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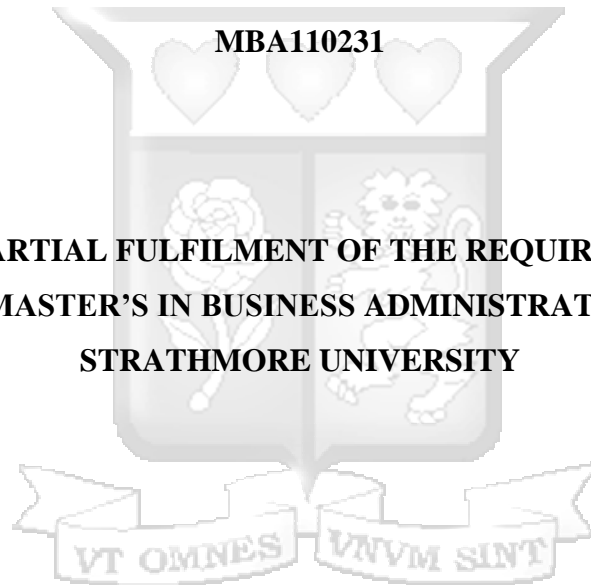
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**FACTORS AFFECTING ADOPTION OF IMPROVED AGRICULTURAL
TECHNOLOGIES AMONG SMALLHOLDER TEA FARMERS IN KERICHO
COUNTY**

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MBA110231

**SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE
DEGREE OF MASTER'S IN BUSINESS ADMINISTRATION (MBA) AT
STRATHMORE UNIVERSITY**



**STRATHMORE UNIVERSITY BUSINESS SCHOOL
MASTER OF BUSSINESS ADMINISTRATION (MBA)**

MAY2021

Declaration

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the dissertation contains no material previously published or written by another person except where due reference is made in the dissertation itself.

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Carren Mercy Ekwang



May 2021

Approval

The dissertation of Carren Mercy Ekwang was reviewed and approved by:



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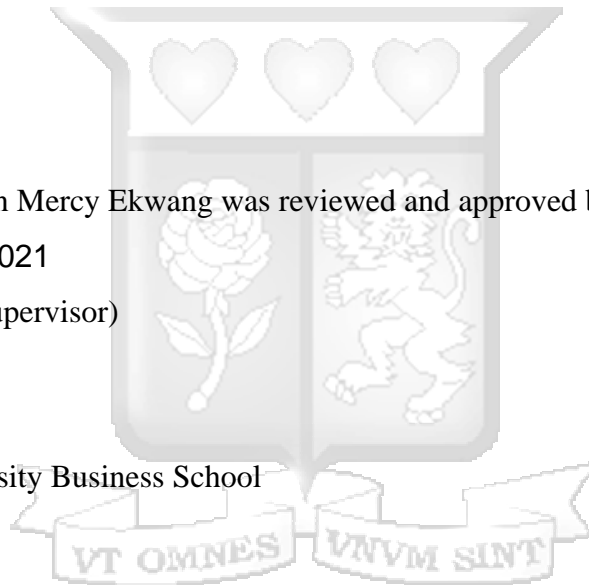
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Abstract

Tea is an important crop in Kenya's economy accounting for 26% of foreign exchange earnings. In order to improve productivity, the Tea Research Institute has developed improved agricultural technologies to enhance tea yields. However, Small holder farmers have not fully adopted the improved agricultural technologies and therefore their yields remain low. The general objective of this study is to establish the factors that influence adoption of improved agricultural technologies among small holder among small holder farmers in Kericho county. The specific objectives are, to determine the effect of personal farmer characteristics on adoption of improved agricultural technologies, to establish the influence of economic factors on adoption of improved agricultural technologies and to investigate the effect of institutional factors on adoption of improved agricultural technologies among smallholder tea farmers in Kericho County The study used a descriptive design. The number of farmers was divided into six factories that the farmers supply leaf to namely Chelal, Toror, Tegat, Momul Kapkatet and Litein Tea factories. Proportionate random sampling was applied to select the number of farmers from each factory. A questionnaire was used to collect data on the personal farmer characteristics, economic and institutional factors influencing technology adoption.

A multivariate probit model was used to determine how the independent variables (personal, economic and institutional factors) relate to the dependent variable (adoption of improved farming technologies). The results show that, higher education levels, age, years of experience in tea farming and household size positively influenced adoption of improved agricultural technologies. On gender, female managed farms are less likely to adopt soil conservation and IWM. Land size did not influence adoption of improved agricultural technologies. Credit constrained households were also less likely to adopt fertilizer use and improved tea varieties. Alternative income enhanced adoption of IWM and soil testing. Membership to a formal or informal institution enhanced adoption of soil conservation and use of improved tea varieties. There is no relationship between provision of extension services and adoption of improved agricultural technologies because the quality of the service offered is poor

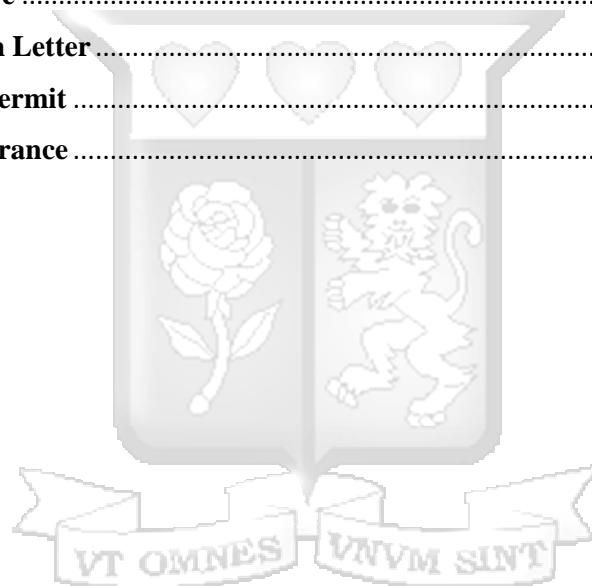
Key words: agriculture, technology, adoption.

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LIST OF ABBREVIATIONS

IAT Improved agricultural technologies

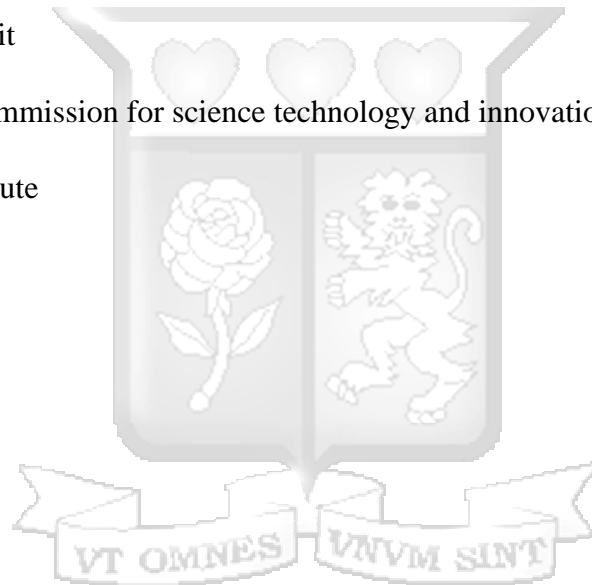
IWM Integrated weed management

KTDA Kenya tea development agency

MVP Multivariate probit

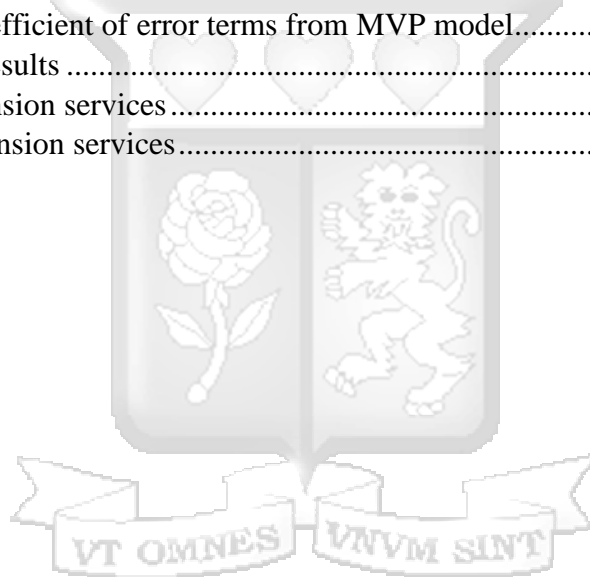
NACOSTI National commission for science technology and innovation

TRI Tea research institute



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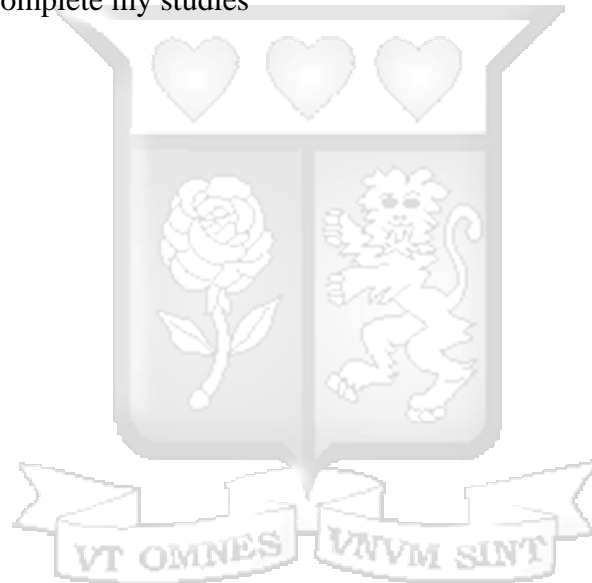
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DEDICATION

I dedicate this work to my late father, Bramwel Etyang Ekwang for his unwavering support towards my education and success.



CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Agriculture is a key contributor to the economic growth of many countries in sub-Saharan Africa. Farming is mainly done by smallholder farmers in rural areas who represent nearly 80% of all farms in sub-Saharan Africa (Livingston et al., 2011). While agricultural productivity has grown in these countries in the past few years, it has mainly been due to increase in the acreage of land under cultivation as opposed to increased yield per acre (IFAD, 2011). With increasing population, demand for food and scarce land resources, increasing agriculture through land expansion alone is not sustainable (Vanlauwe et al., 2014). Increasing the yield per unit area of land is therefore important. Crop yields in Africa are lower than other parts of the world. For instance, the cereal yield in Africa is half that of the global yield (Tadele, 2017). This is mainly attributed to limited use of modern agricultural technologies such as high yielding varieties, irrigation and fertilizer use (Muzari et al., 2012; Porteous, 2020). It is therefore important for efforts to be focused on understanding the barriers to technology adoption in agriculture (Pingali, 2012).

Achieving an increase in agricultural productivity through technology adoption needs several interventions. These include enhanced information access through extension services, research on suitable agronomic practices, ease of access to markets and provision of capital to smallholders (Pingali, 2012; Vanlauwe et al., 2014). Evidence has shown that adoption of improved agricultural technologies leads to increased output, and incomes for rural households, improved nutrition and lower food prices (AsfawKassie et al., 2012; Kasirye, 2013; Martey et al., 2020). This in turn leads to increased household consumption and expenditure, reduced poverty levels and food insecurity therefore spurring economic growth (AsfawShiferaw et al., 2012; Gebeyehu, 2016; Mulugeta et al., 2012).

Tea is grown in 52 countries in the world, all of which fall within tropical and sub-tropical regions (Chen et al., 2012). Kenya is the third largest producer of tea in the world after China and India, but the world's leading exporter of black tea (ITC, 2018). Tea is one of the world's most popular beverages with approximately 3 billion cups of tea consumed daily (Voora et al., 2019).

Tea is a major source of livelihood in many countries, as it has led to the creation of jobs for many people and development of good social infrastructure such as road networks, schools and hospitals in rural areas (Kamunya et al., 2012) .In Kenya Tea is the highest foreign exchange earner. The tea sector contributed to about 4% of Kenya's GDP and 26% of the country's total export earnings in 2017 (TBK, 2018). In most developing countries, including Kenya, tea is mainly grown in rural areas, hence contributing to the improved living standard of the rural communities.

The small holder sector dominates tea production worldwide. For instance, in Sri Lanka small holders contribute over 75% of total production,26% in India and 23 %in Indonesia. China and Vietnam production is also majorly done by smallholders. Here in Kenya smallholder contribute to over 60% of production(Banerjee, 2011).

Small holder tea farmers however encounter several risks in these countries. Price fluctuations of made tea affect their earnings sometimes forcing them, to sell their produce a price lower than the cost of production. Only farmers with diversified farms are cushioned from these losses. In most countries these farmers lack formal contracts with green leaf processing factories apart from Kenya and Sri Lanka. Logistics and transport of the green leaf is left to agents who do not have the farmers' interest at heart.(Banerjee, 2011).Additionally, small holders often experience low yields compared to large plantations. This is because smallholders do not apply improved agricultural technologies. The main hinderances to their adoption are no access to extension services, limited access to credit and lack of membership in farmer organizations. Moreover smallholder farmers have limited access to marketing channels, experience high production costs and cannot easily access markets due to poor infrastructure (Munishi et al., 2017)

IATs should be implemented to boost tea productivity for smallholders. IATs in tea farming include soil testing to check soil acidity and nutrients (tea does well in acidic soils). Minerals are usually applied prior to planting to balance the soil ph. Soil conservation measures like building gabions, terracing, and boxing are done during planting. Irrigation is recommended for areas that do not receive enough rainfall all year round. Fertilizer application is necessary to improve soil fertility. Integrated weed management, which includes use of herbicides and pesticides complimented with mechanical weeding is recommended to combat weeds and pests (Perera, 2014) Researchers recommend use of high yielding varieties to promote productivity, and mechanized or semi mechanized tea harvesting(Sita, 2015).

In Kenya, tea is produced mainly by the small holder farmers (60%) and large multinational companies (40%). In Kenya a smallholder tea farmer is defined as a tea farmer who does not possess his/her own processing factory (Ng'ang'a, 2015). Estates on the other hand have large farms and own their own processing factories (Kamunya et al., 2012). The estate subsector is owned by large multinational companies such as Unilever, Finlays and George Williamson. The small holder farmers are organized Under the Kenya Tea Development Agency (KTDA). The main tea growing areas in Kenya are Kericho, Bomet, Nandi, Kiambu, Murang'a, Nyeri, Kirinyaga, Meru, Kisii and Nyamira counties (TBK, 2018).

While small holder produce 60% of the tea in Kenya, they experience lower yields per hectare compared to large plantations mainly because they do not apply improved agricultural technologies (Mulinge et al., 2013). Although Tea Research Institute of Kenya (TRI) has developed and disseminated several improved agricultural technologies, they have not been completely adopted by farmers (Tanui et al., 2012). It is therefore important to understand the factors that drive adoption of improved agricultural technologies among the farmers, to maximize their usage. The technologies developed and disseminated by TRI cover all the stages of tea growing and include soil testing, soil conservation, selection of high yielding clones, use of fertilizer appropriately, and integrated weed management (Anon, 2002; Owuor, 2005).

Soil conservation refers to the rational use of land resources, application of erosion control measures, water conservation technologies and adoption of appropriate cropping patterns to improve soil productivity and to prevent land degradation (Tiwari et al., 2008). Small holder farmers usually have small land units, this leads them to cultivate steep slopes, forests, and hilly areas to maximize on their yields. Poor soil conservation has led to soil degradation. Despite this most farmers do not practice soil conservation measures (Haghjou et al., 2014). In tea soil erosion mainly occurs during land preparation, planting of young tea, and weeding. Once the tea bushes grow and form a canopy, they provide complete soil cover, reducing soil erosion (Othieno, 1975). Therefore, soil conservation measures should be emphasized during land preparation and planting period because this ultimately affects the productivity of the tea bushes.

Application of fertilizer leads to increased tea production. High productivity of tea leads to depletion of soil nutrients through the harvested crop and leaching. The production can be sustained by replenishing the lost nutrients through regular addition of fertilizers or organic manures. In Kenya,

the recommended fertilizer ratio for tea is 25:5:5:5 corresponding to nitrogen, phosphorus, potassium and sulfur, respectively (Owuor et al., 2008). However, fertilizer application to tea by the smallholders is very low. On average farmers in Africa use less than 10kg of fertilizer per ha compared to the recommended 100 kg/ha used in developed countries (Sinyolo et al., 2018). This has led to little improvement in soil fertility and crop production. This is compounded by the fact that technical advice on its usage from agricultural extension officers is low (Rapsomanikis, 2015)

Improved tea varieties are important for increased productivity (Kamunya et al., 2012). The quality of seed indicates the potential crop yield and consequently the potential gains from the investment (de Roo et al., 2016). Tea improvement research in Kenya has developed and released higher yielding tea varieties of high quality that are well suited to the changing climatic conditions (Kamunya et al., 2012). It is estimated that improved clonal tea accounts for more than 60% of all tea in Kenya. However, farmers only cultivate a few selected clones from the wide variety available thereby failing to fully utilize the available clonal resources (Tanui et al., 2012).

Effective implementation of integrated weed management can boost crop productivity. Herbicides when used responsibly, limit negative effects on the environment. With Integrated weed management, initial herbicide use gradually reduces weed intensity in the first 3 to 4 years of use and thereafter mechanical weeding methods can be used (Muoni et al., 2014). It is therefore important for farmers to be trained on their appropriate use (Norsworthy et al., 2016). The main challenge preventing herbicide application by smallholder farmers is limited access to inputs and capital (Andersson et al., 2014; Nyanga et al., 2012). Most of the tea grown in Kenya is pest free and therefore the use of pesticides currently is limited (Elbehri et al., 2015).

Soil testing is done to determine the soil pH and nutrient levels. Tea does well in acidic soils of pH 4.5-5.5. Minerals can be applied to balance the soil pH where necessary. Soil nutrient analysis shows the fertility status of the soil and the results will guide the farmer on efficient and cost effective use of fertilizer(Zhang, 2018).

1.2 Problem statement

Small holder farmers contribute more to the total tea produced in Kenya. However, they face many challenges. For example, the average yield of small holder farmers is lower than plantations. According to TBK (2018), in 2017 small holders produced 272,528 kgs of tea from an area 107,115

ha while plantations produced a total of 220,471 kgs of tea from a total area of 50,605 ha. This translates to a yield of 2.5tons/ha for small holder farmers and 4.4 tons/ha for plantations. This is attributable to the fact that large firms can easily access and apply IATs and benefit from economies of scale, compared to small holder farmers (Mulinge et al., 2013).

Small holder farmers are faced with high production costs, low tea prices and lack of access to capital. There is also limited access to information among the small holder farmers, due to inadequate extension services provided by government institutions (Tea Research Institute), leading to low yields (Ng'ang'a, 2015). Additionally, most farmers in the rural areas are illiterate and therefore cannot apply modern farming technologies (Tanui et al., 2012)..

Although a lot of research has been conducted to develop improved tea varieties and identify suitable agronomic practices, to boost the yields and quality of tea, productivity is still low among the small holder farmers due to low usage of improved agricultural technologies (Tanui et al., 2012). Productivity of tea small holder farmers is important in ensuring sustainability of the tea sector and enhancing their livelihoods.

Understanding the factors that drive adoption of improved agricultural technologies is therefore important. Some studies have been done on the factors that affect adoption of IATs among small holder tea farmers in Kenya. Tanui et al. (2012) study on socio economic constraints to adoption of yield improving tea technologies in Nandi County focused concluded that gender, input costs and access to extension services influenced adoption. He however found that education level, household size and cooperative membership did not influence adoption. Mutuku (2017) in his study of adoption of mechanical tea harvesting methods in West of Rift Valley region in Kenya showed that tea quality, cost of production, firm size and education level influence adoption. These studies however, only focused on adoption of a single IAT.

This study therefore aims to take a wholistic approach in looking at the factors influencing adoption by focusing on adoption of a combination of improved agricultural technologies. Previous studies did not take this into account(Mutuku, 2017; Ongongâ, 2013; Tanui et al., 2012). The aim of this study therefore is to determine the factors that affect adoption of a combination of improved agricultural technologies among smallholder farmers in Kericho county a major tea growing areas in the West of Rift. This study focuses on how personal farmer characteristics, economic factors and

institutional factors affect adoption of improved agricultural technologies among small holder tea farmers.

1.3 General Objective

The main objective of this study is to establish the factors that influence adoption of improved agricultural technologies among small holder tea farmers specifically focusing on Kericho County

1.3.1 Specific Objectives.

- i. To determine the effect of personal farmer characteristics on adoption of improved agricultural technologies among smallholder tea farmers in Kericho County.
- ii. To establish the influence of economic factors, on adoption of improved agricultural technologies among smallholder tea farmers in Kericho County.
- iii. To investigate the effect of institutional factors on adoption of improved agricultural technologies among smallholder tea farmers in Kericho County.

The specific research questions are:

- i. What are the effects of personal farmer characteristics on adoption of improved agricultural technologies among smallholder farmers in Kericho County?
- ii. How do economic factors influence adoption of improved agricultural technologies among smallholder farmers in Kericho County?
- iii. What are the effects of institutional factors on adoption of improved agricultural technologies among smallholder farmers in Kericho County?

1.4 Significance of the study

This study will be relevant to the Tea Research Institute which develops improved agricultural technologies for use by farmers (Kamunya et al., 2012). Policy makers in Kenya Tea Development Agency which buys tea from small holders and offers extension services will also benefit. The study will benefit the tea growers' association which comprises large scale plantations. These plantations also have contracts with farmers for delivery of tea (TBK, 2018)

This research will fill the knowledge gap on why small holder farmers uptake of improved agricultural technologies is low despite the technologies being available (Tanui et al., 2012) The study will also benefit researchers and can be a basis for future empirical and conceptual research.

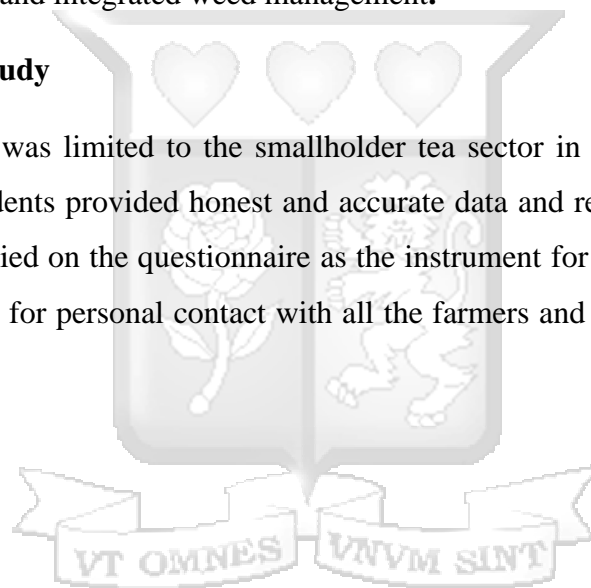
This study aims to contribute to the existing body of knowledge on the factors that influence adoption of improved agricultural technologies among smallholder farmers.

1.5 Scope of the Study

This study will focus on factors affecting adoption of improved agricultural technologies among small holder farmers in Kericho county Kenya. Kericho county is located on the West of the Rift Valley. This study will focus on smallholder farmers growing tea on a parcel of land of 4.5 ha or less. The study will focus on personal, economic, and institutional factors that affect adoption of improved agricultural technologies. The study will focus on technology packages developed by the Tea Research Institute which are soil testing, soil conservation, use of improved tea seedling varieties, fertilizer usage and integrated weed management.

1.6 Limitations of the study

The scope of this study was limited to the smallholder tea sector in Kericho county. The study assumed that the respondents provided honest and accurate data and relied on their willingness to participate. The study relied on the questionnaire as the instrument for data collection. COVID-19 restrictions did not allow for personal contact with all the farmers and some questionnaires had to be administered online.



CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter gives a review of previous studies on technology adoption among small holder tea farmers. It consists of a theoretical review, an empirical review, statement of the research gap that the study aims to fill conceptual framework. and the chapter summary.

2.2 Theoretical review

This study is guided by the theory of innovation diffusion. This theory describes the technology adoption decision and how a technology is communicated over time respectively.

2.2.1 Innovation diffusion Theory

Rogers (2010) defines innovation diffusion as the process by which an innovation is communicated through certain channels over time among the members of a social system. The information passed in this communication is mainly about new ideas. The purpose of this information is to reduce uncertainty about the cause-and-effect relationships in a problem. The diffusion theory aims to explain why and how new technologies are adopted over a long period. The adoption of this technology involves information gathering and analyzing the innovation's benefit compared to its associated cost (Feder et al., 1985).

The diffusion theory has four main elements: innovation, communication channels, time, and social system. The innovation is the idea or practice which is perceived as new. According to Rogers (2010) the newness of an idea is determined by the individual's perception, his/her knowledge, persuasion and decision to adopt and not necessarily the fact that it has not existed or been used before. Based on this definition therefore agricultural technologies are considered innovations.

The communication channel refers to how information exchange occurs between individuals. The time element encompasses the time between the individual gaining knowledge about a technology to its adoption or rejection and the earliness or lateness with which an individual adopts the technology also known as the innovativeness of the individual. The time element also includes the rate of adoption i.e., the number of individuals who adopt a technology in a social system within a given period of time. A social system is defined as "a set of interrelated units that are engaged in

joint problem solving to accomplish a common goal.’ It can be made up of individuals or groups for example small holder households in Kenya(Rogers, 2010).

The innovation diffusion theory encourages the evolution of technologies, products or services to meet the needs of potential adopters therefore enhancing their adoption(Robinson, 2009). Therefore, the rate of adoption for technologies differs based on the technology’s characteristics. These characteristics are outlined by Rogers (2010) as the relative advantage, compatibility, complexity, triability and observability.

Relative advantage refers to the superiority of a technology compared to the existing practice. This can be measured in terms of economic or social gain. People will only adopt a new technology if they find it to be more beneficial than the existing practice. Communication channels should aim to pass information on the benefits of the new technology quickly and accurately (Wani, 2015).

Compatibility is a measure of the consistency of the technology with the personal and cultural values and needs of the individual and society. Technologies that are perceived to be compatible with existing social norms are usually adopted faster than those that are not (Mignouna et al., 2011; Wandji et al., 2012).

Complexity refers to how difficult a technology is to understand or use. More complex innovations will be adopted slowly compared to simple innovations. It is therefore important to pass technology information to potential adopters in the simplest form(Rogers, 2010).

Triability is defined as degree to which an innovation allows for experimenting on a small scale before full roll out. This trials enable the user to interact closely with the technology and reduces uncertainty (Wani, 2015). The potential adopters will decide to either adopt or reject the technology after experimenting.

Observability on the other hand refers to how visible the results of implementing the technology are to outsiders/ the community around. Technologies with observable results create discussions within the community. Non-adopters will seek the adopters opinion on the technology and positive feedback from the adopter usually leads to faster adoption by the rest (Rogers, 2010).

These characteristics determine the speed at which farmers adopt a technology and the extent of spread of a technology (aggregate adoption) within a certain area. They will also determine the intensity or degree of use of a technology at the individual farmer level (Rogers, 2010).

Most technologies have an S shaped rate of adoption curve. The rate of adoption is the “relative speed with which and innovation is adopted by members of a social system”. When a new technology is introduced, only a few individuals adopt it over a given time period for example in one year. Soon after the speed of adoption increases as more individuals adopt the technology, and the diffusion curve begins to rise. The curve then levels off as more people have adopted the technology compared to those who have not. Eventually the curve begins to decline as few people adopt the technology until it becomes obsolete (Rogers 2010).

While the diffusion of innovation theory has been widely used in adoption studies. It has received criticism on its robustness in explaining some concepts, especially relating to complex and networked IT solutions. Lyytinen et al. (2001) argue that the diffusion theory uses a short time scale from a few months to a few years. This may not fully explain adoption of certain technologies and may require research into historical events that occurred in the past. Additionally choices made to adopt technology may not only be based on the adopter’s characteristics, preference and availability of information but also on business strategy and these strategies vary as the business landscape evolves (Damsgaard, 1996). It is also worth noting that the stages in the diffusion process are not necessarily distinct and feedback from one stage to the other affects the shape of the diffusion curve (Lyytinen et al., 2001) and the earliness or lateness of adoption.

2.3 Empirical Review

Although adoption of improved agricultural technologies is important in improving yields and fighting poverty in sub-Saharan Africa, low adoption rates have reduced its impact (Muzari et al., 2012). The reasons for low adoption include lack of funds to purchase inputs and their relatively low profitability, limited access to labor, lack of credit access, and high transport and transaction costs, lack of knowledge on new agricultural technologies and their availability, and climatic and process related risks make farmers shun new agricultural technologies (Dercon et al., 2011; Krishnan et al., 2014; Minten et al., 2013; Mukasa, 2018).

Studies conducted on the factors that influence adoption of IATs agriculture have classified them as personal/household specific factors, economic, institutional and technology factors (Mwangi et

al., 2015) . Personal factors that affect adoption of IATs include, age, gender, education level, and household size (Doss et al., 2003; Mwangi et al., 2015) .Economic factors that affect adoption of IATs are; household income, firm size, and net economic gain of the practice/technology(Ae et al., 2017; Mwangi et al., 2015). Institutional factors are; access to extension services, access to credit and membership to a social organization like SACCO and community based organizations (Genius et al., 2014; Mignouna et al., 2011).

2.3.1 Effects of Personal farmer characteristics on adoption of improved agricultural technologies

About 60% of the developing world's rural population live in small farms of average 2 ha. Small holder farmers produce 80% of the food consumed in sub-Africa. Smallholder farming especially in Africa is characterized by low application of improved agricultural technologies and low yields. Most developing countries experience rural urban migration with young and skilled labor moving to urban areas to look for employment. Therefore most farmers lack the relevant knowledge and skill to apply IATs (Kamara et al., 2019; Rapsomanikis, 2015)

Labor in small holder farms is provided by family members complemented with hired labor to a very small extent. At least 50 percent of the family labor is utilized on the farm in SSA countries like Kenya and Ethiopia. Women form a substantial part of labor provision for these farms (Rapsomanikis, 2015).

Age is one of the personal factors that affects technology adoption. It has been found that older farmers are less likely to adopt technology compared to younger farmers. This is because they hold on to traditional farming methods, they are risk averse and do not have a long term view on technology investments (Denkyirah et al., 2016) However other studies differ with these findings, and report that older farmers have more years of experience and are able make precise evaluations of a technology more easily due to experience and therefore more likely to adopt technology (Donkoh et al., 2019; Mignouna et al., 2011). In contrast a study determinants of soil conservation by small holder tea farmers in Sri Lanka by Dayarathne et al. (2018) showed a negative relationship between age and adoption of soil conservation measures, this is because younger farmers are more educated and consider soil erosion as a challenge compared to older farmers.

Based on gender, women are less likely to adopt technology due to constraints such as limited access to land ownership and child care responsibilities (Addison et al., 2018).In the study of yield

improving tea farming technologies adoption, Tanui et al. (2012) reported that in general less women were involved in tea farming due to cultural traditions that limit land ownership by women. Women are also more disadvantaged because they have less authority for resource allocation in many households (Andersson et al., 2014; Nyanga et al., 2012). In contrast, Muriithi et al. (2018) argued that gender difference did not influence adoption of sustainable agricultural practice. Joint participation by both the husband and wife, on the other hand has been found to promote the highest rate of technology adoption (Lambrecht et al., 2016). Based on Lambrecht et al. (2016) study of gender effects in agricultural extension in the Eastern Democratic republic of Congo it is recommended that both spouses in the household to be targeted during technology dissemination.

Education level has a significant impact on technology adoption. Farmers who are educated have a higher rate of technology adoption, because education increases farmer's ability to understand and apply new technologies (Mignouna et al., 2011). Educated farmers are more open to new ideas hence are able to adopt to new technologies faster (Adebiyi et al., 2013). Similar findings were reported by Lavison (2013) who studied factors influencing adoption of organic fertilizer in Ghana. Donkoh et al. (2019) in his study of adoption of improved agricultural technologies among rice farmers found that technologies that required understanding of a technical theory were adopted more by educated farmers. A study by Mutuku (2017) on factors affecting adoption of mechanical tea harvesting methods in West of Rift Valley region in Kenya. showed that 94% of the farmers had not adopted mechanical tea harvesting methods due to lack of skills and training on how to use the machines and lack of experience. Both formal education and informal trainings are therefore important in enhancing adoption of improved agricultural technologies. However, a different view is that formal education could be a barrier to technology adoption by smallholder farmers. This is especially in the case where educated individuals seek formal employment in order to earn more income and are less motivated to invest in their farms (Uematsu et al., 2010)..

Studies on the availability of human capital which is measured by the size of the household have revealed mixed findings. Larger households can easily adopt technology since the labor required during introduction is readily available (Sodjinou et al., 2015) especially holds for technologies that are labor intensive. This is consistent with the study by Kassie et al. (2015) on the adoption of sustainable intensification practices in eastern and southern Africa which found a positive correlation between household size and adoption. However some studies have shown that smaller households

are more likely to adopt labor saving technologies compared to large households (Anang, 2018). Tanui et al. (2012) found no correlation between household size and technology adoption.

2.3.2 Influence of Economic factors on adoption of improved agricultural technologies

The difference in economic livelihoods of the smallholder farmers in different countries usually reflects the country's stage of economic development. Most smallholder farmers are in remote areas. As a result, they have poor transport networks with limited access to markets which means input prices are high due to high transport costs while output prices are low. This also limits their access to viable economic opportunities.

Smallholder farmers in Africa have limited capital assets and constrained income. They often engage in other economic activities to complement farm income. These include working as seasonal laborers, semi-skilled workers, or self-employment activities like retailers or wholesalers. This off-farm income helps to cushion the household during times of drought or crop failure (Rapsomanikis, 2015).

One of the economic factors affecting technology adoption is the size of the farm. Studies have shown a negative correlation between farm size and technology adoption. Small farms are managed better than larger farms because smaller farmers were more motivated to adopt technology and maximize the use of the scarce land resource compared to farmers with larger farms (Holden, 2014; Kassie et al., 2015). However some studies contradict these findings, Adebisi et al. (2013) asserts that farmers with large farms are more likely to adopt cocoa farm rehabilitation techniques and therefore should be targeted. Similar findings were reported by Mignouna et al. (2011) and Uaiene (2011). Mutuku (2017) also found that farm size is positively correlated with adoption of mechanical harvesting technologies since technology adoption often led to labor savings.

The input costs of a technology will influence its adoption. This includes the time, effort and cost involved in applying the improved agricultural practice. These costs determine the net gain from a technology. If the sum of all the costs involved in implementing the technology is high, the benefit to the farmer is reduced, and the technology may not be adopted (Foster et al., 2010). High cost of inputs and unavailability of input shops have been cited as hinderances to technology Adoption for instance, farmers in Uganda are faced financial difficulty in purchasing inputs with only 2% able to pay for machinery and seeds to apply conservation agriculture. Unavailability of inputs due to distance from markets also discouraged them from adopting technology (Kaweesa et al., 2018). The

profitability or economic gain from technology adoption depends on the cost of the inputs and high input costs especially for farmers in remote areas contribute to low technology uptake evidenced by Minten et al. (2013) in his study of the last mile input distribution in Northwestern Ethiopia.

Several small holder farmers are usually engaged in off farm income generating activities such as working as seasonal laborers and semi- skilled jobs like carpentry and salaried employment in various industries. This ensures they supplement the income from the farm which may not be sufficient to cater for all their daily needs (Rapsomanikis, 2015). There exists evidence that diversified income streams for smallholder households enhance adoption of improved farming technologies and contribute to improved economic welfare. This is shown in the study of rural non-farm income diversification; implication on smallholder farmers welfare and agricultural technology adoption in Ghana done by (Danso-Abbeam et al., 2020). This is because households with increased income can hire labor and purchase inputs required for adoption of improved agricultural technologies. Further, studies have shown that alternative sources of income provide capital for technology adoption and can be used instead of seeking credit from institutions (Diiro, 2013). This has been seen to improve technology adoption among farmers in areas where credit institutions are lacking or not willing to offer credit. However, according to (Goodwin et al., 2004) this may hinder technology adoption since focus on earning an income elsewhere reduces labor available for farming activities.

2.3.3 Influence of Institutional factors on adoption of improved agricultural technologies

Information access through provision of extension services is important for technology adoption. Farmers need to be aware of the technology, its usage, and benefits before they adopt it. Information reduces uncertainty and enables an individual to make an objective decision about the technology. Extension services and farmer associations are key in disseminating information (Mwangi et al., 2015). The role that extension officers play in stimulating technology adoption cannot be ignored. Extension services provide farmers with problem solving skills, and gaining deep knowledge of the new technologies (Davis et al., 2012). One approach to extension services provision by use of farmer field schools was found to have great benefits not only on knowledge gain, but also income, crop and livestock productivity among smallholder farmers in east Africa (Davis et al., 2012; Onduru et al., 2012). Moreover, Genius et al. (2014) in his study of Information transmission in irrigation

technology adoption evidence shows that there exists a positive relationship between extension service provision and adoption of technology.

Membership to farmer groups and associations promotes social learning from peers and has been found to be powerful tool in adoption of new technology. In Ethiopia social learning has been shown give better and longer term results compared to provision of extension services alone (Krishnan et al., 2014). Membership in social groups or associations promotes this through networking and information sharing among farmers. In the context of agricultural innovations, farmers can learn from one another the benefits and usage of a IATs. This presents a complimentary relationship between membership to farmer groups and provision of extension services. Additionally, cooperatives play a critical role in reducing transport and transaction costs for farmers who mainly live in remote areas. Access to markets and availability of inputs is a major hinderance to adoption. Cooperatives reduce this burden buy using economies of scale to acquire inputs on behalf of the farmers (Genius et al., 2014). On the contrary, one study found no correlation between membership to cooperatives and technology adoption (Tanui et al., 2012)

Access to credit facilities is necessary to enhance adoption. This is because Most IATs require an initial capital investment. These costs can be too much for smallholder farmers. Credit access enables farmers to purchase inputs and make long term investments in the farm (Lavison, 2013). A study by Awotide et al. (2016) revealed that rice farmers in Nigeria who could easily access credit were more likely to adopt use of improved rice varieties. In most sub-Saharan countries credit institutions are poorly developed and rarely serve farmers in remote areas. Governments need to intervene in strengthening these institutions and providing subsidies to farmers who lack capital assets (Haghjou et al., 2014; Muzari et al., 2012). Additionally, Balana et al. (2020) states that, while policy interventions will address the supply side constraints like availability of credit institutions and availability of tailored products for smallholder farmers, it is equally important to address demand side constraints which hinder farmers from taking credit even when its available. These include risk aversion due to uncertainty of yield performance, lack of information about the terms of credit available and lack of information on improved agricultural technologies. To address this requires educating farmers and tailor making agricultural insurance policies is necessary.

2.4 Research Gap

Several studies have outlined key variables that form the basis of this study (Awotide et al., 2016; Dayarathne et al., 2018; Kaweesa et al., 2018; Mutuku, 2017; Mwangi et al., 2015; Tanui et al., 2012). From the literature review it is clear that farmer behavior and motivation to adopt or reject technologies vary from one region to another depending on the personal, economic and institutional factors.

However, studies on how personal characteristics, economic and institutional factors influence adoption of a combination of improved agricultural technologies by smallholder tea farmers have not been done. Existing literature only focuses on adoption of one technology (Mutuku, 2017; Tanui et al., 2012). These studies therefore fail to look at the complimentary and substitute relationships that exist by analyzing the adoption of a combination of technologies. This study therefore seeks to bridge this knowledge gap and shed light on the reasons for the low adoption of a combination of IATs among smallholder tea farmers despite their availability and potential to improve yields.

2.5 Conceptual Framework

A conceptual framework shows the relationship between the independent and dependent variables. Figure 2.1 below is this study's framework showing the independent variables which are the personal, economic and institutional factors of the small holder farmers and how they relate to the dependent variable which is the decision to adopt improved agricultural technologies which are, soil conservation, improved tea varieties, fertilizer usage, integrated weed management and soil testing.

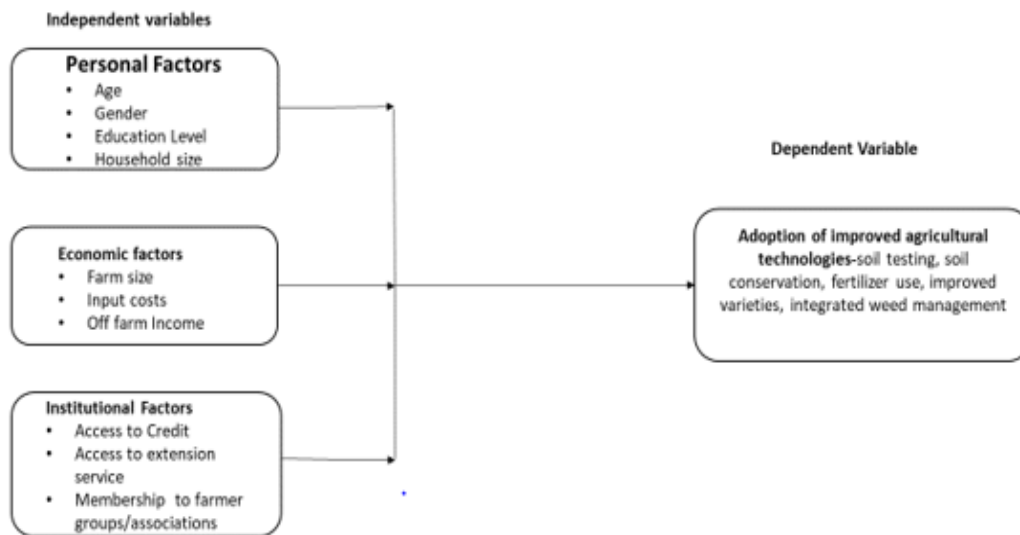


Figure 2. 1 conceptual framework

2.5.1 Independent variables

Age is measured by the age of the household head.

Gender is measured as the household head Gender (Male=0, Female=1)

Education level, is measured by the household head's education level (Dummy variables Primary (1=Yes, 0=otherwise), Secondary Level (1=Yes, 0=otherwise), Tertiary level (1=Yes, 0=otherwise), University level (1=Yes, 0=otherwise))

Household size is measured by the number of people in the farmers household

Farm size is measured as the no of acres that the farmer grows tea on.

Input cost is measured by the cost of the initial investment the farmer makes to implement the recommended improved agricultural practice.

Off farm income is measured by the presence of alternative income to the farmer from other activities (1=Farmer has alternative income, 0=Farmer does not have alternative income).

Access to credit is measured by a credit constrained variable (1= household is credit constrained 0= Household is not household constrained)

Access to extension services is measured as the ability of the household head to access extension services (1=Yes 0 =No)

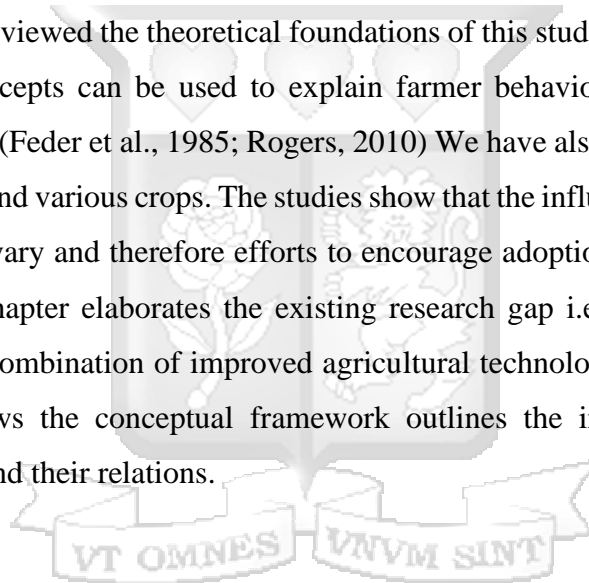
Membership to farmer groups /associations is measured by membership of the household head to a farmer group or association (1=Yes, 0=No)

2.5.2 Dependent variables

This is the adoption of improved agricultural technologies, i.e., soil testing, soil conservation, use of improved tea varieties, use of fertilizer and integrated weed management (1=Adopter, 0=Non adopter).

2.6 Chapter Summary

In this chapter we have reviewed the theoretical foundations of this study. Technology adoption and innovation diffusion concepts can be used to explain farmer behavior in adoption of improved agricultural technologies.(Feder et al., 1985; Rogers, 2010) We have also reviewed adoption studies on in different countries and various crops. The studies show that the influence of personal, economic and institutional factors vary and therefore efforts to encourage adoption should be tailored to suit the target group. This chapter elaborates the existing research gap i.e., the study of factors that influence adoption of a combination of improved agricultural technologies among smallholder tea farmers. Finally, it shows the conceptual framework outlines the independent and dependent variables being studied and their relations.



CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the various steps that were followed in carrying out this study. It consists of research design, population, sampling, data analysis, research quality and ethical considerations.

3.2 Research Design

The purpose of this research was to understand the factors that influence adoption of IATs among smallholder tea farmers. Additionally, the research sought to explain the relationship between personal, economic, and institutional factors and adoption of IATs. Therefore, the research design can be described as descripto-explanatory. Descriptive design studies aim to provide a clear understanding of an event or a situation, while explanatory studies aim to explain the relationship between variables, studies that utilize descriptive design as an antecedent to explanation are known as descripto-explanatory studies (Saunders et al., 2012). This study used the methodological choice of a quantitative research. This type of research is associated with deductive approach where data is used to test a theory. As a quantitative research data was collected by use of a structured questionnaire. The variables were measured numerically, and statistical techniques were used to analyse the data (Saunders,2012).

With regards to the time horizon, this research was conducted as a cross-sectional study. The data was collected in October and November 2020. Additionally, the study utilized a survey strategy by using a structured questionnaire, this allowed for collection of standardized data that can easily be summarized and analyzed to draw conclusions.

3.3 Target Population

A population is defined as the sum of all objects or individuals that conform set of specifications in a particular study (Gravetter et al., 2020).This study was conducted among small holder tea farmers in Kericho County. Kericho is in the West of the Rift Valley in Kenya. It is one of the major tea growing areas in Kenya. The County has six Kenya Tea Development Authority (KTDA) factories namely, Chelal, Toror, Tegat, Momul Kapkatet and Litein Tea factories. These factories are supplied by 74,580 small holder farmers (KTDA, 2019).Due to the large population size the researcher used two stage sampling, explained in the next section.

3.4 Sampling

According to Saunders et al. (2012), sampling frame is the complete list of all the cases in the target population from which a sample is to be drawn. The sample was selected from the sampling frame. The study focused on smallholder farmers who sell tea to Kenya Tea Development Authority (KTDA) factories in Kericho County. Two stage random sampling was used. In the first stage the sample frame was divided into six based on the factories that the farmers deliver their harvested tea. Proportionate random sampling was then used to select the number of farmers from each factory. The sample size was calculated as follows

$$n = p \times q \left[\frac{z}{e} \right]^2$$

Where,

n= minimum sample size required

p=percentage belonging to the specified category i.e. technology adopters

q=percentage not belonging to the specified category

z=value corresponding to the confidence level required (90%=1.65 95%=1.96 99%=2.57)

e=margin of error required.

The sample size (n) was calculated as below, assuming 50% of the farmers will have the specified attribute (adopting improved agricultural technologies)

P=50%, q=50%, z=1.96 (at 95% confidence level) and e=5% (margin of error that can be tolerated)

N=74,580

$$n = 50 \times 50 \left[\frac{1.96}{5} \right]^2$$

n=384

The sample size is therefore 384 small holder tea farmers.

Table 3. 1 sample size selection

Factory	Total Number	Sample size
Momul	16299	84
Tegat	16175	83
Toror	8087.5	42
Litein	8849	46
Kapkatet	16320	84
Chelal	8849	46
Total	74580	384

3.5 Data Collection

The research used a comprehensive questionnaire to collect data. The questionnaire included a cover letter which explained the purpose of the survey. The instrument was adapted from previous studies on factors that influence adoption of improved agricultural technologies. This involved altering the content of these questionnaires to fit the needs of the current study (Saunders et al., 2012). The questionnaires were administered in two ways, face to face by physically visiting the farmers, and through the internet, mainly because the COVID-19 restrictions could not allow the researcher to visit all the farmers. The household was the unit of analysis and the household head was the respondent. Secondary data was collected from government databases i.e. tea directorate.

3.6 Data Analysis

This study focused on five improved agricultural technologies which are soil conservation, use of improved tea varieties, fertilizer use and integrated weed management and soil testing. Farmers can either adopt these technologies as compliments or substitutes. The adoption decision is therefore multivariate. A multivariate probit (MVP) model was therefore used. This model takes into consideration correlation between the error terms of the adoption equations (Greene, 2009; Ndiritu et al., 2014).

A multivariate probit model is represented by two equation systems. The first equation is a linear equation with latent (unobservable) dependent variables, described by a set of observed household and farm level characteristics. and a multivariate normally distributed stochastic term ε_{hf}

Each regression equation is written as follows,

$$Y''_{hfk} = \beta_k X_{hf} + \varepsilon_{hf} \quad (k= S, I, F, Y, T)$$

Where,

Y_{hfk}'' is the latent dependent variable representing the level of expected benefit or gain that will be experienced after adoption.

S, I, F, Y, T denote soil conservation improved tea varieties, fertilizer use, integrated weed management and soil testing respectively

X_{hf} are the explanatory variables at household h and farm f representing the factors that affect technology adoption i.e., personal, economic, and institutional factors.

β_k Regression coefficients representing the condition of the independent variables to the dependent variable

ε_{hf} error term explaining farming technology adoption as a result of extraneous factors not accounted for by the independent variables at household level h and farm f .

Household h will adopt a given improved farming practice if the net gain on adoption is higher than non-adoption. The second equation describes the observable dichotomous choice of the households. It is given as,

$$Y_{hfk} = \begin{cases} 1 & \text{if } Y_{hfk}'' > 0 \\ 0 & \text{otherwise} \end{cases}$$

Y_{hfk} represents the adoption of the k th improved farming practice by the h th household on farm f . In this model the stochastic terms are assumed to be jointly distributed multivariate normal random variables

$(\varepsilon_S \varepsilon_I \varepsilon_F \varepsilon_Y \varepsilon_T) \sim \text{MVN}(0, \Sigma)$ where Σ is a variance covariance matrix. The diagonal terms in the variance covariance matrix represent the variances of the variables. The off-diagonal terms represent the error terms correlation of the estimators for any two adoption equations. Where the error terms correlations i.e. the off-diagonal elements of any two variables become non-zero the second system of equations becomes an MVP model. A positive correlation denotes a complementary relationship while a negative correlation denotes a substitute relationship.

3.7 Research Quality

3.7.1 Reliability

Cronbach's alpha was used to determine the reliability of the questionnaire. Reliability refers to how well the survey measures its objective also known as internal consistency. Pretesting of the questionnaire was done using 20 randomly selected farmers. The Cronbach's alpha was calculated using MINITAB software and produced an alpha value of 0.84. Generally, most scholars consider a Cronbach value of >0.7 acceptable (Saunders et al., 2012). Therefore, the reliability index for this questionnaire indicates that the questionnaire is reliable.

The data was collected by one research assistant and supervised by the researcher. The officer was fluent in both English, Kiswahili and the local dialect of Kericho county.

3.7.2 Validity

The validity of a research instrument refers to the degree to which the instrument in this case, a questionnaire collected relevant data that answer the research questions comprehensively. (Saunders et al., 2012; Taherdoost, 2016). Validity can be classified as face validity, content validity construct validity and criterion validity.

Face validity refers to whether the questionnaire looks relevant reasonable and clear to the respondents or non-experts in the matter. Content validity refers to the extent to which the questions in the questionnaire covers all the relevant aspects of the construct/ subject. It involves reviewing the questionnaire to ensure that it includes relevant items and excludes non-essential items (Oluwatayo, 2012; Saunders et al., 2012). For face validity, a pilot study was conducted to ensure the questions were clearly understood by the respondents and vague questions were revised. To ensure content validity, literature review was done, and the questions were reviewed to ensure the correct operational measures were applied to the questions appropriately.

Construct validity measures the extent to which the instrument measures the intended construct. It involves translation of the construct or idea into empirical indicators especially scales and using these scales to make inferences. Criterion validity measures whether the data collected by the instrument can be used to make accurate predictions. This was done using correlation analysis (Saunders et al., 2012)

3.8 Ethical considerations

A brief introduction of the research and its significance was given to the respondents before administering the questionnaires. All the responses have been kept confidential. Questionnaires were administered on a voluntary basis and all respondents were informed of their right to decline to take part in the survey. In some cases, the questionnaire was administered as an interview and the answers written down as accurately as possible. The respondents were informed of their right to seek clarification during or after filling the questionnaire. Permission from the relevant government bodies i.e., NACOSTI and Strathmore University Ethics Committees was sought before commencement of the study. All publications and books used in this research have been clearly referenced.



CHAPTER FOUR

PRESENTATION OF RESEARCH FINDINGS

4.1 Introduction

This chapter presents the findings obtained from the farmers. Descriptive statistics and inferential statistics are presented here showing how personal characteristics, economic factors, and institutional factors affect adoption of improved agricultural technologies among smallholder tea farmers. Data was gathered exclusively from the questionnaire as the research instrument.

4.2 Response rate

The study had a sample size of 384 from which 379 filled and returned the questionnaire which is a response rate of 98%. A response rate of 50% or higher for academic studies involving individuals is considered reasonable (Baruch et al., 2008; Saunders et al., 2012).

4.3 Effect of Personal Farmer Characteristics on Adoption of improved Agricultural technologies

4.3.1 Descriptive Statistics

This study sought to find out how the personal characteristics of the farmers that is age, gender education level and household size and number of years of experience in tea farming relate to adoption of improved agricultural technologies.

Table 4.3 shows that 69% of the farmers have adopted three or more improved agricultural technologies. The improved farming technologies that had the highest adoption rates are soil conservation, use of improved tea varieties and fertilizer application. Table 4.2 shows that integrated weed management and soil testing had the lowest adoption rates at 30% and 26% respectively.

This study considered the adoption behavior of male and female plot managers. From the sample, farmers 68% of the household heads were male while 32% were female. On the other hand, 52% of the farms had female farm managers while 34% and 14% had male farm managers and joint management respectively (Table 4.1). This shows more farms are managed by women compared to men.

From Table 4.2 adoption by male and female plot managers was similar for the different technologies, except for soil conservation and integrated weed management where only 66% of women farm managers adopted soil conservation compared to 83% of male farm managers.

Additionally, only 18% of women adopted integrated weed management compared to 43% male managers. Overall, joint management of farms led to the highest adoption rates in all the improved agricultural technologies.

Table 4.3 shows that female managers had the lowest adoption rates with 61% adopting three or more improved technologies compared to male managers and jointly management at 75% and 85% respectively.

Table 4. 1 farm management by gender

%	Farm Manager		
	Male	Female	Joint
Household head			
Male	48%	36%	16%
Female	4%	87%	9%
Total	34%	52%	14%

Table 4. 2 mean of adoption by gender

Variable			Farm manager						
	Improved Agricultural Practice	Full sample		Male		Female		Joint	
		Mean	STDEV	Mean	STDEV	Mean	STDEV	Mean	STDEV
Soil conservation(1=Yes,0=No)	0.75	0.44	0.83	0.38	0.66	0.48	0.88	0.32	
Improved tea varieties (1=Yes, 0=No)	0.79	0.41	0.76	0.43	0.79	0.41	0.85	0.36	
Fertilizer application(1=Yes,0=No)	0.83	0.37	0.85	0.36	0.80	0.40	0.90	0.30	
Integrated weed management(1=Yes,0=No)	0.30	0.46	0.43	0.15	0.18	0.16	0.44	0.38	
Soil testing(1=Yes,0=No)	0.26	0.44	0.29	0.00	0.27	0.07	0.15	0.14	

Table 4. 3 number of technologies adopted

No. of Improved technologies	%Adoption by gender					
	0	1	2	3	4	5
Full sample	2%	9%	20%	38%	25%	6%
Male managed	1%	6%	18%	34%	33%	9%
Female managed	3%	12%	24%	38%	20%	3%
Jointly managed	0%	8%	8%	48%	27%	10%

Table 4.4 shows the mean adoption for the five improved agricultural technologies in relation to personal and economic characteristics of the farmers. The mean age of the respondents is 37 years. The youngest is 19 years old while the oldest is 87 years old. From the analysis more older farmers adopted IWM compared to the other improved agricultural technologies. The average number of years of experience in tea farming is 12 years. Similarly, more experienced farmers adopted IWM compared to the other improved technologies.

The farmers had attained various levels of education. 15% had primary level of education, 38% had secondary level, while 31% and 35% had tertiary and university levels of education respectively. Adopters of integrated weed management and soil testing had a higher education levels 53% if soil testing adopters had tertiary level of education and 41% had university level of education while 61% of IWM adopters had university level of education.

The mean household size of the respondents was 5 household members. There was no difference in household size for the adopters of the of the different IATs

Table 4. 4 personal and economic characteristics of farmers

Household characteristics	Mean of adoption of improved practices							
	Mean	stdev	Soil conservati on	improved varieties	fertiliser use	IWM	Soil testing	
Age	37.35	10.81	37.41	38.10	37.54	41.03	37.30	
Education								
Primary(1=yes,0=No)	0.15	0.36	0.82	0.81	0.84	0.37	0.09	
Secondary(1=yes,0=No)	0.38	0.49	0.74	0.79	0.82	0.25	0.05	
Tertiary(1=yes,0=No)	0.31	0.46	0.73	0.78	0.84	0.18	0.53	
University(1=Yes, 0=No)	0.35	0.36	0.72	0.75	0.85	0.61	0.41	
Household size(Number)	4.99	2.79	5.01	5.19	5.12	5.96	4.49	
Aternative income(1=yes 0=No)	0.68	0.47	0.68	0.68	0.67	0.77	0.81	
Credit constrained household(1=yes 0=No)	0.64	0.48	0.62	0.61	0.60	0.62	0.66	
Years of experience	11.66	8.61	11.72	12.33	11.92	15.04	10.91	
Land size	2.44	2.16	2.46	2.44	2.49	2.62	2.68	

Plot characteristics i.e., soil fertility and land slope are important in understanding adoption of improved agricultural technologies and among small holder farmers. From this study, 8%, 28%, and 62% of farmers has poor, medium and good soil fertility respectively. The farms slopes were 18% gently slope, 63% medium slope and 19% steep slope. Soil conservation methods and use of fertilizer have been applied across all the plot characteristics.

4.3.2 Correlation of personal farmer characteristics and adoption of IATs

Correlation analysis was done to determine the relationship between the independent variables and adoption of IATs. The Pearson correlation was used in this study. It ranges for -1 which signifies a perfect negative correlation to +1 which signifies a perfect positive correlation. The p value was used to determine if the significance level. At 95% confidence level a p value < 0.05 shows that the correlation is statistically significant (Mindrila et al., 2017). The value of the Pearson correlation coefficient indicates the strength of the relationship. Generally, a correlation coefficient of < 0.3 is considered weak, a coefficient of between 0.3 and 0.6 is considered moderate while a correlation of 0.7 and above is considered strong (Akoglu, 2018; Profillidis et al., 2018).

The results revealed a weak positive correlation between age of 0.134, and adoption of improved tea varieties. There was also a weak positive correlation of 0.223, between age and IWM. This means older farmers adopt use of improved tea varieties and IWM. Similarly, there exists a weak positive correlation of 0.150, between years of experience in tea farming and a positive correlation of 0.26 and adoption of improved tea varieties and integrated weed management.

The results show a weak positive correlation between household size and adoption of improved tea varieties, fertilizer use and IWM of 0.141, 0.105 and 0.229 respectively. However, there is a weak negative correlation of -0.105 between household size and soil testing.

On education level, there exists a weak positive correlation between farmers with university level of education and adoption of soil testing and integrated weed management of 0.143 and 0.298 respectively. There is also a moderate positive correlation of 0.413 between farmers with tertiary education level and soil testing. This implies that adoption of these two IATs increases with education level. The reverse is also true, farmers with primary and secondary levels of education show a weak to moderate negative correlation with adoption of soil testing of -0.163 and -0.382 respectively.

On gender there exists a weak negative correlation of -0.217 and -0.277 between female farm managers and adoption of soil conservation and IWM. On the other hand, there is a weak positive correlation of 0.137 and 0.204 between male farm managers and adoption of soil conservation and IWM respectively. There also exists a positive correlation of 0.126 and 0.120 between joint farm management and adoption of soil conservation and IWM respectively.

On plot characteristics, there is a weak negative correlation of -0.131 between farmers with medium soil fertility and adoption of improved tea varieties. On the other hand, there exists a positive correlation of 0.116 between farmers with good soil fertility and adoption of soil conservation and a positive correlation of 0.159 between farmers with good soil fertility and adoption of improved tea varieties of. There was no relationship between farmers with poor soil fertility and adoption of the IATs.

The results on land slope revealed mixed findings. Gently slope land is positively correlated with a coefficient value of 0.103 to adoption of fertilizer use and negatively correlated to use of IWM with a coefficient value of -0.107. There exists a weak negative correlation of -0.111 between medium slope land and adoption of fertilizer and use of improved tea varieties. However, there is a positive correlation of 0.143 between medium slope land and adoption of IWM. Additionally, there is a positive correlation of 0.138 and 0.110 between steep sloped land and adoption of improved tea varieties and soil testing.

4.3.3 Multivariate Probit Model Results

The likelihood ratio test of the independence of the error terms was calculated. The result was significantly different from zero, ($\text{Chi}^2 (21) = 29.354$; $\text{Prob} > \text{Chi}^2 = 0.0000$). We therefore reject the null hypothesis that the error terms across the five improved agricultural technologies are not correlated. This implies existence of interdependence among the improved agricultural technologies and supports the choice of the MVP model for this study. This is further supported by the significance of the pairwise correlation coefficients of error terms in table 4.7.

Table 4. 5 correlation coefficient of error terms from MVP model

	Correlation coefficient of error terms	std error	z value
rho21	0.170	0.009	0.001
rho31	0.228	0.010	0.000
rho41	0.069	0.012	0.182
rho51	-0.196	0.007	0.000
rho32	0.182	0.009	0.000
rho42	0.092	0.003	0.073
rho52	-0.215	0.004	0.000
rho 43	0.019	0.008	0.717
rho45	-0.048	0.004	0.358
rho53	-0.292	0.005	0.000

The numbers in rho refer to:1=soil conservation,2=improved tea varieties, 3=fertilizer use,4=IWM,5=soil testing

The correlation coefficients of error terms are shown in Table 4.7. The results show a positive correlation between some IATs and a negative correlation between some IATs and soil testing. There is a significant positive correlation between adoption of soil conservation and improved tea varieties, soil conservation and fertilizer use and improved tea varieties and fertilizer use. This indicates a complimentary relationship. On the other hand, there exists significant negative correlation between soil testing and soil conservation, soil testing and improved tea varieties and soil testing and fertilizer use. This indicates a substitute relationship.

Table 4. 6 MVP model results

Variables	Soil Conservation		Improved tea varieties		Fertilizer Use		Integrated Weed management		Soil Testing	
	Estimate	Std error	Estimate	Std error	Estimate	Std error	Estimate	Std error	Estimate	Std error
(Intercept)	0.047	0.721	0.307	0.727	0.939	0.767	-0.183	0.737	-1.74	0.796
Age	0	0.016	0.001	0.016	-0.022	0.018	0.01	0.016	0.047**	0.019
Primary	0.880***	0.322	-0.087	0.312	-0.139	0.348	-1.362***	0.311	-1.953**	0.403
Secondary	0.309	0.238	-0.031	0.243	-0.286	0.274	-1.450***	0.249	-1.932***	0.312
Tertiary	0.193	0.227	0.085	0.237	-0.087	0.265	-1.303***	0.237	0.286	0.221
years of experience in tea farming	-0.01	0.02	0.018	0.021	0.016	0.023	0.041**	0.02	-0.005	0.025
Household size	-0.021	0.04	0.039	0.044	0.083*	0.047	0.039	0.041	-0.017	0.045
Land size	-0.002	0.035	-0.013	0.035	0.034	0.04	-0.013	0.036	0.002	0.04
Farm Manager Joint	0.212	0.29	0.215	0.279	0.038	0.316	-0.139	0.249	-0.732**	0.319
Farm manager Female	-0.685***	0.179	0.134	0.179	-0.248	0.193	-0.826***	0.184	-0.106	0.196
Alternative Income	0.109	0.169	0.006	0.175	-0.129	0.189	0.358**	0.18	0.339	0.208
Member of formal or informal farmer group or institution	0.470*	0.253	0.332	0.251	0.327	0.272	-0.147	0.269	0.011	0.295
credit constrained household	-0.231	0.172	-0.245	0.185	-0.569***	0.211	-0.098	0.181	0.069	0.199
Access to extension services	0.187	0.508	0.165	0.485	0.786	0.504	0.023	0.49	0.241	0.485
Good soil	0.389	0.245	0.4	0.252	0.072	0.276	-0.181	0.268	-0.061	0.311
Medium Soil	0.241	0.261	0.059	0.267	-0.016	0.294	-0.05	0.294	-0.343	0.336
Gently slope .	0.461*	0.251	-0.564**	0.279	0.345	0.303	-0.236	0.273	-0.833***	0.283
Medium slope	0.044	0.192	-0.668***	0.239	-0.24	0.225	0.319	0.219	-0.021	0.222

probability value * $p < 0.1$, ** $p < 0.05$ *** $p < 0.01$

The results of the MVP in Table 4.8 show that farmers with primary level of education are more likely to adopt soil conservation. However, farmers with primary and secondary education are less likely to adopt IWM and soil testing. Additionally, farmers with tertiary level of education are less

likely to adopt IWM. This shows that farmers with low levels of education are less likely to adopt complex IATs

On age, older farmers are more likely to adopt soil testing compared to younger farmers. The relationship between age and adoption of the other improved technologies is however not significant. Farmers with more years of experience in tea farming are more likely to adopt use of IWM. However, there is no significant relationship between years of experience and the other improved technologies.

Household size which is an indicator of the labor available for implementation of IATs is positively significant for adoption of fertilizer use meaning larger household sizes are more likely to adopt fertilizer. However, household size is not significant for the other IATs.

Female managed farms are less likely to adopt soil conservation and IWM. The results also show that jointly managed farms are less likely to adopt soil testing.

On plot characteristics, farmers with gently slope land were less likely to adopt soil testing and use of improved tea varieties. However, they were more likely to adopt soil conservation. Farmers with medium slope plots were less likely to adopt use of improved tea varieties

4.4 Influence of Economic factors on Adoption of Improved Agricultural technologies

4.4.1 Descriptive Statistics

From Table 4.4, the average land size of the respondents was 2.4 acres. There results show no difference in adoption behavior for the 5 improved agricultural technologies based on land size.

High input costs are hinderance to technology adoption. This includes the initial cost of purchasing inputs and costs associated with implementation of the improved farming practice. 41% and 46% of the farmers cited high input implementation costs as a hinderance to adoption of IWM and soil testing respectively. Only 3%,4% and 5% cited high implementation costs as a hinderance to adoption of soil conservation, use of improved seed varieties and use of fertilizer respectively. Additionally, famers said that difficulty in accessing herbicides and soil testing centers hindered them from adopting these technologies. Fertilizer and improved seed varieties can be accessed from KTDA factories on credit.

The results show that 68 % of the farmers have alternative sources of income. This mainly came from salaried employment of the household head or spouse. More farmers who adopted integrated weed management and soil testing had alternative income, 77% and 81% respectively.

4.4.2 Correlation of Economic factors and adoption of improved agricultural technologies

The correlation results revealed that there is a weak positive correlation of 0.116 between presence of alternative income for a household and adoption of IWM. Similarly, there exists a positive correlation of 0.159 between existence of alternative income and adoption of and soil testing.

In contrast, there was no correlation between land size and adoption of the IATs.

4.4.3 Multivariate Probit Model Results

The MVP model results showed that that farmers with alternative income sources were more likely to adopt IWM. There was however no significant relationship between off farm income and the other IATs.

On land size, there exists no relationship between land size and adoption of the IATs. This is consistent with correlation results presented above.

4.5 Effect of Institutional factors on Adoption of Improved Agricultural Technologies

4.5.1 Descriptive Statistics

Access to credit has been identified as factor that influences technology adoption among smallholder farmers. We used Feder et al. (1985) method by creating a credit constraint variable to distinguish between farmers who needed credit and it was not available to them and those who choose not to use the available credit. The results showed that 64% of the farmer households are credit constrained showing that many farmers lack access to capital to implement IATs.

Membership to farmer groups or association is an indication of the social capital available to a farmer. Farmers were asked whether they were members of a farmer group or association and what the main functions of the group were. 92% of households said either the household head or spouse was a member of a formal or informal institution. The main function of these groups was savings and provision of credit and access to information on agriculture.

Provision of extension services enhances information access on improved agricultural technologies to farmers. 98% of farmers had access to extension services. This service is offered by KTDA. However, most farmers were visited at most once in a year.

To determine the quality of extension services offered, we asked whether the information offered is relevant to farmer, whether it is easy to understand and if it solves the problems in their farm. The

farmers felt that the information met these needs from a small to a moderate extent (2.5). We also asked the farmers whether they received the information they needed at the right time and whether the service offered was accurate. The farmers said these two aspects were met sometimes (2). This shows that despite the provision of extension services, the quality of the service offered has been poor.

Table 4. 7 access to extension services

Access to extension services	Mean	Stdev
Access to extension service 1= Yes 0 = No	0.98	0.15
Soil conservation	0.89	0.31
Improved varieties	0.94	0.23
Fertilizer use	0.95	0.21
Integrated weed management	0.95	0.21
Soil testing	0.66	0.47
Visit frequency	0.92	0.47

Table 4. 8 quality of extension services

Quality of extension service (1=Not at all, 2=To a small extent, 3=to a moderate extent, 4=to a large extent)	Mean	Stdev
The information offered by extension officers is relevant to me	2.54	0.56
The information offered by extension service is easy to understand and apply	2.55	0.57
The information and services offered solve the problems in my farm	2.54	0.55
Quality of extension service (1=not at all, 2=sometimes, 3=always)		
I get the information I need at the right time	2.00	0.19
The service offered is accurate	2.03	0.21

4.5.2 Correlation of institutional factors and adoption of improved agricultural technologies

On institutional factors, there exists a weak negative correlation of -0.174 and -0.124 between credit constrained households and adoption of fertilizer use and improved tea varieties. Smallholder farmers require capital to purchase inputs such as fertilizer and improved tea varieties.

The exists a weak positive correlation of 0.107 between membership to a formal or informal institution and adoption of improved tea varieties. However there in no correlation between membership and adoption of the other IATs.

Additionally, there is no relationship between access to extension services and adoption of IATs. While most farmers receive extension services, the descriptive results show that the quality of the service offered is poor.

4.5.3 Multivariate probit model analysis

The results on Table 4.8 reveal that there exists a significant negative relationship between credit constrained households and adoption of fertilizer. This is consistent with the correlation results and shows that credit constrained farmers are less likely to adopt fertilizer use.

The MVP results also reveal that farmers who are members of a formal/ informal institution are more likely to adopt soil conservation. However, there is no relationship between membership to a formal/ informal institution and adoption of the other IATs for the MVP results.

From the results, there is no significant relationship between access to extension services and adoption of any of the IATs. This result corresponds with the correlation analysis results.

4.6 Summary of findings

The results show that 52% of the farms are managed by women, 34% by men and 14% by both men and women. However, women have the lowest adoption rates with 61% adopting three or more IATs compared to 75% men and 85% joint management. The average age of the farmers was 37 years. Majority of the farmers has secondary level of education followed by 35% university level, 31% tertiary level and 15% primary level.

The correlation results show a weak positive correlation between age and adoption of improved tea varieties and IWM at 0.134 and 0.223 respectively. Additionally, the MVP model results show a positive relationship between age and adoption of soil testing.

There exists a weak positive correlation between household size and adoption of improved tea varieties fertilizer use and IWM of 0.141,0.105 and 0.229 respectively and a negative correlation with soil testing of -0.105. Additionally, MVP model results show that larger household sizes are more likely to adopt fertilizer use.

On education level there is a weak positive correlation between university education level and adoption of soil testing and IWM of 0.143,0.298 respectively. There is also a moderate correlation

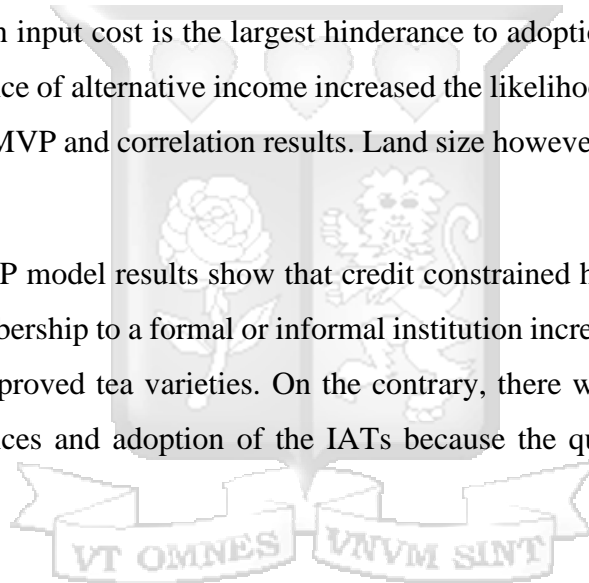
of 0.413 between farmers with tertiary level of education and soil testing. Moreover, the MVP results show farmers with primary and secondary education are less likely to adopt IWM and soil testing

Both the correlation and MVP model results reveal a weak negative correlation between female farm managers and adoption of soil conservation and IWM of. -0.217 and -0.277 respectively.

There is a positive correlation between farmers with good soil fertility and adoption of soil conservation and improved tea varieties at 0.116 and 0.159 respectively. There is also a positive correlation between steep sloped land and adoption of improved tea varieties and soil testing at 0.138 and 0.110 respectively. Additionally, the MVP results show that farmers with gentle sloped land are less likely to adopt soil testing and use of improved tea varieties

On economic factors high input cost is the largest hinderance to adoption of IWM and soil testing. On the other hand, presence of alternative income increased the likelihood of adoption of IWM, and soil testing based on the MVP and correlation results. Land size however did not influence adoption of the IATs.

The correlations and MVP model results show that credit constrained households are less likely to adopt fertilizer use. Membership to a formal or informal institution increased chances of adoption of soil conservation and improved tea varieties. On the contrary, there was no relationship between access to extension services and adoption of the IATs because the quality of extension services offered was poor.



CHAPTER FIVE

DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter discusses the findings in chapter 4 on the relationship between personal, economic, and institutional factors and adoption of improved agricultural technologies. The conclusions and recommendations are also outlined.

5.2 Discussions

5.2.1 Effect of Personal characteristics on adoption

The mean age of the farmers is 37 years showing that young people are engaged in tea farming. The correlation analysis reveals that older farmers are more likely to adopt use of improved tea varieties and IWM. The MVP results show that older farmers are more likely to adopt soil testing. This shows that older tea farmers are more skilled and experienced in adopting IATs to maximize productivity. They are more experienced selecting high yielding tea varieties and in complimentary use of mechanical weeding and use of herbicides. While it is expected that younger farmers would adopt soil testing more, this is not the case for smallholder tea farmers. These findings agree with Mignouna et al. (2011) found a positive correlation between age and adoption of disease resistant maize technologies in western Kenya. However, this contrasts previous studies which have found a negative correlation between age and adoption of IATs arguing that older farmers hold on to traditional farming methods and don't take long term investments on their farms (Denkyirah et al., 2016). Moreover, the correlation and MVP results show a positive relationship between years of experience tea farming and adoption of improved tea varieties and IWM. Anang (2018) also found a positive correlation between years of experience and adoption of IATs.

On education, farmers with lower levels of education were less likely to adopt IWM and soil testing. The correlation results show a positive correlation between farmers with university education levels and adoption of soil testing. This means higher education is important for adoption of complex IATs. The importance of soil testing and IWM may not be easily understood by farmers with lower education levels. Studies have shown that education increases an individual's ability to understand the benefits of a technology especially those that need understanding of a technical theory (Adebiyi et al., 2013; Donkoh et al., 2019).

On gender, 68% of the households were headed by men. However, majority of the farms were managed by women, 52% of the farms had female plot managers while 34% and 14% had male and joint plot managers respectively. This is because women bear most of the household and farm responsibilities (Raney et al., 2011). However, they are less likely to adopt soil conservation and IWM. Women are usually disadvantaged from owning land and property due to cultural technologies that prevent them from inheriting land and lack of resources to purchase their own land (Ndiritu et al., 2014; Tanui et al., 2012). Additionally, most female managers lack access to capital to hire labor or purchase inputs (Andersson et al., 2014). On the other hand, there exist no gender differences in adoption of improved tea varieties, fertilizer use and soil testing in this study. Ndiritu et al. (2014) also found no gender differences in adoption of improved seed varieties, and chemical fertilizer among smallholder maize farmers in Kenya. The results show a negative correlation between joint management and adoption of soil testing. This contrasts previous studies which found joint management to enhance adoption of IATs like fertilizer use and row planting (Lambrecht et al., 2016).

The household size average is five members. Households with more members are more likely to adopt fertilizer use. Moreover, there is a positive correlation between household size and adoption of improved varieties and IWM. More household members provide additional labor for adoption of IATs. A study by Kassie et al. (2015) also revealed a positive correlation between household size and adoption of manure use in Tanzania and crop diversification in Ethiopia.

On plot characteristics, farmers with good soil fertility are more likely to adopt soil conservation and improved tea varieties. Farmers with gently sloped land were more likely to adopt soil conservation and less likely to adopt use of improved varieties and soil testing. Different soil conservation methods are suited for different slopes of land. Farmers with steep slope land were more likely to adopt use of improved tea varieties and soil testing. This shows that farmers who have land with good soil fertility are more likely to adopt IATs that maximize yields from the good soil. Additionally, farmers of steep sloped land test the soil use improved tea varieties to maximize yields on their land resource. These results show that farmers' perception of their farm characteristics influences adoption of IATs (Mwungu et al., 2018).

5.2.2 Influence of Economic factors on adoption

The average land size from the study is 2.4 acres. The results show no relationship between land size and adoption and improved technologies. This means that the size of land does not influence adoption of IAT among smallholder tea farmers. This contradicts the findings by Mutuku (2017) and Adebiyi et al. (2013) who found a positive correlation between farm size adoption.

Input costs are a hinderance to adoption of IWM and soil testing. The smallholder farmers cited that the cost of herbicides and soil testing hindered them from adopting these IATs. Additionally, lack of access to soil testing centers prevented them from adopting this practice. Therefore, input cost and ease of access is critical to promote adoption.

The study found that 68% of farmers had alternative sources of income. Most of this income came from salaried employment. Farmers with alternative income were more likely to adopt IWM and soil testing. The income from other economic activities provided the capital required to purchase inputs for IWM. They can also easily access and pay for soil testing services. Danso-Abbeam et al. (2020) found similar findings in his study on the implications of rural non-farm income diversification among smallholder farmers in Ghana.

5.2.3 Influence of Institutional factors on adoption

The results show that 64% of the farmers were credit constrained, revealing that farmers still have a challenge with access to credit. The data shows that credit constrained households are less likely to adopt use of fertilizer and improved tea varieties. It is costly to purchase fertilizer and improved tea varieties. Smallholder tea farmers use the income they get to meet their basic needs and therefore have limited capital. This shows the importance strengthening rural financial institutions and providing subsidies to farmers to enable them access capital for technology adoption (Namwata et al., 2010; Teklewold et al., 2013).

The study found that 92% of farmers were members of formal or informal institutions. Membership increased likelihood of adoption of improved tea varieties and soil conservation practices. The adoption of these technologies is encouraged by farmers sharing information and experiences on the different varieties they have adopted. Previous studies have shown that social networks play an important role in adoption of IATs (Genius et al., 2014; Krishnan et al., 2014).

Extension services were provided by KTDA for smallholder tea farmers. 98% of farmers had access to extension services. However, there were no follow up visits and the quality of extension services offered was poor. Access to extension services therefore had no relationship with any of the IATs. This contradicts previous studies that have found provision of extension services to enhance adoption of IATs (Krishnan et al., 2014). This also shows the importance of follow ups and quality of extension services (Kaweesa et al., 2018)

5.3 Conclusion

This study concluded that there are complimentary relationships between adoption of soil conservation and improved tea varieties, soil conservation and fertilizer use and improved tea varieties and fertilizer use. There also exist substitute relationship between soil testing and soil conservation, soil testing and improved tea varieties and soil testing and fertilizer use. This therefore means that adoption of one of these technologies could enhance or hinder adoption of another.

The study concluded that personal farmer characteristics have influence the adoption of the 5 IATs differently. Age, education level, years of experience and household size of farmers should be considered in disseminating IATs. Education is important for adoption of complex IATs and older more experienced farmers are more likely to adopt IATs. Household size also provides labor and encourages adoption. The study concluded that farmers perception of their plot characteristics also influences adoption.

Economic factors also influenced adoption of improved agricultural technologies. High input costs and difficulty in input access are a barrier to adoption of IATs despite the benefits they offer. Off farm income enhanced adoption of IATs that require high capital investment. The study concluded that land size does not influence adoption of IATs among smallholder tea farmers.

On institutional factors, the study concluded that credit constrained households are less likely to adopt IATs because of lack of capital to purchase inputs. Membership to formal or informal institution influenced adoption of IATs due to sharing of information and experience among farmers. Access to extension services did not influence adoption of IATs since the quality of extension services offered was poor.

5.4 Recommendations

Government bodies and research institutions should consider the complimentary and substitute relationship between IATs during dissemination of the technologies.

Policy makers should consider how age, education level, years of experience in farming and gender influence adoption of the individual technologies during roll out. Young people should be encouraged to engage in tea farming early to gain experience and maximize profitability. Government should work with KTDA and non-governmental organizations to empower women and enhance their access to financial resources and participation in decision making. Additionally, government policies and activities to enhance education in rural areas should be intensified.

Smallholder tea farmers should be encouraged to participate in other economic activities to substitute income from tea farming. Extension agents should encourage income diversification as this ultimately provides financial resources for adoption of IATs. KTDA and other government agencies should ensure inputs such as fertilizer, herbicides, soil testing facilities and improved tea varieties are easily accessible to farmers. Government should provide subsidies where possible to make these inputs more affordable.

Since credit access is still a challenge for small holder farmers, the government should implement policies to strengthen rural financial institutions and farmer associations that offer credit. KTDA should intensify activities to offer inputs such as fertilizer and herbicides to farmers on credit.

All tea sector players should encourage formation of farmer groups and associations focused on information sharing on IATs to farmers.

Government agencies and KTDA should review the quality of its extension services. They should work closely with the farmers to develop programs that meet the farmer's needs.

5.5 Suggestion for further studies

This study looked at how personal, economic, and institutional factors influence adoption of soil conservation, use of improved tea varieties, fertilizer use, IWM and soil testing among smallholder tea farmers in Kericho County. There is room for further studies to be done on adoption in other regions and covering adoption of IATs that have not been covered in this study. Further studies can also be done on other cash crops like coffee and sugarcane.

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Appendix 1: Questionnaire

This questionnaire is part of an academic research to understand technology adoption for improved agricultural practices among smallholder tea farmers. Your responses will enable me to understand this issue and your decision to take part in this survey is completely voluntary.

If you agree to participate, the questionnaire should take you approximately 10 minutes to complete. Please answer the questions in the spaces provided and feel free to give any additional comments. I assure you that the information you provide will be used for academic purposes only and will be treated with utmost confidence.

Your responses together with others will be used as the main data set for my research project for my Master's in Business Administration (MBA) at Strathmore Business School.

I hope that you enjoy completing the questionnaire. If you have any questions or would like further information, you can reach me On 0726209044 or email me on carrenekwang@gmail.com

Thank you

Carren Ekwang

INSTRUCTION: *Please answer all the questions honestly and exhaustively by putting a tick (✓) or numbers in the appropriate box that closely matches your view or alternatively writing in the spaces provided where necessary.*

PART A: Background Information

1. Name (Optional)
2. Location:
3. Gender: Male Female
4. Mobile no.
5. Age:
6. Level of education.....
7. The number of years of experience in Tea farming?
8. What is the size of your household?.....
9. Have you adopted improved farming practices in your farm? Tick where appropriate
 - a) Soil conservation Yes No

- b) Improved tea varieties [] Yes [] No
- c) Fertilizer use [] Yes [] No
- d) Integrated weed management [] Yes [] No

		Hinderances				
		Cost of implementation	Lack of motivation	Lack of knowledge	Technology has no added benefit to productivity	Lack of access to input
Improved farming practice	Soil conservation					
	Improved tea varieties					
	Fertilizer use					
	Integrated weed management					

- e) Soil testing [] Yes [] No

PART B: Economic factors

i) Input Cost

What are the challenges that hinder you from the using the below improved farming practices? Tick where appropriate in the boxes for each farming practice, you can tick more than one hindrance for each.

ii) Land size and Plot Characteristics

- 10. What is the approximate size of your land in acres?
- 11. What is the size of your land in acres is under tea growing?

12. How much green leaf do you harvest in a month?.....
13. Who manages the farm on a day to day basis. Tick the appropriate answer
- a) Male
- b) Female
- c) Both
14. How would you describe the soil fertility of your land?
- a) Good b) Medium c) Poor
15. Describe the slope of your land.
- a) Gently slope(flat) b) Medium slope c) Steep slope
16. Have you done soil testing on your land? Yes No
17. If Yes what was the soil pH?
18. What interventions did you make to correct the soil pH (if not within the required range 4.5-5.6)?
19. If No in question 16. Why did you not do a soil test?.....

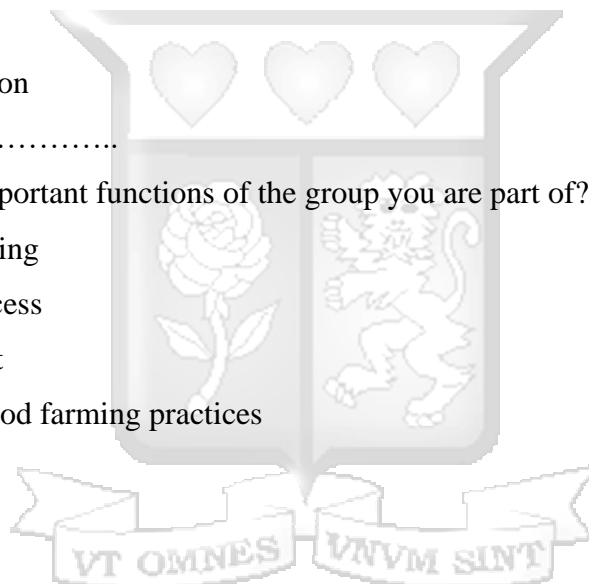
iii) Alternative Income sources

20. Do you or your spouse earn money from other sources of income apart from tea farming?
- Yes No
21. If Yes, who earns?
- a) Self
- b) Spouse
- c) Both
- d) Son/Daughter
22. If Yes, in 20 what is the source of income?
- a) Salaried employment
- b) Other business net income e.g. (shops, grain milling)
- c) Other farming related activities e.g. dairy farming, rented farm land
- d) Pension
- e) Others(specify).....
23. What was your total annual income from these activities in the last 1 year? Kshs.....

PART C: Institutional Factors

i) Membership to Forma/Informal institutions

24. How many people do you rely on for farming advise and support?
- a) Relatives Yes No . If Yes, how many?.....
- b) Friends Yes No If Yes, how many?.....
- c) Extension officers Yes No
- d) Others (Specify).....
25. Are you or your spouse a member of formal or informal farmer group or institution?
 Yes No
26. If yes, which type of group?
- a) Farmer cooperative/association
- b) Women group/Chama
- c) Youth association
- d) Church organization
- e) Others(specify).....
27. What are the most important functions of the group you are part of?
- a) Green leaf marketing
- b) Enhance Input access
- c) Savings and credit
- d) Information on good farming practices
- e) Socializing
- f) Other(Specify)



ii)Access to Credit

Please fill the section below indicating whether you have been able to access credit in the last 2-3 years

28. Have you needed a loan in the past 2- 3 years? Tick where appropriate
- a) Yes
- b) No
29. If Yes, why did you need the loan?
- a) To buy farm equipment for soil conservation
- b) To buy improved tea varieties
- c) To buy fertilizer

- d) To buy herbicides and/or pesticides
- e) To pay for soil testing
- f) Buy basic needs (food, clothing, school fees)
- g) Other: specify

30. If **No**, to *Question 28* then why?

- a) I am not cash constrained
- b) Borrowing is risky
- c) I have an existing loan
- d) Other: specify

31. If **Yes**, to *Question 28* did you get the loan?

- a) Yes
- b) No

32. If **No**, to *Question 31* then why?

- a) I expected to be rejected, so did not try it
- b) I have no asset for collateral
- c) There are no money lenders in this area for this purpose
- d) Lenders don't provide the amount needed
- e) There is no credit association or SACCO available
- f) Other: specify.....

33. If **Yes**, in *Question 31* where did you get the loan from?

- a) Farmer cooperative/association
- b) Merry go round
- c) Microfinance
- d) Bank
- e) SACCO
- f) Mobile Application

iii) Access to Extension Services

34. Do you have access to extension services? Yes No

35. If Yes, which services have you received? Tick where appropriate:

- a) soil conservation: Yes [] No []
- b) Use of improved tea varieties: Yes [] No []
- c) Fertilizer usage and rates of application Yes [] No []
- d) Use of herbicides and pesticides Yes [] No []
- e) Soil testing Yes [] No []
- f) Other (Specify).....

36. Where do you get the above service from?

- a) Government/(KTDA) extension service
- b) Farmer cooperatives or groups



- c) Neighbor/relative farmers
- d) Other, specify.....

37. From your experience, how often are extension service visits?

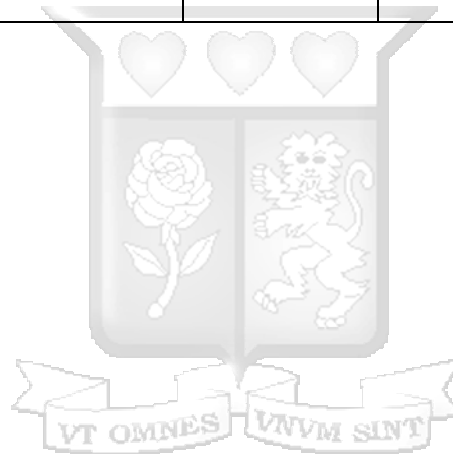
- a) Less than once a year
- b) Once a year
- c) Twice a year
- d) 3 times a year
- e) More than 3 times a year

38. Please tick where appropriate, regarding the quality of extension service you receive.

	1. Not at all	2. To a small extent	3. To a moderate extent	4. To a large extent
The information offered by extension officers is relevant to me				
The information offered by extension service is easy to understand and apply				
The information and services offered solve the problems in my farm				

39. Please tick where appropriate, regarding the quality of extension service you receive.

	1.Not at all	2.Sometimes	3.Always
I get the information I need at the right time			
The service offered is accurate			



Appendix II: Introduction Letter

Ole Sangale Rd, Madaraka Estate,
P.O. Box 59857 00200, Nairobi, Kenya,
Cell: +254 703 414/6/7, Twitter: @SSSKenya
Email: info@sbs.ac.ke or visit www.sbs.strathmore.edu



Friday, October 30, 2020

To whom it may concern.

RE: FACILITATION OF RESEARCH – CARREN MERCY EKWANG

This is to introduce Carren Mercy Ekwang who is an MBA student at Strathmore University Business School, admission number MBA/110231/18. As part of our MBA Program, Carren is expected to do applied research and to undertake a project. This is in partial fulfilment of the requirements of the MBA course. To this effect, she would like to request for appropriate data from your organization.

Carren is undertaking a research paper on "*Technology adoption for Improved Agricultural Practices among Smallholder Tea Farmers in Kericho County.*" The information obtained from your organization shall be treated confidentially and shall be used for academic purposes only.

Our MBA seeks to establish links with industry, and one of these ways is by directing our research to areas that would be of direct use to industry. We would be glad to share the findings with you after the research, and we trust that you will find them of great interest and of practical value to your organization.

We appreciate your support and we shall be willing to provide any further information if required.

Yours sincerely,

A handwritten signature in black ink, appearing to read "Caroline Tiara".

Caroline Tiara,
Manager – MBA Programs.

Strathmore Business School is a Proud member of:

Appendix III: Research Permit



REPUBLIC OF KENYA

Ref No: **136150**



**NATIONAL COMMISSION FOR
SCIENCE, TECHNOLOGY & INNOVATION**

Date of Issue: **25/November/2020**

RESEARCH LICENSE

Applicant Identification Number

136150



License No: NACOSTI/P20/7482

This is to Certify that Mrs. Caron Mercy Elwang of Strathmore University, has been licensed to conduct research in Kericho on the topic: TECHNOLOGY ADOPTION FOR IMPROVED AGRICULTURAL PRACTICES AMONG SMALLHOLDER TEA FARMERS IN KERICHO COUNTY for the period ending : 25/November/2021.

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.

Appendix IV: Ethics Clearance



27th August 2020

Ms Ekwang, Carren
carrenekwang@gmail.com

Dear Ms Ekwang,

RE: Technology adoption for improved agricultural practices among smallholder tea farmers in Kericho County

This is to inform you that SU-IERC has reviewed and **approved** your above research proposal. Your application approval number is **SU-IERC0876/20**. The approval period is **27th August 2020 to 26th August 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,


Dr Virginia Gichuru,
Secretary; SU-IERC

Cc: Prof Fred Were,
Chairperson; SU-IERC



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