriculture technologies

Variable	Cronbach's Alpha	Number of Items	Comment
Adoption of Agriculture Technologies	.840	5	Accepted
Resource Capability	.784	6	Accepted

Managerial Capability	.825	5	Accepted
Access to Extension Services	.810	6	Accepted

The study adopted the constructs with an Alpha score of above 0.7 as widely adopted as the standard alpha score. From the results above, all the research variables had a Cronbach alpha of above 0.7; hence were considered for the main research.

3.7.2 Validity Tests of Research Instrument

The accuracy of the research instruments' content validity was ascertained. The content validity approach measures the degree to which the test items represented the domain or universe of the trait or property being measured (Creswell, 2014). In order to ascertain content validity, the instruments were constructed and handed to the supervisor for constructive criticism. Orodho (2009) notes that content validity is concerned with if the instrument is representative of the full content of the item being measured. A judgmental procedure was applied in consultation with experts in the digital lending platforms development.

3.8 Data Analysis and Presentation

Data analysis is defined as a mechanism for reducing and organizing data to provide findings that require interpretation (Burns, Grove, & Gary, 2015). After the data is collected, it was reprocessed by checking the missing variables and erroneous entries that could have skewed the results. Descriptive and inferential statistics were used to analyze and interpret the data. Descriptive statistics relate to means, frequency distributions and standard deviations. The study adopted inferential analysis in testing the association between the research variables using Spearman correlations, regression analysis, ANOVA testing and regression coefficients. The quantitative data were presented through statistical techniques that include frequencies, pie charts, bar graphs and measures of central tendency. The study adopted the following regression model;

$$\mathbf{Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon}$$

Where;

Y = Dependent variable (adoption of digital technologies)

α = the model intercept

$\beta_{1\text{-}4}$= Coefficient of independent variables

X_1 – resource capabilities

X_2 – managerial capabilities

X_3 – access to extension services

X_4 – socioeconomic factors

ε - error Term

3.8.1 Tests for Linear Regression Assumptions

Inferential methods of testing hypotheses such as correlation and regression analysis require that the data meets the normality requirement. This is the assumption that the populations from which the samples are drawn are normally distributed. Normality can be assessed using a graphical method or analytical test procedures (Das & Imon, 2016). The study adopted the normality curve p-p plot to determine the distribution of the responses along the normal curve. The study further conducted Durbin-Watson statistics to tests for autocorrelation between the research variables (Razali & Wah, 2011). Multicollinearity refers to the linear correlation among variables. In regression models, multicollinearity causes the standard error of co-efficient to increase, making them unreliable. Variance Inflation Factor (VIF) is used to test whether variables are correlated. A Variance Inflation Factor greater than 10 implies that multicollinearity is a problem in the model (Sinan & Alkan, 2015).

3.9 Ethical Considerations

The research observed ethical standards before, during, and after the study is done. Before piloting and actual data collection, the researcher obtained permission from the University, giving the go-ahead to collect data. The research further obtained a research permit to collect data from the National Commission for Science, Technology and Innovation (NACOSTI). Complete disclosure of the study objective was made to the respondents by way of an introduction letter. Participation in the study was voluntary, and the respondents were made aware and guaranteed of nondisclosure of the information they provided, and secrecy of the data source as the questionnaire was not required disclosure of identity.

CHAPTER FOUR

PRESENTATION OF RESEARCH FINDINGS

4.1 Introduction

The fourth chapter of the study presented the results of the analysis of the collected research data. The study findings were presented in line with demographic information, descriptive tabulation of responses, and inferential analysis to determine the association between the research variables.

4.2 Background Information

The research aim was to collect responses from 387 farmers within Embu and Kirinyaga County who had adopted various digital technologies in farming.

Table 4.1 Background Information

Item		Frequency	Percent
Response Rate	Responded	363	93.0
	Did not Respond	24	7.0
	Total	**94**	**100.0**
Gender	Male	266	73.0
	Female	97	27.0
	Total	**94**	**100.0**

The study was able to obtain a response rate of 93% (N=363) from the sample participants. This response was viewed as adequate for utilization in the study in line with Cooper and Schindler (2012), who posited that a 60% response rate and above is deemed sufficient for statistical analysis. The study reviewed the gender distribution among the participants of the study. The results of the research indicated that 73% (N=266) of the participants were male members, while 27% (N=97) of the respondents were female farmers.

4.2.1 Socioeconomic Factors

The study sought to examine the socioeconomic profile of the small-scale farmers within the counties. The study specifically reviewed the age, education, household size, farm size, years of farming and annual income. The findings are presented in Table 4.1 below.

Table 4.2 Socioeconomic Factors

	Valid	Mean	Minimum	Maximum
Age	363	43.2039	27.00	72.00

Years in school	363	11.7163	.00	30.00
Size of household	363	6.1405	1.00	25.00
Farm size	363	2.2869	.25	35.00
Farming experience	363	14.7906	1.00	60.00
Farming income	363	107,752.7824	60.00	1,000,000.00

The findings of the study indicate that the average age of the farmers within the counties was 43.2 years, with the oldest farmer being 72 years of age. The study results show that, on average, the small-scale farmers had attended school for at least 11.7 years. The research findings further show that the average size of the household within the counties was six members with an average land size of 2.2869 acres. The results further show that on average, participants have been in the farming business for at least 14.79 years and were earning at least 107,752 shillings annually.

4.3 Exploratory Factor Analysis

Factor analysis works on the assumption that quantifiable and observable variables can be condensed to fewer latent variables that share a common variation and are unobservable which is known as reducing dimensionality (Bordens & Abbot, 2003). This study applied the Kaiser-Meyer-Olkin Test KMO (Bartlett's Test of Sphericity) and factor loadings using the Eigen values. The results are presented in line with the research variables.

4.3.1 Factor Analysis for Digital Technologies Adoption

The dependent variable for the study was the digital technologies adoption and the KMO results are shown below.

Table 4.3 KMO and Bartlett's Test for Digital Technologies Adoption

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.737
Bartlett's Test of Sphericity	Approx. Chi-Square	257.273
	df	10
	Sig.	.000

The findings illustrated a KMO value of .737>.05, which implied there is sampling adequacy for factor loading to be considered. Bartlett's test of sphericity yielded a significance value = .000<.05, which showed that there is correlation between the variables. This indicates that factor analysis ca be conducted in the data set.

Table 4.4 Exploratory Factor Analysis for Digital Technologies Adoption

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.184	43.687	43.687	2.184	43.687	43.687
2	.908	18.166	61.854			
3	.784	15.690	77.543			
4	.595	11.892	89.435			
5	.528	10.565	100.000			

Extraction Method: Principal Component Analysis.

The study results showed that one the factor had eigenvalue, which was higher than 1. The main factor was responsible for 43.687% of the total variability in the dependent variable.

4.3.2 Factor Analysis for Resource Capabilities

The first variable for the study was the resource capability within small-scale farmers, and the results of the Kaiser-Meyer-Olkin tests are shown below.

Table 4.5 KMO and Bartlett's Test for Resource Capabilities

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.838
Bartlett's Test of Sphericity	Approx. Chi-Square	640.786
	df	15
	Sig.	.000

The results shown above indicated KMO value of .838>.05, which implied there is sampling adequacy for factor loading to be considered. Bartlett's test of sphericity yielded a significance value = .000<.05, which indicates that a factor analysis will be useful in the study.

Table 4.6 Exploratory Factor Analysis for Resource Capabilities

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.099	51.658	51.658	3.099	51.658	51.658
2	.847	14.108	65.766			
3	.692	11.538	77.304			
4	.495	8.250	85.554			

5	.465	7.755	93.308			
6	.401	6.692	100.000			

Extraction Method: Principal Component Analysis.

The study results showed the total variance explained for resource capabilities showed that one component explained 51.658% of the total variability in the variable. This indicates that all the constructs or items were found to belong to these the factor.

4.3.3 Factor Analysis for Managerial Capabilities

The second variable for the study was the managerial capability within small-scale farmers, and the results of the Kaiser-Meyer-Olkin tests are shown below.

Table 4.7 KMO and Bartlett's Test for Managerial Capabilities

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.792
Bartlett's Test of Sphericity	Approx. Chi-Square	572.897
	df	10
	Sig.	.000

The results in Table 4.7 show a KMO value of .792>.05, which implied there is sampling adequacy for factor loading to be considered. Bartlett's test of sphericity yielded a significance value = .000<.05, which showed that there is correlation between the variables. This indicates that factor analysis ca be conducted in the data set.

Table 4.8 Exploratory Factor Analysis for Managerial Capabilities

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.831	56.610	56.610	2.831	56.610	56.610
2	.757	15.147	71.757			
3	.577	11.539	83.296			
4	.518	10.361	93.658			
5	.317	6.342	100.000			

Extraction Method: Principal Component Analysis.

The factor analysis results indicated that total variance explained for managerial capabilities showed that one component explained 56.610% of the total variability in the variable. This indicates that all the constructs or items were found to belong to these the factor.

4.3.4 Factor Analysis for Access to Extension Services

The third variable for the study was the access to extension services and the KMO results are shown below.

Table 4.9 KMO and Bartlett's Test for Access to Extension Services

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.740
Bartlett's Test of Sphericity	Approx. Chi-Square	266.152
	df	10
	Sig.	.000

The results indicated a yielded KMO value of .740>.05, which implied there is sampling adequacy for factor loading to be considered. Bartlett's test of sphericity yielded a significance value = .000<.05, which showed that there is correlation between the variables. This indicates that factor analysis ca be conducted in the data set.

Table 4.10 Exploratory Factor Analysis for Access to Extension Services

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.226	44.520	44.520	2.226	44.520	44.520
2	.917	18.350	62.870			
3	.690	13.806	76.676			
4	.624	12.489	89.165			
5	.542	10.835	100.000			

Extraction Method: Principal Component Analysis.

The study results showed the total variance explained for access to extension services showed that one component explained 44.520% of the total variability in the variable. This indicates that all the constructs or items were found to belong to these the factor.

4.4 Descriptive Analysis

The main aim of the study was to establish the determinants of digital technologies adoption among small scale farmers in Kenya. The study specifically focussed on how resource capabilities, managerial capabilities and access to extension services influence adoption levels. The study adopted means, standard deviation, maximum and minimum in the presentation of the tabulated responses.

4.4.1 Digital Technologies Adoption

The dependent variable was the level of digital technologies adoption among the small-scale farmers and the findings are presented as shown below. The following key was applied in the scale interpretation in the research. ***SME*** *= To a small extent* ***SE****= To some extent* **ME** *= To a moderate extent* **GE** *= To a great extent* **VGE** *= To a very great extent*

Table 4.11 Descriptive Statistics for Digital Technology Adoption

Statement	SME	SE	ME	GE	VGE	Mean	Std.Dev
Use of Kilimo Salama app	68.3%	24.8%	6.6%	.3%	0%	1.3884	.62240
Use of Farm Weather app	47.4%	32.5%	15.7%	3.6%	0.8%	1.7796	.89561
Use of Apollo app	63.4%	26.4%	8.5%	1.7%	0%	1.4848	.72193
Use of Digi Farm app	58.2%	32.2%	8.0%	1.7%	0%	1.5317	.71369
Use of Smart Cow app	77.1%	13.8%	7.2%	1.9%	0%	1.3388	.69593

The findings indicate that in regard to the utilization of the Kilimo Salama app in farming activities, the majority of the respondents 68.1% used it to a small extent, 6.6% used it to a moderate extent. Regarding the usage of the smart cow app the majority of the respondents 77.1% used it to a small extent; 13.8 % used it to some extent while only 1.9% used it to a great extent. The results show that most of the respondents 47.4% used the farm weather to a small extent, 32.5% use it to some extent while 3.6% of the respondents use it to a great extent.

4.3.2 Resource Capabilities

The first independent variable was the level of resource capabilities among the small-scale farmers and the findings are presented as shown below. The following key was applied in the scale interpretation in the research. ***SME*** *= To a small extent* ***SE****= To some extent* **ME** *= To a moderate extent* **GE** *= To a great extent* **VGE** *= To a very great extent*

Table 4.12 Descriptive Statistics for Resource Capabilities

Statement	SME	SE	ME	GE	VGE	Mean	Std.Dev

I have access to adequate financial resources	25.6%	43.8%	28.1%	2.5%	0%	2.0744	.79535
I have access to the required modern farming equipment	30.6%	40.5%	24.8%	4.1%	0%	2.0248	.84875
I have access to adequate support staff within the farm	27.8%	33.6%	30.0%	7.7%	0.8%	2.2011	.96101
I have access to technological infrastructure	31.7%	35.8%	24.5%	5.5%	2.5%	2.1129	.99774
I have access to credit facilities	25.9%	35.8%	30%	6.3%	1.9%	2.2259	.96839
There is access to a ready market for the products	13.2%	37.5%	39.7%	7.7%	1.9%	2.4766	.88660

The findings indicate that 43.8% of the respondents agreed to some extent they have access to adequate financial resources, while only 2.5% agreed they had to a great extent. The study shows that to some extent, 40.5% of the respondents showed there was access to the required modern farming equipment among the farmers. In contrast, 4.1% noted there was a great extent. The research further shows that 39.7% of the respondents to a moderate extent, indicated there was access to a ready market for the products. The study shows that to some extent, 35.8% of the participants indicated there was access to technological infrastructure among the small-scale farmers.

4.3.3 Managerial Capabilities

The second independent variable was the level of managerial capabilities among the small-scale farmers and the findings are presented as shown below. The following key was applied in the scale interpretation in the research. ***SME*** *= To a small extent* ***SE****= To some extent* **ME** *= To a moderate extent* **GE** *= To a great extent* **VGE** *= To a very great extent*

Table 4.13 Descriptive Statistics for Managerial Capabilities

Statement	SME	SE	ME	GE	VGE	Mean	Std.Dev
I engage in collaboration with other farmers in the area	16.3%	31.1%	18.2%	21.2%	13.2%	2.8402	1.29676
I have adequate experience in modern farming	27.3%	37.2%	27.8%	6.6%	1.1%	2.1708	.94227
I have adequate technological knowledge	36.4%	33.3%	21.8%	6.9%	1.7%	2.0413	1.00328

I have undertaken managerial training in the past	44.4%	34.7%	16.5%	3.0%	1.4%	1.8237	.90840
I have been exposed to the various farming technologies	25.9%	41.6%	26.4%	5.0%	1.1%	2.1377	.89676

The results indicate that to a small extent, 31.1%, to a moderate extent, 18.2%, and to a very great extent, 13.2% of the farmers were engaging in collaboration with other farmers in the area. The findings show that, to some extent 37.2%, to a moderate extent 27.8% and to a great extent 6.6% of the respondents had adequate experience in modern farming. The results show that to a very small extent 44.4%, to a moderate extent 16.5% and to very great extent 1.4% the respondents have undertaken managerial training in the past. The study further indicates that to some extent 33.3% and toa great extent 6.9% of the respondents have exhibited adequate technological knowledge.

4.3.4 Access to Extension Services

The third independent variable was the access to extension services among the small-scale farmers. The study results indicate that majority of the respondents 76% (N=276) had access to extension services. In contrast only 24% (N=87) of the study participants did not have an access to extension services. The study further showed that 40% of the respondents accessed extension services from farmers union, 20% from private **farms**. 20% from non-governmental organizations and government institutions respectively.

Figure 4.1 Source of Information

The following key was applied in the scale interpretation in the research. ***SME*** *= To a small extent* ***SE****= To some extent* **ME** *= To a moderate extent* **GE** *= To a great extent* **VGE** *= To a very great extent.*

Table 4.14 Descriptive Statistics for Extension Services

Statement	SME	SE	ME	GE	VGE	Mean	Std.Dev
I have been part of agriculture training programs	14.6%	26.4%	37.2%	17.9%	3.9%	2.6997	1.04626
I have access to relevant market information	11.6%	30.3%	39.9%	16.8%	1.4%	2.6612	.93626
I have access to advisory services	23.1%	37.2%	25.6%	11.6%	2.5%	2.3306	1.03306
I have access to logistic support services	35.5%	32.8%	24.0%	6.6%	1.1%	2.0496	.97921
I have access to in-service training on emerging farming tools	33.1%	32.2%	28.7%	4.7%	1.4%	2.0909	.96055

The results indicate that to a moderate extent 37.2%, to some extent 26.4% and to a very great extent 3.9% of the study participants had been part of agriculture training programs. The findings further show that to a moderate extent 39.9% and to a very great extent 1.4% of the farmers had access to relevant market information. The study results indicate that to some extent 35.5% and to a great extent, 6.6% of the farmers had access to logistic support services. The study results indicate that, to some extent 32.2%, to a moderate extent 28.7% and to a great extent 4.7% of the farmers had access to in-service training on emerging farming tools.

4.5 Inferential Analysis

The study sought to tests the association between the variables of the study using correlation analysis and the magnitude of the relationship between independent variables and the dependent variable of the study. The research conducted tests of linear regression assumptions prior to undertaking the inferential analysis.

4.5.1 Diagnostic Tests

The study conducted three main diagnostic tests to determine if the study model adhered to regression assumptions. The study adopted autocorrelation, normality and multicollinearity tests.

4.5.1.1 Autocorrelation Tests

This test checks whether the residuals of the models were not autocorrelated (Checks for the independence of error terms, which implies that observations are independent.

Table 4.15 Autocorrelation Tests

Model	Std. Error of the Estimate	Durbin-Watson
1	2.24851	1.816

a. Predictors: (Constant), Extension Services, Resource Capabilities, Managerial Capabilities

b. Dependent Variable: Adoption of Digital Technology

The study utilized the Durbin-Watson statistic to measure for autocorrelation. The results indicated no autocorrelation as shown on Table above. As a rule of thumb Durbin-Watson Scores between 1.5 and 2.5 indicate independent observations. The D-W statistics was 1.816 thus indicating no autocorrelation problems.

4.5.1.2 Collinearity Tests

The study adopted the variance inflation factor and tolerance values in examining the collinearity between the predictor variables of the study.

Table 4.16 Collinearity Statistics

Model		Sig.	Collinearity Statistics	
			Tolerance	VIF
1	(Constant)	.000		
	Resource Capabilities	.856	.364	2.746
	Managerial Capabilities	.000	.334	2.996
	Extension Services	.002	.653	1.532

a. Dependent Variable: Adoption Digital Technology

The study results indicate that VIF values are all less than 10, meaning that there was no multicollinearity. The Tolerance value checks on the degree of Collinearity, where a tolerance value lower than 0.1 shows that the variable could be considered as a linear combination of other independent variables. All the tolerance values for the study were above 0.1, hence no collinearity problems.

4.4.1.3 Normality Tests

In testing for normality, the researcher intended to assess whether the distribution was normal. The study adopted the normal curve to present the distribution of the responses along with the p-p plot.

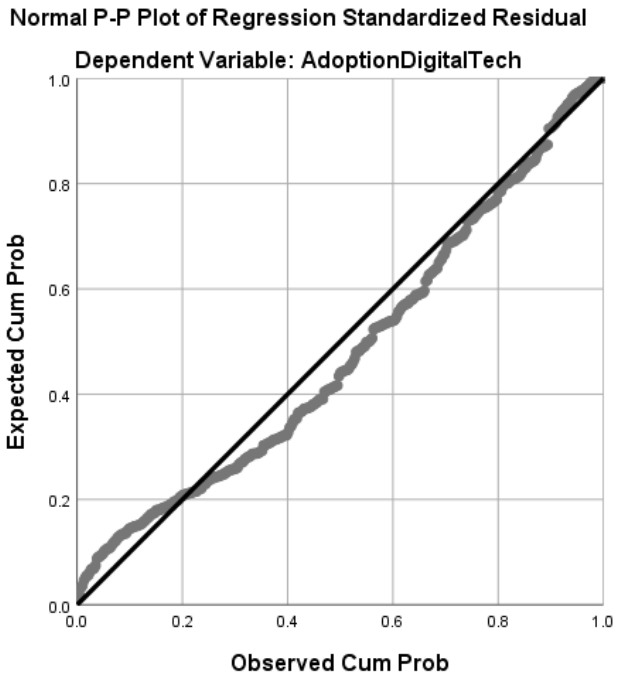

Figure 4.2 Normality P-P Plot

4.5.2 Correlation Analysis

The study adopted correlation analysis to determine the type of association between independent and adoption of digital technologies. The study adopted Spearman Rank correlation and findings are shown in the table below.

Table 4.17 Correlation Results

		Adoption Digital Tech	Resource Capabilities	Managerial Capabilities	Extension Services	Age1	Farming Experience	Education	Household Income	Household Size	Gender
Adoption Digital Technology	Pearson Correlation	1									
	Sig. (2-tailed)										
	N	363									
Resource Capabilities	Pearson Correlation	.288**	1								
	Sig. (2-tailed)	.000									
	N	363	363								
Managerial Capabilities	Pearson Correlation	.372**	.793**	1							
	Sig. (2-tailed)	.000	.000								
	N	363	363	363							
Extension Services	Pearson Correlation	.193**	.525**	.579**	1						
	Sig. (2-tailed)	.000	.000	.000							
	N	363	363	363	363						
	N	363	363	363	363						
Age1	Pearson Correlation	-.098	.104*	-.029	-.012	1					
	Sig. (2-tailed)	.063	.049	.581	.824						

	N	363	363	363	363	363					
Farming Experience	Pearson Correlation	-.251**	-.063	-.176**	-.066	.656**	1				
	Sig. (2-tailed)	.000	.234	.001	.208	.000					
	N	363	363	363	363	363	363				
Education	Pearson Correlation	.144**	.267**	.347**	.244**	-.190**	-.153**	1			
	Sig. (2-tailed)	.006	.000	.000	.000	.000	.003				
	N	363	363	363	363	363	363	363			
Household Income	Pearson Correlation	-.047	.197**	.007	.007	.338**	.505**	.045	1		
	Sig. (2-tailed)	.373	.000	.892	.901	.000	.000	.397			
	N	363	363	363	363	363	363	363	436		
Household Size	Pearson Correlation	-.006	-.006	-.073	-.171**	.238**	.295**	.106*	.198**	1	
	Sig. (2-tailed)	.915	.909	.163	.001	.000	.000	.043	.000		
	N	363	363	363	363	363	363	363	436	436	
Gender	Pearson Correlation	-.041	-.106*	-.145**	-.024	.002	.048	-.080	.070	-.039	1
	Sig. (2-tailed)	.439	.044	.005	.649	.972	.360	.128	.186	.462	
	N	363	363	363	363	363	363	363	363	363	363

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

The study sought to determine the effect of resource capabilities on the adoption of digital technologies in small-scale farmers. The results show that resource capability has a positive and significant association with the adoption of digital technology *(P= .238, Sig= .000<.05).* The findings are consistent with Aura (2016) who found out that improving farm labour capacity, size and financial resources was key to integrating technologies in agricultural farming. The findings indicate that managerial capabilities have a positive and significant effect on the adoption of digital technologies among small-scale farmers *(P= .306, Sig= .000<.05).* The findings are consistent with Cavallo, Ferrari, Bollani, and Coccia (2014) who revealed that managerial experience in terms of knowledge, collaboration with stakeholders and years of activity are essential to technological innovation in the agricultural sector.

The research findings further established that access to extension services had a positive and significant effect on the adoption of digital technologies *(P= .188, Sig= .000<.05).* Further research findings established that there is a positive and significant association there is a significant negative association between a farming experience *(P= -.251, Sig= .000>.05);* insignificant negative effect of age of the farmer *(P= -.098, Sig= .063>.05),* and significant and positive effect of education of farmer *(P= .144, Sig= .006<.05)* and the adoption of digital technology. The study findings further indicated that household income had a negative and insignificant effect on adoption of digital technologies *(P= -.047, Sig= .373>.05),* results established a negative and insignificant correlation between household size and adoption of digital technologies *(P= -.006, Sig= .915>.05)* and a negative and insignificant effect of gender of respondents *(P=.041, Sig= .439>.05) on* adoption of digital technologies.

Omoro (2015) in a study established that access to extension staff, socioeconomic factors and capacity building was key to adoption of greenhouse technology in small-scale farms. Choudhury, Das, Sarmah and Ahmed (2018) also established that farming experience, education attainment, and farmer's age is critical to the adoption of new technologies in agriculture.

4.5.3 Regression Analysis

The study analyzed the magnitude of the relationship between the three main determinants and the level of adoption of digital technology. The research utilized ordinary least square regression analysis.

Table 4.18 Regression Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.431[a]	.185	.165	2.20588

a. Predictors: (Constant), Gender, Age, Extension Services, Household Size, Household Income, Education, Resource Capabilities, Farming Experience, Managerial Capabilities

The study aimed to determine the magnitude of the relationship between education, farming experience, age of farmer, access to extension services, resource capabilities and managerial capabilities on the adoption of digital technology. The results indicate a coefficient of determination of (R^2= *.185*); which implies that 18.5% variations in the adoption of digital technology are determined by the four study constructs.

Table 4.19 ANOVA Analysis

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	390.881	9	43.431	8.926	.000[b]
	Residual	1717.670	353	4.866		
	Total	2108.551	362			

a. Dependent Variable: AdoptionDigitalTech

b. Predictors: (Constant), Gender, Age, Extension Services, Household Size, Household Income, Education, Resource Capabilities, Farming Experience, Managerial Capabilities

The aim of the ANOVA analysis was to determine the statistical significance of the study model. Findings of the ANOVA analysis indicate a *f-statistic = 8.926> F- (critical f; 1.162), p-value = .000<.05*. This indicates that the model was statistically significant and fit in predicting the relationship among the study variables.

Table 4.20 Regression Coefficient

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	4.708	.914		5.154	.000
	Resource Capabilities	-.016	.053	-.026	-.309	.758
	Managerial Capabilities	.229	.056	.359	4.081	.000
	Extension Services	-.001	.045	-.002	-.032	.974
	Age	.014	.015	.061	.921	.358
	Farming Experience	-.065	.017	-.289	-3.940	.000
	Education	-.011	.038	-.016	-.289	.773
	Household Income	.162	.151	.064	1.075	.283
	Household Size	.282	.184	.080	1.529	.127
	Gender	.108	.267	.020	.405	.686

a. Dependent Variable: AdoptionDigitalTech

$$Y = 4.708 + -.016X_1 + .229X_2 + -.001X_3 + .014X_4 + -.053X_5 + .005X_6 + .162X_7 + .82X_8 + .108X_9 + .914$$

The study results indicate a constant of 4.708 which is statistically significant (P-value of.000<.05). Findings further show the coefficient of resource capability = **-.016**, which is not statistically significant as shown by the (P-value of .758>.05), which shows there is no significant influence. The study shows a coefficient of managerial capabilities = **.229** which is statistically significant (P-value of .000<.05), implying that a unit change in managerial capabilities will yield a .214 change in the adoption of digital technology. The research indicates a coefficient of access to extension services is **-.001** which is not statistically significant (P-value of .974>.05).

The research indicates a coefficient of farmers age is = **.014** which is statistically insignificant (P-value of .358>.05). The research indicates a coefficient of farming experience is **-.065** and it is statistically significant (P-value of .000<.05). This shows that a unit change in the level of

farming experience will result in a -.053 change in the adoption of digital technology. The research indicates a coefficient of farmers education is **-.011** which is statistically insignificant (P-value of .895>.05).

The findings further show a coefficient fo household income which is .162 and (P-value of .283>.05) indicating a positive and insignificant influence on adoption of digital technologies. The results also show a coefficient of household size = .282 with (P-value of .127>.05) denoting a a positive and insignificant influence on adoption of digital technologies. Finally the study yielded a coefficient of .108 for the variable gender with (P-value = .686>.05) showing there is a a positive and insignificant influence on adoption of digital technologies.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Introduction

This chapter presented a summary of the research and the discussion of the results obtained from the analysis. The chapter further presented the conclusions, recommendations and suggestions for further research.

5.2 Summary

Various sectors within the Kenyan economy have witnessed an increased digitalization and reliance on technologies in running their daily operations. The same has, however, not been witnessed in the agriculture sector, which is one of the top contributors to economic growth and a source of livelihood for many families. This study sought to examine the determinants of digital technology adoption among small-scale farmers in Embu and Kirinyaga counties. The study specifically examined how resource capability, managerial capability, and access to extension services influences the adoption of digital technologies.

The study was grounded on the technology, organization and environment framework. The approach helps in identifying how internal and external factors of the **farms** interact to support better adoption of digital technologies. The study adopted a positivism research philosophy with a descriptive research design being used in the study. The research targeted 12,000 farmers drawn from the two counties. The research employed a quantitative approach with a semi-structured questionnaire being used in the data collection. The research data was analyzed using descriptive statistics, Spearman correlation, and regression analysis.

The study was able to obtain a 93% response rate from farmers drawn from both counties. The study findings indicate that on average most farmers had been in school for at least 11 years, had an average land size of 2 acres. The results also indicate that most of the farmers have practiced farming for at least 14 years with an average annual income of 107,752 shillings. The findings of the study indicate that resource capability, managerial capability and access to extension services had a positive and significant effect on the adoption of digital technologies. The results of the regression analysis show that 18.5% variations in the adoption of digital technologies are determined by, gender, household income, household size, age, farming experience, farmers' education, the level of resource capability, managerial capability and access to extension services.

5.3 Discussions

The discussions on the findings of the study are presented here and they are grouped as per the variables.

5.3.1 Resource Capabilities

The respondents were in agreement that to some extent, the **farms** had access to adequate financial resources and had access to the required modern farming equipment. Beshir, Emana, Kassa, and Haji (2012) also found out that accessibility to credit facilities fostered the **farms** ability to acquire large tracts of lands as well as improve the adoption of new technologies. The research showed that farmers had to some extent, accessed adequate support staff within the farm as well as technological infrastructure. Pierpaoli, Carli, Pignatti, and Canavari (2013), in their study, made similar assertions that skilled employees and adequate technological knowledge are critical to the adoption of new technologies. Findings show that to an extent the **farms** had access to credit facilities as well as a ready market for the products. Ingabire, Yonggong, Pesha, and Hardi (2018) contend that the accessibility of financial products and farmers' knowledge/skills were critical to the adoption of modern agricultural technologies. Kinyangi (2014) study also showed similar results that the availability of capital and increased access to credit facilities was critical to the adoption of agricultural technologies in Kenya. The study findings showed that resource capabilities did not have a statistically significant influence on the adoption of digital technologies within small-scale farms in Kenya (B= .006, Sig = .904>.05).

5.3.2 Managerial Capabilities

The findings indicate that to a moderate extent the farmers engaged in collaboration with their farmers. The results are consistent with Mwaura (2014), who revealed that group membership was critical to technology adoption in small farms. The study found out that group membership enabled farm managers to improve their decision-making capacity. The results further show that there was adequate experience in modern farming among farmers as well as had adequate technological knowledge. Dehinenet, Mekonnen, Kidoido, Ashenafi, and Bleich (2014) in their research notes that the level of farming experience and off-farm activity participation was critical to enhancing the integration of new technologies among small-scale farmers. The study results indicated that to some extent, the farms had undertaken managerial training in the past as well as gained exposure to various farming technologies. Nato, Shauri, and Kadere (2016) also found out that enhancing capacity building programs within small farms was essential to enhancing agriculture technology utilization. The study findings showed that managerial

capabilities had a statistically significant influence on the adoption of digital technologies within small-scale farms in Kenya (B= .214, Sig = .000<.05).

5.3.3 Access to Extension Services

The study indicates that most of the farmers accessed information from farmers union, government institutions as well as private **farms**. The results show that to a moderate extent most of the farmers were taking part in agriculture training programs as well as accessed relevant market information. Altalb, Filipek, and Skowron (2015) similarly opined that agricultural extension services were key contributors to the transfer of knowledge on agri-techs and the adoption of emerging technologies. The study showed that to some extent the farmers had access to advisory services and logistic support services. Similar views are held by Ntshangase, Muroyiwa, and Sibanda (2018) who note that increased extension services are critical to farmers' likelihood of shifting from traditional farming methods. The results indicated that to some extent the farmers were able to access in-service training on emerging farming tools. Okuthe (2014) also found out that extension services offered farmers access to the market and was a key predictor of the adoption of integrated technologies. Omoro (2015) also made similar assertions that extension services were essential to small scale farms as they fostered their exposure to new farming technologies. The study findings showed that access to extension services did not have a statistically significant influence on the adoption of digital technologies within small-scale farms in Kenya (B= -.017, Sig = .697>.05).

5.3.4 Socioeconomic Factors

The research indicates farmers' education does not have a significant influence on the adoption of digital technology. These results are not consistent with earlier evidence by Mittal and Mehar (2016) who suggested that education level and farmers' behavior are key predictors of ICT adoption in farming. Similarly, Choudhury, Das, Sarmah and Ahmed (2018) noted that education level and farming experience were critical to the technology adoption in farming. In the same vein, Bunde and Kibet (2016) acknowledged that education level were significant predictors of beekeeping technologies adoption in Kenya. The study results further indicated that farmers' age did not have a significant influence on the adoption of digital technology. Contrary to earlier literature, this study established that farming experience has a statistically significant negative effect on the adoption of digital technology which is not in line with the observations made by Bunde and Kibet (2016). The findings showed there exists a positive and insignificant effect of household income, household size and gender on the adoption of digital technology.

5.4 Conclusions

The study concludes that to some extent there has been an increase in the usage of various technologies among small-scale farmers. The research concluded that the capacity of the **farms** to adopt agricultural technologies was determined by the resource capacity, managerial capacity and access to extension services. The study concluded that resource capabilities within small-scale farmers did not have a significant influence on adoption of digital technologies.

Concerning the management capacity, the research concludes fostering collaboration and linkages between **farms**, enhancing managerial training and level of experience running the **farms** is essential to the adoption of agriculture technologies. The study concludes that access to extension services does not have a significant influence on the adoption of digital technologies among small-scale farmers. The study concluded that the age and the education of the farmer had insignificant and positive effect on the digital technology adoption. The study concludes that farming experience has significant and negative effect on the digital technology adoption in small-scale farms. The study finally concludes that household income, household size and gender have a positive and insignificant effect on the adoption of digital technology.

5.5 Recommendations

5.5.1 Policy Recommendations

The country has been grappling with food insecurity which is a major challenge to maintaining sustainable food supply in the country. This coupled with changing global climate patterns there is a need for government policymakers to institute a sweeping reform process in the agriculture industry which will be critical to integrating agricultural technologies in Kenya. Further, the government through state authorities and departments should support increased research and development into various programs and technologies that can be introduced in small-scale agriculture in Kenya. The study recommends that the government should also decentralize extension services to enhance accessibility in rural areas in Kenya. In a bid to support the capacity of small-scale farmers the research recommends that county governments and other non-state actors should create programs to provide funding to entrepreneurs and software developers to develop successful technologies that can be integrated into small-scale farming. The study also recommends that the government to provide additional legal support to increase ease of access to globally accessible innovations regarding agricultural productivity.

5.5.2 Practice Recommendations

The study also recommends that more research should be undertaken on how technology can be fully incorporated into farming and other value chain activities to enhance productivity at farm level and during food distribution. The study recommends that more should be done by farmers unions and extension offices to support managerial training and raising awareness on the various technologies that farmers can adopt in Kenya. The research recommends that farmers should seek collaboration with stakeholders to expand their opportunities for training and capacity building since this will increase the levels of awareness on what technologies exist and their application in increasing the productivity of farmers. The study noted that most of the farmers had an annual income of less than 100 000; hence the research recommends that farmers should pool resources together and purchase the modern equipment's and machinery in groups; this will enable them to adopt modern agricultural technologies. The study recommends that farmers should improve their education and training on emerging agricultural technologies as this will be pivotal to adoption of technology in their farming activities.

5.5.3 Recommendation for Further Research

The study findings indicated that there was some extent of adoption of the selected modern agriculture technologies. This study suggests that a more extensive study should be considered examining farm-level factors that affect integration of modern technologies among farmers in Kenya.

5.6 Limitations of the Research

The study was conducted across only small-scale farms in two counties in Kenya which may limit the generalizability of the study findings across other counties. Further the study focussed only on adoption of pre-selected applications among farmers in Embu and Kirinyaga county which may have hampered the inclusion of farmers who could be utilizing other forms of digital technologies.

REFERENCES

Achieng, S. G. (2018). The Principle of Territorial Integrity as a Determinant of Kenya's National Security Policy 2002-2016. *A Doctoral dissertation, United States International University-Africa*.

Acquaah, M., & Agyapong, A. (2015). The Relationship between Competitive Strategy and Firm Performance in Micro and Small Businesses in Ghana: The Moderating Role of Managerial and Marketing Capabilities. *Journal of Development Entrepreneurship*, 16 (1): 103-126.

Adeyemo, A. (2013). Information System Review: An e-farming framework for sustainable agricultural development in Nigeria. *Journal of Internet and Information System Review*, 50(2), 179-211.

Ajayi, M. T., & Solomon, O. (2017). Influence of extension contact and farmers' socio-economic characteristics on adoption of oil palm technologies in Aniocha North Local Government, Delta State, Nigeria. *Jomo Kenyatta University of Agriculture and Technology*.

Akudugu, M. A., Guo, E., & Dadzie, S. K. (2012). Adoption of modern agricultural production technologies by farm households in Ghana: What factors influence their decisions. *International Institute for Science, Technology and Education*, Vol. 2; Issue 3.

Altalb, A. A., Filipek, T., & Skowron, P. (2015). The role of agricultural extension in the transfer and adoption of agricultural technologies. *Asian Journal of Agriculture and Food Sciences*, ISSN: 2321–1571, 3(05).

Amponsah, K., & Paliwal, N. (2015). Technology And Managerial Gaps In The Adoption Of Improved Groundnut Varieties In Malawi And Uganda . *University of Connecticut*, No. 330-2016-13565.

Angeles, R. (2014). Using the technology organization environment framework for analyzing Nike's "considered index" green initiative, a decision support system driven system. . *Journal of Management and Sustainability*, 4(1), 96-113.

APA. (2016). *Socioeconomic Status*. Retrieved from American Psychological Association: http://www.apa.org/topics/socioeconomic-status/

Asiedu-Darko, E. (2013). Agricultural extension delivery in Ghana: A case study of factors affecting it in Ashanti, Eastern and Northern regions of Ghana. . *Journal of Agricultural Extension and Rural Development*, 5(2), 37-41.

Aura, S. (2016). Determinants of the adoption of integrated soil fertility management technologies in Mbale division, Kenya. . *African Journal of Food, Agriculture, Nutrition and Development*, 16(1), 10697-10710.

Ayoola, J. B. (2012). Socio-economic determinants of the adoption of yam minisett technology in the Middle Belt region of Nigeria. *Journal of Agricultural Science*, 4(6), 215.

Babin, B., & Zikmund, W. (2012). *Essentials of marketing Research.* Florida: Harcourt Brace College Publishers.

Barney, J., & Hesterley, W. (2006). Organizational economics: understanding the relations between organizations and economics analysis. *Handbook of Organization Studies*, pp.111-148.

Beshir, H., Emana, B., Kassa, B., & Haji, J. (2012). Determinants of chemical fertilizer technology adoption in North eastern highlands of Ethiopia: the double hurdle approach. *Journal of Research in Economics and International Finance*, 1(2), 39-49.

Bordens, K., & Abbot, B. B. (2003). *Research design and memthods: A process approach.* . New York: McGraw-Hill.

Bunde, A., & Kibet, K. (2016). Socio-Economic Factors Influencing Adoption of Modern Bee Keeping Technologies in Baringo County, Kenya. *International Journal of Science and Research (IJSR)*, 5(6), 960-969.

Burns, N., Grove, S. K., & Gary, J. R. (2015). *Understanding nursing research: Building an evidence nased practice.* St. Louis, MO: Elsevier Saunders.

Cavallo, E., Ferrari, E., Bollani, L., & Coccia, M. (2014). Strategic management implications for the adoption of technological innovations in agricultural tractor: the role of scale factors and environmental attitude. *Technology Analysis & Strategic Management*, 26(7), 765-779.

Chesang, D., & Ayuma, C. O. (2016). Effect of Financial Leverage on Profitability of Listed Agricultural Firms at the Nairobi Securities Exchange. *International Journal of Economics, Commerce and Management*, 4(12), 445–493.

Chiu, L. (2017). An integrated perspective of TOE framework and innovation diffusion in broadband mobile applications adoption by enterprises. *International Journal of Management, Economics and Social Sciences*, 191-229.

Choudhury, B. N., Das, S. C., Sarmah, M. C., & Ahmed, M. (2018). A study on the influence of socio-economic factors on knowledge and technology adoption of sericulture farmers of Aizawl district of Mizoram. *International Journal of Advance Research, Ideas and Innovations in Technology*, Volume 4, Issue 3.

Cooper, D. R., & Schindler, P. S. (2012). *Business Research Methods.* . New York: McGraw.

Creswell, J. (2007). *Qualitative Inquiry and Research Design: Choosing among Five Approaches.* Thousand Oaks, CA: Sage Publications.

Dehinenet, G., Mekonnen, H., Kidoido, M., Ashenafi, M., & Bleich, E. G. (2014). Factors influencing adoption of dairy technology on small holder dairy farmers in selected zones of Amhara and Oromia National Regional States, Ethiopia. *Discourse Journal of Agriculture and Food Sciences*, 2(5), 126-135.

Droesch, A. C. (2015). *Technology diffusion, outcome variability, and social learning: Evidence from a field experiment in Kenya.* Job Market Paper.

Eidt, C. M., Hickey, G. M., & Curtis, M. A. (2012). Knowledge integration and the adoption of new agricultural technologies: Kenyan perspectives. *Food Security*, 4(3), 355-367.

Ekber, T., & Gökhan, P. (2013). The Effects of Socioeconomic Characteristics of Students on Their Academic Achievement in Higher Education. *American Journal of Educational Research*, , 1 (10), pp 449-455. .

Field, A. (2009). *Discovering statistics using SPSS (and sex and drugs and rock "n" roll).* . London: Sage Publications.

Food and Agriculture Organization . (2017). *Africa Regional Overview of Food Security and Nutrition.* Food and Agriculture Organization of the United Nations.

Frankfort-Nachmias, C., & Nachmias, D. (2008). *Research methods in the social sciences (7th ed.).* New York, NY: Worth Publishers.

Gill, J., & Johnson, P. (2010). *Research methods for managers.* London: Sage.

Graves, C., & Thomas, J. (2006). Internationalization of Australian family businesses: A Managerial capabilities perspective. *Family Business Review*, 19 (3): 207-224.

Hoti, E. (2015). The technological, organizational and environmental framework of IS innovation adaption in small and medium enterprises. Evidence from research over the last 10 years. . *International Journal of Business and Management*, 3(4), 1-14.

IFAD. (2011). *Rural Poverty Report 2011 - IFAD.* Geneva.

Ingabire, M. C., Yonggong, L., Pesha, J. C., & Hardi, A. (2018). Factors affecting adoption of artificial insemination technology by small dairy farmers in Rwanda: A case of Rwamagana District. *Journal of Economics and Sustainable Development*, 9, 46-53.

ITU. (2016). International Telecommunication Union. *Journal of Law, Economics, and Organization*, 34-98.

Kabunga, N., Dubois, T., & Qaim, M. (2012). Heterogeneous information exposure and technology adoption: The case of tissue culture bananas in Kenya. *Agricultural Economics DOI*, 10.1111/ j.1574-0862.2012.00597.

Kadenyi, G. (2017). *Food Safety: Fresh Fruits and Vegetables in Kenya's Domestic Markets.* Hivos Org.

Kalungu, J. W., & Leal-Filho, W. (2018). Adoption of appropriate technologies among smallholder farmers in Kenya. *Climate and Development*, 10(1), 84-96.

Kamaara, M. (2014). The relationship between the design and the roles of boards on performance of commercial state corporations in Kenya. . *Unpublished PhD thesis, Juja: Jomo Kenyata University of Agriculture and Technology.*

Kanchanatanee, K., Suwanno, N., & Jarernvongrayab, A. (2014). Factors affecting the intention to use E-marketing of small and medium sized businesses in the three southern border provinces of Thailand. *International Journal of Business and Social Science, ,* 5(6).

Kerlinger, F. N., & Lee, H. B. (2000). Survey research. *Foundations of behavioral research, ,* 599-619.

Kheiri, S. (2015). Identifying the Barriers of Sustainable Agriculture Adoption by Wheat Farmers in Takestan, Iran. *International Journal of Agricultural Management and Development (IJAMAD)*, 5(1047-2017-1614), 159-168.

Kinyangi, A. A. (2014). Factors influencing the adoption of agricultural technology among smallholder farmers in Kakamega north sub-county, Kenya. . *University of Nairobi*.

Kinyanjui, S. (2012). Social-Economic factors influencing sustainability of DairyGoat farming in Kenya. A case of Kakuzi Division in Thika East District. *University of Nairobi, Kenya*.

Kipserem, J., Sulo, T., Chepng"eno, W., & Korir, M. (2011). Analysis of factors affecting dairy goat farming in Keiyo North and Keiyo South Districts of Kenya. *Journal of development and Agriculture Economics*, Vol 3 (11) pp. 555-560,12.

Kothari, C. R. (2004). *Research methods: methods and techniques (2nd ed.).* . New Delhi: New Age International Publishers.

Lamuka, P. O. (2015). *Public Health Measures: Challenges of Developing Countries on Management of Food Safety.* . Food Safety Summit Africa 2015 Conference & Expo, Nairobi, 2015.

Langat, B. K., Ngéno, V. K., Nyangweso, P. M., Mutwol, M. J., Kipsat, M. J., Gohole, L., & S., Y. (2014). Drivers of Technology Adoption in a Subsistence Economy: The case of Tissue Culture Bananas in Western Kenya. *International Conference of the African Association of Agricultural Economists*.

Leichman, A. (2019). *The Top 12 Ways Israel is Feeding the World.* Israel is Feeding the World.

Long, T. B., Blok, V., & Coninx, I. (2016). Barriers to the adoption and diffusion of technological innovations for climate-smart agriculture in Europe: evidence from the Netherlands, France, Switzerland and Italy. *Journal of Cleaner Production*, 112, 9-21.

Lopokoiyit, M., Onyango, C., & Kibett, J. K. (2013). Extension Management Competency Needs of Agricultural Extension Agents in Kenya. *Mediterranean Journal of Social Sciences*, 4 (6).

Mabaya, E., Fulton, J., Simiyu-Wafukho, S., & Nang'ayo, F. (2015). Factors influencing adoption of genetically modified crops in Africa. *Development Southern Africa*, 32(5), 577-591.

Magugu, J. W., Feng, S., Huang, Q., & Ototo, G. O. (2018). Socio-economic factors affecting agro-forestry technology adoption in Nyando, Kenya. *Journal of water and land development*, 39(1), 83-91.

Mariano, M. J., Villano, R., & Fleming, E. (2012). Factors influencing farmers' adoption of modern rice technologies and good management practices in the Philippines. . *Agricultural Systems*, 110, 41-53.

Masavi, J. M., Kiweu, M., & Kinyili, J. (2017). Capital Structure and Financial Performance of Agricultural Companies Listed in Nairobi Securities Exchange, Kenya. . *International Journal of Economics, Commerce and Management,*, 5(11), 653–665.

Mashall, B., & Miguel, E. (2014). Innovative Finance for technology adoption in Western Kenya. . *Innovation for poverty publication*.

Milkias, D., & Abdulahi, A. (2018). Determinants of agricultural technology adoption: the case of improved highland maize varieties in Toke Kutaye District, Oromia Regional State, Ethiopia. *Journal of Investment and Management*, 7(4), 125-132.

Mittal, S., & Mehar, M. (2016). Socio-economic factors affecting adoption of modern information and communication technology by farmers in India: Analysis using multivariate probit model. *The Journal of Agricultural Education and Extension*, 22(2), 199-212.

Mugenda, O. M., & Mugenda, A. G. (2003). *Research methods: Quantitative and qualitative approaches.* Nairobi: African Centre for Technology Studies.

Mwangi, M., & Kariuki, S. (2015). Factors determining adoption of new agricultural technology by smallholder farmers in developing countries. *Journal of Economics and sustainable development*, 6(5).

Mwaura, F. (2014). Effect of farmer group membership on agricultural technology adoption and crop productivity in Uganda. *African Crop Science Journal*, 22, 917-927.

Nato, G. N., Shauri, H. S., & Kadere, T. T. (2016). Influence of social capital on adoption of agricultural production technologies among beneficiaries of African Institute for

capacity development training programmes in Kenya. *International Journal of Social Science and Technology*, Vol. 1 No. 1;ISSN: 2415-6566 .

Ndemo, B., & Weiss, T. (2016). *Digital Kenya: An entrepreneurial revolution in the making.* Springer.

Newbert, S. L. (2007). Empirical research on the resource- based view of the firm: An assessment and suggestions for future research. *Strategic management journal,*, Vol.28.

Ngecu, M. (2004). *Understanding the research process and methods.* Nairobi: Acts Press.

Nguyen, T. H., Alam, Q., Perry, M., & Prajogo, D. (2009). The entrepreneurial role of the state and SME growth in Vietnam. *Journal of Administration & Governance*, 4(1), 60-71.

Ntshangase, N., Muroyiwa, B., & Sibanda, M. (2018). Farmers' perceptions and factors influencing the adoption of no-till conservation agriculture by small-scale farmers in Zashuke, KwaZulu-Natal Province. *Sustainability*, 10(2), 555.

Obaji, N. O., & Olugu, M. U. (2014). The role of government policy in entrepreneurship development. *Science Journal of Business and Management*, 2(4), 109-115.

Ogutu, S., Okello, J., & Otieno, D. (2014). Impact of Information and Communication Technology-based Market Information Services on Smallholder Farm Input Use and Productivity: The case of Kenya. *World Development*, 64, 311-321.

Okuthe, I. K. (2014). The influence of institutional factors on the adoption of integrated natural resource management technologies by small scale farmers in South Western Kenya. *Asian Journal of Agricultural Sciences*, 6(1), 16-32.

Oliveira, T., & Martins, M. F. (2011). Literature review of information technology adoption models at firm level. *The Electronic Journal Information Systems Evaluation,* , Vol 14, Issue 1.

Olwande, J., Smale, M., Mathenge, M., Place, F., & Mithofer, D. (2015). Agricultural Marketing by Smallholders in Kenya: A Comparison of Maize, Kale & Dairy. *Food Policy*, 52, 22-32.

Omoro, P. A. (2015). Assessing the extension staff farm visits frequency effect on greenhouse technology performance in small scale farms in Gusii highlands, Kenya. . *Open Access Library Journal*, 2(02), 1.

Ozor, N., & Urama, K. (2013). The Role of Technology in Ensuring Adequate Food Security in Africa. *Society for International Development*, 56 (2), 266 – 273.

Parliamentary Service Commission. (2018). *Eye on the 'Big Four': Budget Watch for 2018/19 and the Medium Term.* PSC.

Pavlou, P. A., & El Sawy, O. A. (2011). Understanding the elusive black box of dynamic capabilities. *Decision Sciences*, 42(1), 239-273.

Pierpaoli, E., Carli, G., Pignatti, E., & Canavari, M. (2013). Drivers of precision agriculture technologies adoption: a literature review. *Procedia Technology*, 8, 61-69.

Radhakrishna, R. B. (2007). Tips for developing and testing questionnaires/instruments. *Journal of Extension*, 45(1).

Ramachandran, V. (2011). Strategic corporate social responsibility: A dynamic capabilities perspective. *Corporate Social Responsibility and Environmental Management*,, Vol.18.

Reardon, T., Chen, K., Minten, B., & Adriano, L. (2012). *The Quiet Revolution in Staple Food Value Chains. Enter the Dragon, the Elephant, and the Tiger.* Mandaluyong City, Philippines: Asian Development Bank (ADB). International Food Policy Research Institute.

Sekaran, U., & Bougie, R. (2009). *Research methods for musiness: A skill-building approach (5th ed.).* Hoboken: John Willey & Sons.

Tey, Y. S., & Brindal, M. (2012). Factors influencing the adoption of precision agricultural technologies: a review for policy implications. *Precision agriculture*, 13(6), 713-730.

Tey, Y. S., Li, E., Bruwer, J., Abdullah, A. M., Brindal, M., & Darham, S. (2017). Factors Influencing The Adoption Of Sustainable Agricultural Practices In Developing Countries: A Review. *Environmental Engineering & Management Journal (EEMJ)*, , 16(2).

Tornatzky, L. G., Fleischer, M., & Chakrabarti, A. K. (1990). *Processes of technological innovation.* Lexington Books.

Uzonna, U. R., & Qijie, G. (2013). Effect of extension programs on adoption of improved farm practices by farmers in Adana, Southern Turkey. *Journal of Biology, Agriculture and Healthcare*, 3(15), 17-23.

Wanyama, J. M., Obare, A., Owuor, G., & Wasilwa, L. (2013). Factors Influencing Adoption of Tissue Culture Bananas in Western Kenya. A Research Paper presented at an . *International workshop of AAAE in Tunisia*.

APPENDICES

Appendix I: Questionnaire for Commercial Agriculture Farms

Purpose of the Survey

The purpose of this questionnaire is to assist in examining the determinants of adoption of digital technologies among commercial farmers in Embu and Kirinyaga County. The duration to complete was 10 minutes. Your participation in this survey is purely voluntary, and you are free to terminate should you feel uncomfortable to proceed, and there was no implications. The information provided was treated with the utmost confidentiality and was used solely for the research. The findings was reported on aggregate, not on an individual basis.

Should you have any questions, kindly contact Hussein Kiarie.

a. **Have you adopted any digital technologies in your small-scale farming?**

   Yes ( ) No ( )

   (***If no to the above kindly do not participate in the study)***

PART A: GENERAL INFORMATION

1. **Gender**

   Male [ ] Female [ ]

2. **What is your age?**

   _____

3. **How many years have you been in school?**

   _____

4. **What is the size of your household?**

   _____

5. **What is the size of your farm?**

   _____

6. **How many years have you been a small-scale farmer in Embu and Kirinyaga County?**

   _____

7. **What is your position within the farm/firm?**

   _____

8. **What is your annual level of income from farming?**

   _____

PART B: DIGITAL TECHNOLOGIES ADOPTION AMONG SMALL SCALE FARMS IN KENYA

This section examines the extent of adoption of the various digital technologies availed to the farms within your location. Kindly indicate your response in the table below:

1 = To a small extent 2 = To some extent 3 = To a moderate extent 4 = To a great extent 5 = To a very great extent

This section examines the extent of adoption of the various digital technologies availed to the farms within your location. Kindly indicate your response in the table below:

1=Not at all, 2=Small extent, 3=Moderate extent 4=Great extent

No	Adoption of Digital Technologies	1	2	3	4	5
1)	I utilize the Kilimo Salama app in my farming activities					
2)	I utilize the Farm Weather app in my farming activities					
3)	I utilize the Apollo app in my farming activities					
4)	I utilize Digi Farm app in my farming activities					
5)	I utilize Smart Cow app in my farming activities					

PART C: RESOURCE CAPABILITY AND DIGITAL TECHNOLOGY ADOPTION

Kindly indicate to what extent the following factors affect digital technology adoption:

1 = To a small extent 2 = To some extent 3 = To a moderate extent 4 = To a great extent 5 = To a very great extent

No	Resource capabilities	1	2	3	4	5
6)	I have access to adequate financial resources					

7)	I have access to the required modern farming equipment					
8)	I have access to adequate support staff within the farm					
9)	I have access to technological infrastructure					
10)	I have access to credit facilities					
11)	There is access to a ready market for the products					

PART D: MANAGERIAL CAPABILITY AND DIGITAL TECHNOLOGY ADOPTION

Kindly indicate to what extent the following factors affect digital technology adoption:

1 = To a small extent 2 = To some extent 3 = To a moderate extent 4 = To a great extent 5 = To a very great extent

No	**Managerial Capabilities**	**1**	**2**	**3**	**4**	**5**
12)	I engage in collaboration with other farmers in the area					
13)	I have adequate experience in modern farming					
14)	I have adequate technological knowledge					
15)	I have undertaken managerial training in the past					
16)	I have been exposed to the various farming technologies					

PART E: EXTENSION SERVICES AND DIGITAL TECHNOLOGY ADOPTION

17) Have you accessed extension services?

Yes ( )

No ( )

18) What are your main sources of extension services?

Government offices ( )

Non-Government organization ( )

Private firms ( )

Farmers unions ( )

Kindly indicate to what extent the following factors affect digital technology adoption:

1 = To a small extent 2 = To some extent 3 = To a moderate extent 4 = To a great extent 5 = To a very great extent

No	**Access to extension services**	**1**	**2**	**3**	**4**	**5**
19)	I have been part of agriculture training programs					
20)	I have access to relevant market information					
21)	I have access to advisory services					
22)	I have access to logistic support services					
23)	I have access to in-service training on emerging farming tools					

Thank for your Time

Appendix II: Ethical Review Permit

Strathmore UNIVERSITY

11th June 2020

Mr Kiarie, Hussein
hussein.kiarie@strathmore.edu

Dear Mr Kiarie,

RE: Determinants of Digital Technologies Adoption Among Small Scale Farmers in Kenya (A Case Study of Embu and Kirinyaga Counties)

This is to inform you that SU-IERC has reviewed and **approved** your above research proposal. Your application approval number is **SU-IERC0720/20.** The approval period is **11th June 2020 to 10th June 2021.**

This approval is subject to compliance with the following requirements:

i. Only approved documents including (informed consents, study instruments, MTA) will be used
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by SU-IERC.
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to SU-IERC within 72 hours of notification
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to SU-IERC within 72 hours
v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to SU-IERC.

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://oris.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely,

for Dr Virginia Gichuru,
Secretary; SU-IERC

STRATHMORE UNIVERSITY INSTITUTIONAL ETHICS REVIEW COMMITTEE (SU-IERC)
11 JUN 2020
TEL: +254 (0)703 034 000
P. O. Box 59857 - 00200
NAIROBI - KENYA

Cc: Prof Fred Were,
Chairperson; SU-IERC

Ole Sangale Rd, Madaraka Estate. PO Box 59857-00200, Nairobi, Kenya. Tel +254 (0)703 034000
Email info@strathmore.edu www.strathmore.edu

Appendix III: NACOSTI Research Licence

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **303990**

Date of Issue: **23/March/2020**

RESEARCH LICENSE

This is to Certify that Mr.. Hussein Abdalla Kiarie of Strathmore University, has been licensed to conduct research in Embu, Kirinyaga on the topic: DETERMINANTS OF DIGITAL TECHNOLOGIES ADOPTION AMONG SMALL SCALE FARMS IN KENYA for the period ending : 23/March/2021.

License No: **NACOSTI/P/20/4415**

303990

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.