

**SOCIO-ECONOMIC AND ADMINISTRATIVE FACTORS INFLUENCING
ADOPTION OF IRRIGATION TECHNOLOGY IN THARAKA NITHI COUNTY**

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Declaration

This research project is my original work and has never been presented to any other university for any award.

Signature í í í í í í í í í í í í í í Date í í í í í í í í í í í í ..

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Dedication

I dedicate this work to my loving wife Cecilia, daughter Melody, son Carlos, my brothers; Willie, Kim, Ngudi, Vinnie, sister Evelyne, mum Anne and late dad Muthui for their support and patience during the time of writing this project.

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Table of contents

Declaration.....	ii
Acknowledgements	iv
List of tables.....	vii
List of figures.....	viii
Key words.....	ix
Abbreviations and Acronyms	x
Abstract.....	xi
CHAPTER ONE: INTRODUCTION.....	1
1.1 Agriculture in developing world.....	1
1.2 Agriculture in Kenya.....	2
1.3 Irrigation.....	3
1.4 Agricultural technology adoption	4
1.5 Problem statement.....	5
1.6 Main research question.....	6
1.7 Main study objective.....	7
1.7.1 Specific study objectives	7
1.8 Significance of the study.....	7
1.9 Scope and limitations of the study.....	8
CHAPTER TWO: LITERATURE REVIEW AND THEORITICAL FRAMEWORK.....	11
2.1 Rain fed agriculture.....	11
2.2 History of irrigation	12
2.3 Irrigation and poverty reduction	13
2.4 Agricultural technology adoption	15
2.5 Barriers to adoption of agricultural technology.....	18
2.6 Theoretical framework.....	19
2.7 Conceptual framework.....	22
CHAPTER THREE: METHODOLOGY	27
3.1 Site selection.....	27
3.2 Sampling.....	27
3.3 Data collection methods	29

3.4 Data collection tools.....	29
3.5 Data analysis techniques	30
CHAPTER FOUR: DATA ANALYSIS, INTERPRETATION AND DISCUSSION	31
4.1 Demographic characteristics.....	31
4.2 Perceptions and attitudes	33
4.3 Social factors	34
4.4 Economic Factors.....	45
4.5 Administrative factors.....	53
CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS..	57
5.1 Introduction	57
5.2 Summary of the findings	57
5.3 Conclusion.....	58
5.3 Recommendations.....	59
5.4 Study limitations and Future research.....	60
REFERENCES.....	61
Appendices.....	1
Appendix 1: Questionnaire.....	1
Appendix II: Focus group guide.....	7

List of tables

Table 2.1: Operationalisation of study variable.....	26
Table 4.2 Respondents economic activities.....	32
Table 4. 3 Adoption reasons.....	34
Table 4.4.Age of respondents and adoption.....	35
Table 4.5 Correlation between age and adoption.....	35
Table 4.6: Duration of stay and adoption.....	36
Table 4.7 Adoption and duration of stay.....	37
Table 4.8 Education levels.....	37
Table 4.9 Education level and adoption.....	38
Table 4.10 Gender and adoption.....	39
Table 4.11 Membership to groups and adoption.....	40
Table 4.12 Relationship of membership to groups and adoption.....	41
Table 4.13 Agricultural information access and adoption.....	42
Table 4.14: Sources of agricultural information.....	43
Table 4.15 Sources of income.....	45
Table 4.16 Income levels.....	45
Table 4.17 Access to credit.....	46
Table 4.18 Correlation between crops grown and crops marketed.....	47
Table 4.19 Size of land accessed.....	48
Table 4.20 Size of land owned and adoption.....	49
Table 4.21 Land ownership status.....	50
Table 4.22 Land tenure and adoption.....	50
Table 4.23 Sources of credit.....	52
Table 4.24 Credit access and adoption.....	52
Table 4.25 External support and adoption.....	53
Table 4.26 Sources of external support.....	54

List of figures

Figure 1: Conceptual Framework.....	25
Figure 2: Marital status.....	31
Figure 3: Adoption patterns	33
Figure 4: Respondents sex analysis.....	39
Figure 5: Reasons for failure to source information	44
Figure 6: Adoption benefits	47
Figure 7: Acreage under irrigaion	49
Figure 8: Access to credit	51
Figure 9: Adoption and external support.....	55

Key words

Technology, Innovation, Diffusion, Adoption, Irrigation, Administrative, Social and Economic factors

Abbreviations and Acronyms

ALDEV	African Land Development Unit
ASAL	Arid and Semi Arid Land
ASDS	Agricultural Sector Development Strategy
COMESA	Common Market for Eastern and Southern Africa
CIG	Common Interest Group
CIMMYT	International Maize and Wheat Improvement Center
DOI	Diffusion of Innovations
FAO	Food and Agriculture Organisation
FGD	Focus Group Discussion
GOK	Government of Kenya
GDP	Gross Domestic Product
HYV	High Yielding Variety
MDG	Millennium Development Goals
MTP	Medium Term Plan
NGO	Non Governmental Organisation
NEMA	National Environment Management Authority
PEOU	Perceived Ease of Use Usefulness
WRMA	Water and Resource Management Authority
WRUA	Water Resource Users Association

Abstract

The importance of irrigation in increasing agricultural productivity in arid and semi arid areas in Kenya cannot be underscored. Tharaka-nithi county is one of the forty seven (47) counties created by the Kenya constitution 2010 that has prioritised irrigation technology development in her County Development Intergrated Plan 2013-2017. An estimated 80% of the county population is engaged in agricultural activities. The semi-arid (lower zone) covering Tharaka North and South subcounties receives less, erratic and unreliable rainfall for agricultural production. Crop farming is characterized by frequent crop failures especially in the two subcounties. Several efforts and resources from both the government and donor community have been expended in promotion of irrigation technology to increase food production over the years. Despite this investment, adoption levels have remained low and largely unsustainable (Ngigi, 1999).

In a bid to explain this gap, this study sought to examine farmers perceptions, attitudes, socio-economic and administrative factors that affect adoption of irrigation technologies in the county. Data for this study was collected through secondary data review of existing information in similar studies and reports, primary data was collected through survey using structured questionnaire, interview with key informants was guided by structured guides and focus groups discussion guides were used for the focus groups. Data was collected between the period of June ó July, 2014 across six irrigation groups comprising of both adopters and non adopters. The data was then cleaned, coded and analysed using SPSS descriptive and inferential statistics, t-tests were carried out to establish correlation coefficient and significance.

The results illustrated that age, gender, size of land cultivated, years of residence and education level did not have significant relationship with decision to adopt or not adopt irrigation technology implying that they overallly didn't influence adoption decisions. On the other hand, membership to farmers groups, information access, land tenure and external support had a significant relationship, implying that they really affected farmers decision to adopt or not adopt irrigation technology. Further, the ten socio-economic variables viz; age, sex, marital status, education level, size of land owned, distance to the market, access to credit and external support when taken together were found to be significant in predicting farmer's adoption of irrigation technology.

CHAPTER ONE: INTRODUCTION

1.1 Agriculture in developing world

Agriculture is a vital part of household livelihood and the economics of developing countries in Sub-Saharan Africa, approximately 60 percent of the labour force is employed in agriculture (Earth Trends, 2000). The majority of this labour force is comprised of households engaged in small-scale and subsistence agriculture. The vital role a country or community's food supply plays in the survival of her citizen sets the productivity of the agriculture sector apart from other sectors of production.

In Africa, 80% of the continent's poor live in rural areas as producers, 70% of all Africans and nearly 90% of their poor work primarily in agriculture (World Bank, 2000). If individuals are excluded from the market in other sectors because of problems in production, it does not carry the same consequences as shortfalls in the agriculture sector (Perkins et al., 2006). Therefore, the productivity of labour and technology employed in agriculture is central to household livelihood and food security in developing countries.

Previous innovations and technology advancements in agriculture have led to increased productivity and yields in agriculture. For example, a major breakthrough in agricultural innovations and technologies, what has been termed as the Green Revolution increased productivity greatly during the 1950s and 1960s. The increase in agricultural productivity through the development of new seed varieties and application of chemical fertilizer and irrigation enabled the increase in food supply and food security in Asia and South America (Lipton et al., 1989).

Despite the advances that have been achieved, hunger and food insecurity still plague many parts of the developing world. The Food and Agriculture Organization (FAO) reports 30 percent of the population in Sub-Saharan Africa is under-nourished (FAO, 2009). In contrast, 16 percent in Asia and 8 percent in South America are undernourished. Sub-Saharan Africa still faces a considerable need for advances in its agricultural production and food security.

1.2 Agriculture in Kenya

In Kenya, as in many parts of the sub-Saharan Africa, agriculture is the mainstay of the livelihood of her citizens. Over 75% of the population of Kenya relies heavily on subsistent farming and 52% of her entire workforce directly practices small-scale farming including pastoral activities. Small-scale/subsistence farming produce accounts for over 75% of the entire agricultural output and over 70% of the marketed agricultural produce in Kenya. Sixty six (66) percent of the country's manufacturing sector is agro-based, These statistics go to show the importance of small-scale farming to Kenya's economy. The same statistics underscore the importance of focusing on this sector with interventions geared towards achieving success (FAO,1986).

The country enjoys a variety of climates and soils but less than 20% of the land size is considered arable under rainfed-fed condition. The remaining 80% is classified as arid and semi arid lands (ASALs) and experiences perennial water shortage which is a major constraint to agricultural production. Due to population pressure in the high and medium-potential areas, people whose livelihoods traditionally depended on subsistence farming have since moved to the ASALs and intensively cultivated them. Cultivation in this fragile ecosystems has not been sustainable without external inputs such as water and nutrients, (Okumu et al., 2004).

According to Okumu (ibid),between the mid-1960s and the mid-1980s, parastatal irrigation agencies were established and irrigation infrastructure was installed in significant tracts of land. Besides installing infrastructure and providing support services, many agencies took on responsibility for purchasing inputs, selling outputs and organizing production processes, in fact taking on the character of 'command-and-control' operations, with smallholder farmers largely treated as labourers.

According to National Irrigation Board Mid Term Plan (MTP) 2013-2017, to achieve vision 2030 for Kenya, Irrigation is critical to increasing agricultural productivity. In this regard, incentives will be provided for farmers to invest in energy and water-efficient irrigation systems and technologies. Further the existing schemes need to be rehabilitated and expanded while new ones will be put place.

Both the Kenya vision 2030 and the First Medium Term Plan (MTP) 2008-2012 underscore the important role that irrigation is expected to play in improving agricultural productivity and meeting Kenya's food security needs. The MTP estimates that irrigation can increase agricultural productivity four-fold and depending on the crops, multiply incomes by up to ten times. To promote agricultural productivity, the government plans to increase the area under irrigation and drainage from the current 140,000 ha to 1.2 million ha in 2030, an expansion of irrigation acreage by 48,000ha (34%) per year. The government targets to exploit the agricultural potential in ASAL areas by putting an additional 600,000 ha under irrigation.

1.3 Irrigation

Reducing vulnerability to rainfall failure shocks and variability of production is extremely important for subsistence farmers. Fewer or less severe shocks mean the household is able to maintain proper consumption levels and is less likely to deplete savings or productive assets (tools and livestock) to cope with a shock. Reduced vulnerability enables poor farmers to maintain their productive assets and avoid indebtedness of credit used for consumption (Burney et al., 2010).

According to FAO (1986), Irrigated land is only 3.6% of total cropland on the continent compared with the world average of 18.4%, while the use of fertilizers is minimal at nine kilograms per hectare compared with the world average of 100 kilograms per hectare. The development of irrigated agriculture is highest in COMESA (14.4% of arable land), possibly due to the large irrigation projects in Egypt and Sudan. In Kenya, Irrigation accounts for only 1.7 percent of the total land area under agriculture, but contributes 3 percent to the GDP and provides 18 percent of the value of all agricultural produce demonstrating its potential in increasing agricultural production and productivity.

Irrigation is linked to poverty reduction through its effect on crop production and increased farm income. Adequate water supply to crops increases the production available for household consumption and or sale. Irrigation can enable farmers to have a second and sometimes a third crop planting, increasing income for the farmer. In addition to increasing overall production, irrigation increases the reliability and consistency of production (Smith, 2004). Irrigation enables the farmer to control the available water throughout the growing season which boosts production and reduces exposure to water

shortfalls or seasonal droughts. In arid and semi-arid areas where rainfall is inadequate, unreliable, or incorrectly timed, reducing the farmer's dependency on unsuitable weather patterns is important for the best production.

Irrigation technologies in Kenya dates back to some 400 years, longer than that of most countries in East and Southern Africa. Today, it is worthy noting that Kenya is well ahead of other countries in the sub-region in utilizing low-cost technologies for small-scale irrigation, defined here as irrigation on small plots where farmers have the major controlling influence and using a level of technology which farmers can effectively operate and maintain (Carter, 1994).

Kenya has an estimated irrigation potential of 1.3 million ha and a drainage potential of 600,000 ha. Currently, 114,600 ha of irrigation and 30,000 ha of drainage have been developed. Of the available irrigation potential, 540,000 ha can be developed with the available water resources, while the rest of the area will require water harvesting and storage. The developed irrigation potential can be categorized into the following three main types: smallholder schemes, 49,000 ha, (43%); public/national schemes, 20,600 ha, (18%); and, private schemes, 45,000 ha (39%). The remaining potential of over 424,400 ha and 570,000 ha of irrigation and drainage calls for increased focus to unleash this potential (ASDS, 2010-2020).

1.4 Agricultural technology adoption

It is estimated that 82% of the population in Kenya live in rural areas, mainly as small-scale farmers. Among the many factors that contributed in the growth of agricultural productivity, technology is the most important. The rate of adoption of a new technology is subject to its profitability and the degree of risk and uncertainty associated with it and is highly influenced by the capital requirement, agricultural policies and socio-economic characteristics of the farmers.

The question of adoption and non adoption is important, however, intensity of adoption is actually the most important criterion in the adoption process. According to Rogers (1963), there are several factors affecting farmer's decision to adopt irrigation technologies. Extension creates awareness on existence of irrigation technology, the farmers assess whether the technologies are acceptable to them given their land sizes, crops grown,

education, experience, labour availability or demand, expected improvement in fertility, availability of credit facilities input cost and other factors.

According to FAO (ibid), the decision to determine whether it is feasible and profitable for farmers to adopt and implement the irrigation technology on their farms may be instantaneous, i.e. They can adopt immediately in the same year when the technology is introduced or it can take several years depending on socio-economic factors such as education, frequency of extension contact, technology input prices and literacy levels.

1.5 Problem statement

The challenge to researchers as Tarde (1903), asked is, "To learn why given One hundred different innovations conceived of at the same time innovations in the form of words, in mythological ideas, in industrial processes etc, ten will spread abroad while ninety will be forgotten".

This study seeks to explore why there is low irrigation technology adoption. More recent literature shows that in the last two decades agricultural production has not been able to keep pace with the increasing population. To address this challenge, Kenya is working on ways to improve and stabilise agricultural production to cater for the needs of ever increasing population. The biggest potential for increasing agricultural production lies in the development of ASALs, especially through the development of irrigation and water harvesting technologies.

However, despite the irrigation growth since 1975 when the government launched the first massive irrigation development plan, the area under irrigation is far less than the potential irrigatable area estimated between 244,700 and 539,500 hectares in Kenya. According to Ngigi (1999), for irrigation technology adoption to have had such slow ripple effect despite the persistent food shortages, there must be various reasons. There is a clear indicator that something must have went wrong along the way in development of irrigation projects in Africa and specifically in Kenya.

Most of existing literature on agricultural technology adoption is focused on Green Revolution (GR) technologies such as irrigation, fertilizer use, and the adoption patterns of high-yield variety (HYV) seeds. Due to the development process of HYV and the inputs required to make them productive, studies examining HYV adoption look at very

advanced forms of technology; HYV seeds are often the product of intensive laboratory research, and when they are targeted to farmers they are bundled with other technology inputs such as chemical fertilizers, pesticides and extensive irrigation because these are necessary for the HYV seeds to perform as designed.

Moreover, much of the focus of the adoption literature has been on the individual farmers e.g. the attitude or personality of the farmers or their socio-economic characteristics, such as wealth, landholding or education and the characteristics of the technologies, rather than the context in which technology adoption and diffusion takes place. According to Omarra & Parnell (2003), during the Green Revolution only limited attention was paid to the complexity and diversity of the farmer's physical, economic and social environment while more recently attention has been shifting towards a focus on farming systems.

Because so many studies of agricultural technology adoption and diffusion focus on HYV and other GR inputs, their findings are concentrated on a 'high-tech' definition of agricultural technology. Further studies have focused on the economic models which have limited ability to explain decision and also capture complexity of farmers attitudes and behaviour.

In extensive review of adoption studies in developing countries (Feder et al.,1993), No study was found to have analysed the direct effects of farmers subjective assessments of agricultural technology characteristics on adoption decision.

This study sought to address this gap by focusing on small scale farmers and the context in which they make their daily agricultural choices, specifically, the study examined farmers perceptions and attitudes influence on irrigation technology adoption. The researcher also explored the role of socio-economic factors in delaying or facilitating irrigation technology adoption. The study sought to establish the role of micro level (county) administrative environment and how it influences farmers adoption decisions.

1.6 Main research question

- ❖ Does farmer's attitudes, socio-economic statuses and administrative factors influence their decisions in adoption of irrigation technology?

1.6.1 Specific research questions

1. What are farmers' perceptions and attitudes to irrigation technology?
2. Do small scale farmers' socio-economic statuses affect their irrigation technology adoption?
3. How does the administrative environment affect irrigation technology adoption?

1.7 Main study objective

1. The main objective of this study was to establish whether attitudes, socio-economic statuses and administrative factors influence small scale farmers' adoption of irrigation technology in Tharaka Nithi county.

1.7.1 Specific study objectives

1. To investigate whether perceptions and attitudes influence irrigation technology adoption among small scale farmers.
2. To determine the role of socio-economic status in irrigation technology adoption.
3. To establish administrative context influence on irrigation technology adoption.

1.8 Significance of the study

Despite the benefits of irrigation, adoption of the technology has been very low in Africa. According to FAO only 6 percent of the cultivated land in Africa is irrigated, in contrast, 35 percent of the cultivated land in Asia is irrigated. In response to the potential benefits of irrigation and the low adoption rates in rural areas, especially in Africa, there are many organizations, governmental and non-governmental promoting small-scale irrigation technology.

The irrigation projects implemented in developing countries provide a wide variety of information, services and financial assistance; however, very little rigorous evaluation has been conducted on the actual factors affecting adoption among both participating and non-participating households.

This study sought to fill this knowledge gap as an understanding of factors affecting small scale farmer adoption of irrigation technology intervention not only explains the apathy in adoption but also low adoption intensity as cited by (Ngigi *ibid*:16), Further the

findings provide useful insights that can inform the implementation of similar projects in Tharaka nithi county and lessons learnt shared across similar initiatives in Kenya.

Moreover, findings are crucial in informing current irrigation technology adoption decision making processes among small scale farmers within a particular social context, identification of constraints (perception, socio-economic and administrative) that hinder wide adoption of irrigation technology, provides the basis to work on their solutions and improve technology adoption among small scale farmers.

1.9 Scope and limitations of the study

This study focused on irrigation technology promotion in Tharaka nithi county and people perceptions on irrigation technology as a means to address the persistent food insecurity in the county.

Further, the study sought to examine (social, economic and administrative) factors influencing people adoption of irrigation technology innovation either positively or negatively.

However, this study did not explore the strength of each factor in influencing adoption or non adoption decisions, also the study did not examine in depth the cultural influence on adoption decisions, therefore the findings may not be ideally generalisable for other areas in Kenya.

1.9.1 Definition of key terms

Innovation; This refers to any idea that is perceived as new by an individual or other unit of adoption. In this study, irrigation is gaining popularity among small scale farmers as a new concept and a panacea to persistent food insecurity facing the two sub-counties of Tharaka North and South sub counties.

Technology; Used in this report as new innovations developed by the researchers, that are intended to improve agricultural productivity for high quality and quantity yield gains. Rogers (1971), defines technology as a means by which resources are combined to produce the desired output, while innovations are ideas, practices or objects that are perceived as new by their recipients. In this study irrigation is considered a new technology among the target population.

Adoption; Refers to the stage in which a technology is selected for use by an individual or organization. Rogers (1995), defines adoption as a decision to make full use of an innovation as the best course of action available. At individual level, it is the degree to which a new technology is used in the long- run equilibrium when the farmer has full knowledge about the technology including its potential (Feder et al., 1985). Adoption in this study refers to favourable decisions made by farmers to practise irrigation, similarly non adoption refers to decision not to practise.

Irrigation; Irrigation refers to the action of applying water to land in order to supply crops and other plants to supplement rain water. This study defined irrigation as all different forms of farmer initiatives to apply water to their farmers from off-farm water sources like rivers, dams and boreholes.

Social factors; Refers to aspects of life that influences human behaviours in a society. It dictates that every one conform to societal norms or expectations. In this study social context refers to education levels, Membership to groups\association,Information access,Gender,Age and extension services received.

Economic factors; Refers to factors of production land,labour,capital and enterprise used in production of goods and services. In this study economic context include; Income levels, Access to Banks, Assets,Distance to roads, Source of income and Land ownership.

Administrative factors; In this study administrative factors include both county and sub county government interventions in promoting technology adoption. These include allocation of resources to support extension service, credit/grants and construction materials. Further administrative support include support to institutions like Water Resource Management Authority and NEMA whose access by farmers facilitate irrigation technology adoption and also water resource users committee WRUAs which determine who is supplied irrigation water or not.

CHAPTER TWO: LITERATURE REVIEW AND THEORITICAL FRAMEWORK

This chapter provides insights to previous publications relevant to this topic. The first section analyses trends in rain-fed agriculture, history of irrigation, agricultural technology development and existing theoretical and empirical literature that has been developed during the past decade. The second section explores literature on agricultural technology adoption and barriers to adoption - insights into how and why farmers adopt and modify adopted systems, factors influencing the intensity of adoption, spatial analyses of adoption, existing adoption theories and finally my conceptual framework.

2.1 Rain fed agriculture

Rain-fed agriculture is practiced on 80% of the world's agricultural area and generates 60-70% of the world staple food (Rockstorm et al., 2009). In sub-Saharan Africa more than 95% of the farmed land is rain-fed, while in Latin America is almost 90%, for South Asia is about 60%, for East Asia 65% and for the Near East and North Africa 75%. In the developing countries, rain-fed agriculture constitutes the livelihood base for the vast majority of rural inhabitants (about 75 percent of the poor in south Asia, and about 80 percent of the population in east Africa) is a source of food security, employment and cash income (Wanj et al.,2009).

According to the World Bank, in Sub-Saharan African agriculture is 96% rain fed and highly vulnerable to weather shocks and diverse agro-ecological conditions producing a wide range of farming systems based on many food staples and livestock. High temperatures cause reduction in yields of desirable crops and encourage weed and pest proliferation while changes in rainfall patterns increase the likelihood of short-run crop failures and long-run production declines causing food insecurity (Nelson et al., 2009). According to wanj et al. (ibid:46), of the 6.5 billion populations today, about 850 million people face food insecurity and 60% of them live in South Asia and Sub-Saharan Africa.

Agriculture plays a key role in poverty reduction, economic growth and development in sub-Saharan Africa where it accounts for 35% of the Gross Domestic Product (GDP) and employs over 70% of the population. According to Rockstorm and Karlberg (2009), in many areas poverty is strongly influenced by agricultural production, which is in turn

dependent on climate, particularly rainfall. Every 1% increase in agricultural yields translates to a 0.6-1.2% decrease in the percentage of the absolute poor people. In Kenya, over 80 percent of the population earn their living through farming and employment in agricultural sector (Huho et al., 2010). However, droughts have been the major hindrance to agricultural activities in the arid and semi-arid lands affecting large number of people.

Declining performance of the sector in terms of its growth has been one of the major concerns facing policy makers and those having interests in the sector. The performance of agriculture, which remains the backbone of the economy slackened dramatically over the post-independence years from an average of 4.7% in the first decade to only below 2% in the 90s. This decline culminated in a negative growth rate of -2.4% in 2000. As a sector that engages about 75% of the country's labour force, such a decline implies lower levels of employment, incomes and more importantly, food insecurity for a vast majority of rural Kenyans.

It is instructive to note that a sizeable proportion of the rural labour force (over 51%) is engaged in small-scale agriculture and that women are the majority in the sector. A decline in agriculture has thus far reaching implications in terms of employment and income inequality as well as food security for the country (UNDP, 2002). Lessons from China show that detailed and sustained focus on small-scale farmers by unleashing their potential and meeting their needs can lead to growth and poverty reduction, even when the basic agricultural conditions are unfavourable.

2.2 History of irrigation

Throughout history, irrigation has played an important role in the development of civilizations. Archaeological findings show irrigation was used by civilizations along the Nile, Euphrates, Tigris, Indus, and Yellow rivers (Bucks et al., 1986), however, early irrigation methods were mainly surface or gravity irrigation. Drip or trickle irrigation is a relatively recent method. Drip irrigation was developed from sub-irrigation techniques used in Germany beginning in 1860 where underground clay tiles were used to raise the water table to supply water to plants.

Experiments at Colorado State University in 1913 first applied trickle irrigation to a plant's root zone without raising the water table (Bucks et al., 1986). Further experimentation in Germany developed the use of porous subsurface piping to supply

water to plants. A lack of suitable and economical piping prevented the development of drip irrigation, but with the development of plastics in the 1940s, plastic drip systems began to be used for irrigation in greenhouses. Simcha Blass, an Israeli water engineer, patented the first water emitter for use in surface drip irrigation around 1963. The use of surface drip irrigation spread from Israel to Australia, North America, and South Africa by the late 1960s. By the Second International Drip Irrigation Congress in 1974, drip irrigation had spread worldwide with attendance from 26 countries. With the development of new plastics and refined components, today, drip irrigation has become a reliable and economical irrigation method.

Irrigation in Kenya has a long history spanning over 400 years. Historical records show that irrigation in Kenya has existed for many years along the river valleys around Kipini, Malindi, Shimoni and Vanga where slaves were used to construct the rice schemes in the early nineteenth century. Asian workers building the Mombasa-Nairobi Railway line also started some irrigation activities around Makindu and Kibwezi (Ngigi, 1999).

In 1946, the African Land Development Unit (ALDEV) for the first time focused on irrigation as part of a broad agricultural rehabilitation programme. The unit in pursuing its objectives initiated a number of irrigation schemes including *Mwea*, *Hola*, *Perkerra*, *Ishiara* and *Yatta*. Cheap labour supplied by Mau-Mau was used to establish these schemes. Most of the refugees were eventually settled in the schemes (FAO, 1986).

The national irrigation board was established in 1966 through an act of parliament (Cap 347) to take over the activities of ALDEV. The board took over the running of *Mwea*, *Hola*, and *Perkerra*. Later the board developed *Ahero*, *West Kano*, *Bunyala* and *Bura* schemes. The first three schemes were developed as pilot in the 1960s and early 1970s and remain so even today.

2.3 Irrigation and poverty reduction

Despite major breakthroughs in agricultural technologies such as drip irrigation, agricultural households in many parts of the world, Africa still struggle to produce enough to support themselves. Significant portions of the population in Sub-Saharan Africa are food insecure as measured by a variety of nutritional and caloric indicators (FAO, 2008). With approximately 60 percent of the labor force employed in agriculture

in Sub-Saharan Africa, the level and reliability of agricultural productivity is a critical element in food security. As a result of low prices of staple crops coupled with poor yields and erratic rainfall, small-scale agriculture production is both risky and low-return (Burney et al., 2010).

The problems of poor yields and erratic rainfall are expected to worsen in the future as a result of climate change and related environmental degradation. Small-scale irrigation is frequently cited as an innovation that can bolster rural livelihoods through climate adaptation, food security and poverty reduction (World Development Report, 2008).

Small-scale irrigation has been identified as a vital part in reaching international goals on reducing hunger and poverty such as the United Nations Millennium Development Goals. Polka and Yoder (2006) point out three characteristics of small-scale drip irrigation that enables it to impact the poor and set it apart from other irrigation technology. First, the affordability of small-scale irrigation technology makes it accessible to poor farmers. The cost of a treadle pump for water extraction is approximately one-twentieth the price of a small diesel powered pump. Low-head gravity fed drip systems are much less expensive than conventional high pressure systems. Second, the divisibility of small-scale irrigation increases the ability of small-scale farmers to adopt the technology.

Similar to the divisibility of improved seed varieties that enabled the Green Revolution to have such a great impact, advancements have made drip irrigation kits a less lumpy investment. Many investments in new technology require large expenditures, such as buying a tractor, because they cannot be divided up into smaller pieces; however, there are low cost drip systems available for as little as US \$2.50 for garden sized plots (Polka, 2005). The third important characteristic of small-scale irrigation technology is its expandability. Small low-cost systems need to be available for entry level needs, but as farmer's income increases, a portion of the additional revenues can be reinvested in additional equipment, expanding irrigation capacity.

These three characteristics make small-scale irrigation an important tool for increasing the productive capacity of small-scale poor farmers. Increasing farm output has been shown to have significant impacts on poverty reduction. The poverty reduction elasticity of farm output has been shown to be around -0.35 Hussain (2007), that is, a one percent

increase in farm output leads to a 0.35 percent reduction in poverty. Both direct and indirect benefits of irrigation contribute to the elasticity of poverty reduction for irrigation. In the long run, indirect benefits can be a major contributor to poverty reduction because the indirect benefits of employment and price effects are realized by the poorest and generally landless class.

Further, irrigation technology leads to poverty reduction through substantial increase in farm income due to an increased area of cultivation, better crop yields, enhanced output quality, early crop maturity and hence higher unit prices and reduced cultivation costs.

2.4 Agricultural technology adoption

According to Rogers (2003) an innovation is "an idea, practise, or object that is perceived as new by an individual or other unit of adoption, if an individual considers an idea new then it is an innovation". According to Sunding and Zilberman (2001:5), *Adoption* of a technology may be measured by both the timing and extent of new technology utilization by individuals, *Diffusion*, in turn, is defined as "the process in which an innovation is communicated through certain channels over time among the members of a social system" Rogers (ibid).

The timing of adoption and diffusion can be split into three levels, i.e. the decision process of the farmer whether to adopt or not (or to abandon a technology once adopted), the innovativeness of the farmer in terms of when to adopt in the diffusion process, and the rate at which a technology is adopted in the system (ibid). The extent of adoption can be measured by intensity of cultivation e.g. in terms of number of farmers, total area, area within farms or harvest (CIMMYT, 1993).

From sociological viewpoint an innovation is an idea, practise or object that an individual perceives as new since the focus is on the perception of the idea, the innovation need only be "new" to the potential adopter this suggests that adoption is the mental process from first hearing about an innovation to deciding to make full use of the idea (Shoemaker et al., 1972). However, Feder et al. (1985) argued that sociological definitions of adoption are usually inadequate for rigorous theoretical and empirical analysis due to their imprecision and failure to distinguish on farm- level adoption from aggregate adoption.

According to Marra et al. (2003:55), two main strands of technology adoption research have emerged; some sociologists have traditionally focused on the characteristics of the

adopters, their perceptions of the innovation, adoption rates and communication channels in the decision process. Seminal study of the diffusion of hybrid corn in Iowa was one of the first economic studies in this area which shifted the emphasis towards economic variables as the most important determinant of technology adoption (Griliches, 1957:17).

Farmers adopt innovations for various reasons; an innovation is likely to be adopted because of enhancing social status, convenience and efficiency. According to Sunding and Zilberman (2001:6), S-shaped diffusion curves have become widely used to explain adoption dynamics over time. According to this school of thought innovations are first adopted by the very innovative people in the society and few early adopters. Then adoption rates accelerate as the early majority adopts the technology before it gradually slows down again as fewer remaining individuals adopt the innovation *ölaggardsö*. In this context, diffusion studies have focused on the differences between early and late adopters, the perceived attributes of an innovation that affects its rate of adoption and why critical mass of early adopters is needed for an innovation to become widely spread (ibid).

Adoption studies may fall into two categories; the rate of adoption and the intensity of adoption (Rogers, 1995). It is important to explore these two concepts since they frequently have different policy implications. The rate of adoption refers to relative speed in which farmers adopt an innovation and one of its key pillars is time. The rate of adoption is usually measured by the length of time required for certain members of the social system to adopt an innovation. Intensity of adoption on the other hand refers to level of use of given technology any given time (Feder et al., ibid). The intensity of adoption can be measured at individual farm level or region within a particular time.

The adoption process according to Rogers (ibid) involves five stages; Firstly, farmers must learn about the innovation (*Knowledge*); Secondly, they must be persuaded of the value of the innovation (*persuasion*); then, they must decide to adopt it or not (*Decision*); the innovation must then be implemented (*Implimentation*); and finally the decision must be reaffirmed or rejected (*Confirmation*). Other authors such as Spence (1994) have indicated that the stages involved in the adoption process are; Awareness, interest, evaluation, trial and adoption, the terms are different but the steps are similar, with minor differences.

Adoption process is a dynamic one, not only in terms of the diffusion of new technologies over time and space but also from the perspective of the individual farmer. As a result, the willingness and ability to adopt new technologies, the relative weight of the influencing factors and the associated needs for support may change over time. For instance, the willingness to adopt may change with age and experience (ibid).

Older farmers may be less willing to invest in technologies that only pay off in the longer term (Feder et al.,1993), but may also have more resources to invest in new technologies. Younger farmers on the other hand may be more educated or be more open to trying out new technologies. Moreover, farmers often modify their perceptions of the riskiness of new technologies over time as they acquire more information (O'Mara, 1980; Marra et al., 2003).

New technologies are more likely to emerge in response to scarcity and economic constraints. Food shortages or high prices of agricultural commodities will likely lead to the introduction of high yielding varieties, finally changing consumer preferences also has a great influence on technological development and diffusion. Farmers' rationale for adopting these technologies may be different from the policy objectives of the state governments, Farmers may give more weight to the other attributes of micro irrigation technologies such as improvements in yield, reduction in labour requirement, improvement in output quality, etc. in their adoption decisions.

According to chambers et al.(1989:56), in the 1950s and 1960s non adoption was often attributed to ignorance and extension education was recommended. In the early 1970s and earlier 1980s, non adoption was more often attributed to farm- level constraints, in the 1980s, however a new interpretation more challenging to the agricultural professions and to science has gathered support. It is that the problem is neither the farmer nor the farm but the technology and that the faults of the technology can be traced to the priorities and processes which generate it.

In my view, majority of the technologies intended for small scale farmer adoption are designed to respond to available donor funds, funding research opportunities and donor development goals as opposed to intended beneficiary's needs and priorities. The donor coverage area or operational area also plays a significant role in determining where

innovation originates and the general assumption that the same can be replicated elsewhere.

Further, most of these innovations have also not taken cognisance of the existing indigenous knowledge and innovations which can be scaled up. Thrupp(1987:32), points out that, "Technological development can be seen not only in the terms of their material impact on the disadvantaged people, but also in relation to their psychological effect. If imported technology seems all people, people may feel that their own efforts to improve land and grow better crops are futile."

2.5 Barriers to adoption of agricultural technology

According to (Feder et al, 1985:98; William, 2010: 11), the potential barriers to the adoption of a technology such as irrigation are; Inadequate information, education and training. Further, He Cao et al. (2007:74), underscores lack of access to credit especially when a significant expenditure is required to purchase equipment, inadequate or unreliable supply of equipment, insufficient transportation or infrastructure, Uncertainty and risk associated with information about the technology as other major barriers to adoption of a new technology.

Gareth Et.al (ibid) in a related study findings reinforced that micro parameters are crucially important to understanding agricultural technology adoption and can best be statistically assessed using micro- level data. The same study also supports the findings that heterogeneity of asset quality is critical in the general study of technology adoption. Hochman et al. (1978: 28) in their theoretical research identified three broad classes of factors affecting irrigation technology choices; economic variables, environmental characteristics and institutional variables. One of the major contributions of the past studies of agricultural technology adoption to the general adoption literature is that they emphasize the role of heterogeneity of asset quality in the adoption process.

Heterogeneity is a crucial element of the threshold model of diffusion (Davies et al. ibid), but many of the early threshold models focus exclusively on variations in wealth or related factors such as farm size. The agricultural technology problem highlights the importance of differences in physical or geographical conditions in explaining adoption

behaviour and points out that geographic information must be combined with economic data to predict adoption patterns.

Kean et al. (1987:34), in a study in Zambia found that Social and cultural interactions between members of households and other specialised groups in society also help in understanding local innovation. Complex social and cultural relationships and norms affect the use and ownership of resources, how farming operations are undertaken, how new ideas and technologies are perceived within the family; male-female interactions also influence innovation. At household level gender power relations effect decisions on adoption or failure to adopt, some technologies are easily promoted through women depending on the cost implications or even economic significance.

Chambers (1997:67), in explaining variance in technology adoption in time and space critically analyses Training and visit (T&V), *warabandi* and the rigid ranch models as some extension methodologies that share common features; all being top-down, centre outwards, control oriented and intended to standardise and regulate behaviour. In conclusion he says that in practise none could fit or serve local complex, diverse, dynamic and unpredictable conditions. They concluded that farmers do not think of adoption or non-adoption as scientists do, but select elements from the technological complexes to suit their constantly changing circumstances.

2.6 Theoretical framework

There are a number of theories that explain adoption of technologies, the "top-down" and "bottom-up" models of adoption/diffusion provide a directional perspective to the process. Another theory dichotomy relates to the scale of innovation efforts by distinguishing between macro-level theories and micro-level theories.

Citing Wahid (2007) in Taylor & Todd (1995:64), the problem of innovation diffusion can be approached from several levels. Some researchers have approached it from macro-view or at country level and still other researchers have approached this issue by exploring the factors influencing adoption and usage by individuals. Macro-level theories focus on the institution and systemic change initiatives. Innovation typically involves broad aspects of curriculum and instruction might encompass a wide range of technologies and

practices. Micro-level theories, on the other hand, focus on the individual adopters and a specific innovation or product rather than on large-scale change.

The following are some of the theories that have been used in explaining technology adoption studies;

2.6.1 Theory of Reasoned Action (TRA)

Theory of Reasoned Action, developed by Fishbein and Ajzen (1975), assumes that influencing behavior is done through influencing the intention to perform that behavior. They believed that the two factors played a part in determining whether or not a person would perform a given behavior: 1) personal attitudinal judgments, this being one's attitude toward the behavior, and 2) social-normative considerations, meaning what one believes others think about performing the action.

According to O'Keefe et al. (2002), in studying persuasion, TRA theory is often represented by the formula:

$$BI = A_B(W_1) + SN(W_2)$$

In this formula, BI represents behavioral intention, A_B stands for attitude towards the behavior, and SN represents one's subjective norm. The W 's represent the weights for each factor.

When A_B is broken down, we can see that the evaluation of each belief (ei) and the strength of the belief held (bi) determine the attitude toward the behavior.

Proponents argue that the theory has been proven to work well in predicting topics like voting, consumer purchases, exercise and more. It is also further noted that often times A_B has a stronger influence than SN. Opponents on the other hand argue that it has some limitations including a significant risk of confounding between attitudes and norms since attitudes can often be reframed as norms and vice versa. A second limitation is the assumption that when someone forms an intention to act, they will be free to act without limitation. In practice, constraints such as limited ability, time, environmental or organisational limits, and unconscious habits will limit the freedom to act.

2.6.2 Diffusion of Innovations Theory

Pioneered by Ryan and Gross (1943) of Iowa State University, this theory traces the process by which a new idea or practice is communicated through certain channels over time among members of a social system. The model describes the factors that influence people's thoughts and actions and the process of adopting a new technology or idea.

Rogers (1995), defines Diffusion of innovations (DOI) as the process by which an innovation is communicated through certain channels over time among members of the social system. DOI is a theory of how, why, and at what rate new ideas and technology spread through cultures, operating at the individual and firm level. DOI theory sees innovations as being communicated through certain channels over time and within a particular social system (Rogers, 1995).

Individuals are seen as possessing different degrees of willingness to adopt innovations, and thus it is generally observed that the portion of the population adopting an innovation is approximately normally distributed over time (Rogers, 1995). Breaking this normal distribution into segments leads to the segregation of individuals into the following five categories of individual innovativeness (from earliest to latest adopters): innovators, early adopters, early majority, late majority, laggards (Rogers, 1995). Critics of this model say that it is an overly simplified representation of a complex reality. Adopters often fall within different categories for different innovations: a current laggard can be an early adopter the next time around.

2.6.3 Constructivist theory

Formalisation of the theory of constructivism is generally attributed to Jean Piaget, who articulated mechanisms by which knowledge is internalised by the learner (Piaget, 1950). Today, constructivist theories are influential throughout much of the so-called informal/adult learning sector. Piaget suggests that through a process of accommodation and assimilation, individuals construct new knowledge out of their experiences. Assimilation occurs when new experiences are aligned and integrated in individuals' already existing framework and perception of the world. Most approaches that have grown from constructivism suggest that learning is accomplished best using hands-on techniques, where learners experiment rather than being told what will happen. They are

left to make their own inferences, discoveries, conclusions and where new knowledge is integrated with old experiences.

Proponents of this theory argue that the way a technology is used cannot be understood without understanding how that technology is embedded in its social context. Social constructivist theories consider the importance of language, culture, context, politics, power, symbolism, social contact and a host of other aspects as well as the role each plays in knowledge creation. According to constructivist thinking, reality is based on persons' individual perceptions and everything a person understands to be a reality is based on social construction.

The basic tenet of constructivism is that students learn by doing rather than observing. Students bring prior knowledge into a learning situation in which they must critique and re-evaluate their understanding of it. This process of interpretation, articulation, and re-evaluation is repeated until they can demonstrate their comprehension of the subject.

2.7 Conceptual framework

Various studies have proposed other technology adoption theories but there seems to be no congruence on one. Rogers himself seems to move away from his linear technology transfer with the convergent model in the latest version of his theory on the diffusion of innovations (Rogers, 1995). The theory of innovations and related transfer-of-technology model has tended to work better in developed rather than developing nations, but even within developed nations, the perceived process has evolved into the more interactive model.

To understand the reasons for failure to adopt or slow process of adoption of irrigation in the study area, this study is based on a more interactive theory model, which has a much more focus on the endogenous nature of innovations and farmer participation in innovation diffusion process.

It is hankered on a more constructivist reasoning where farmers are seen not as passive recipients of innovations but active participants who can rework, repackage and contextualise ideas. To answer this question, the study specifically explores farmer's perception, socio-economic and political factors in irrigation technology as discussed below;

❖ **Social factors**

Social structure in developing countries has been found to be a powerful determinant of individual's access to technology innovation; often, structural rigidities must be overcome before communication of innovations can have effect (Bordenave, 1976). People of higher social status are more often than not, the opinion leaders who are the targets for extension workers who assume that once opinion leaders adopt a technology it will trickle down to the rest of the society. These opinion leaders are mostly found near roads, small shopping centres hence easily accessible to extension agents who are unable to reach the most remote areas with their cars. Because of their social status they are also the most vocal and active in meetings hence influencing most of the decisions. It is expected that membership in the cooperative societies or common interest groups with high frequency of extension visit will increase adoption.

❖ **Economic factors**

Development agencies tend to provide assistance to their innovative, highly educated, wealthy and information seeking clients who are easy to convince. This class of people is able to take risks by being innovative and can meet the initial cost of any technology particularly that require capital investment. High household incomes increase access to credit, which is a major constraint to adoption of improved technologies in Kenya. Economic factors also determine the acreage size, labour availability and other assets which play a role in influencing the adoption decisions that farmers make.

❖ **Administrative factors.**

Irrigation technology adoption requires reasonable capital investment and which is beyond means of most small scale farmers. Where the government has intervened in strategic promotion of the technology through grants, subsidies and extension service providers there is significant adoption rates as opposed to other areas. Presence of government extension officers in some areas influences information availability to the farmers, credit access, and support to institutions like WRMA and WRUA's play a great role in facilitating adoption.

In conclusion, households are intermediate institutions between policies, programs and the targeted individuals. Households do not function in a sterile economic environment. Social norms and customs influence their behaviour and therefore the outcomes.

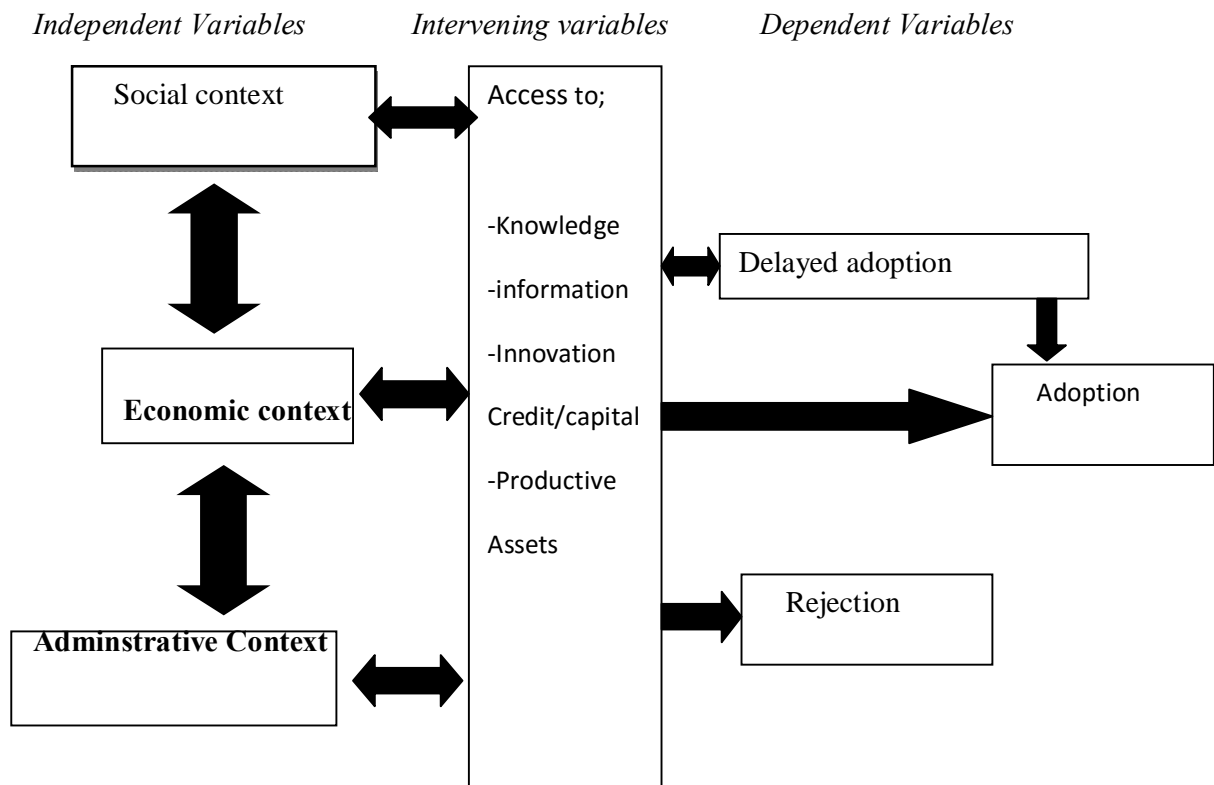
Household decision-making affects many choices with important consequences including the distribution of income, allocation of resources, the allocation of time, purchase of goods, and fertility decisions.

In the frame work diagram next page, household's decision is influenced by combination of factors; information available within an individual's context/social system; this information is availed through any of the following channels; observation, previous experience or ideas penetrating the decision maker through his/her associates or peers, Radio, new training\contact with extension workers and meeting etc, referred to here as the intervening variables.

These interactions are within specific administrative and socio-economic context. Sources of information will be greatly influenced by the social status of the individual; for example, whom does he/she associate with? Which church does he/she attend? Who are his friends? What is his or her education level?, Gender and membership in groups etc. The higher social status the more likely one will be first to get information and vice versa.

The decision taken either positive or negative and the period is greatly influenced by economic factors referred to here as the "economic context", when household members receive information, the decision they make will be further influenced by financial capability, acceptability of the action within their social system, age, gender, access, ownership and control of factors of production if required and innovativeness referred here as "social context". Farmers could delay adoption decisions to get more information or out rightly reject it. An adopted technology may be discontinued based on farmer's new lessons or refined to fit into their environment and process goes on.

Figure 1: Conceptual Framework



2.8 Operationalisation of study variables

Operationalization of the study variables was according to the objectives of the study; to examine people perceptions and attitude to adoption of irrigation technology and to analyse the administrative and socio-economic factors that influence irrigation technology adoption among small scale farmers in Tharaka Nithi County.

Operationalization of the study variables was established between the following variables;

Table 2.1: Operationalisation of study variable.

Objective	Variable		Indicator
	Independent	Dependent	
To examine people's perceptions and attitude to irrigation technology adoption	People perceptions and attitudes	Irrigation technology adoption	Positive attitude to new ideas Negative attitudes to new ideas Interactive Innovativeness Adoption history
To analyse the economic factors that influence irrigation technology adoption	Household Economic status	Irrigation technology adoption	Income levels Access to Banks Assets Distance to roads Source of income Land ownership
To examine the social factors that influence irrigation technology adoption.	Household social status	Irrigation technology adoption	Education levels Membership to farmer groups\association Information access Gender Age Trainings attended
To examine the administrative factors that influence irrigation technology adoption.	Administrative factors	Irrigation technology adoption	Available Subsidies Grants Extension officers Distance to GOK/county offices

CHAPTER THREE: METHODOLOGY

3.1 Site selection

Tharaka nithi county has four subcounties; Meru south, Maara, Tharaka north and north. Meru south and Maara subcounties fall under different ecological zone greatly influenced by proximity to Mt. Kenya, they receive high rainfall, low temperatures and generally highly productive. This study was carried out in Tharaka North and South subcounties which are Arid and Semi Arid generally prone to drought and food insecure. Promotion of irrigation technology to supplement rainfed agriculture has been undertaken by both the government and Non-governmental organisations.

The site was selected because there has been tremendous efforts to promote irrigation to increase food security. The researcher has wide experience working in the area and has developed close relationship with the interviewees which made collection of needed information easy. The study area was also convenient, close and easy to access hence allowing more time to collect data at a minimal cost.

The target group comprised of both adopters and non-adopters.

3.2 Sampling

A multi-stage sampling procedure was used to select subcounties, groups and farm households.

In the first stage the two subcounties Tharaka north and south were purposively sampled, the subcounties occupy the arid and semi arid region generally prone to drought and food insecurity. Promotion of irrigation technology to supplement rainfed agriculture has been undertaken by both the government and Non-governmental organisations to mitigate the effects. In second stage based on available records at the department of irrigation, water and also Gender and social services five active groups were randomly selected.

Finally, simple random sampling was used to identify irrigation adopter sample for study. Against the background of a proper sampling procedure, Yamane (1967), formulae was used to derive a sample size of 94 against a population of 1603 as follows;

(a 95% confidence level and $p=0.05$)

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

where;

n - sample size

N ó the population size

e ó the level of precision

the calculated sample size;

$$n = \frac{1603}{1 + 1603(0.1)^2} = 94$$

Non adopter sample of 29 respondents was identified through snowball sampling as there was no existing records. Sudman (1976), suggests that a minimum of 100 elements is needed for each major group or subgroup in the sample and for each minor subgroup, a sample of 20 to 50 elements is necessary for comparative analysis of subgroups.

The size of the sample was selected on the basis that it allowed the researcher to complete the study given the time and resources available for the study. Both the farmers who had adopted irrigation technology and those who had not adopted were interviewed in order to gain an understanding of the different decisions made by the farmers. The actual size interviewed represented 85% of sampled size as 15% of sampled respondents were unavailable during the time of the interview visit. Farmers were interviewed using mix of local Kitharaka, Kiswahili and English languages .

The researcher also interviewed key informants comprising of; two officers, one each from the department of water and irrigation ,Water Resources Management Authority (WRMA), also two representatives from NGOs (Plan International and Meru diocese). The department of Water and Irrigation,WRMA and the two NGOs were selected because they have been involved in irrigation technology promotion in the county. They have also been working with these communities for long time and they know them too well.

3.3 Data collection methods

Several methods were used in data collection. This was necessary for triangulation purposes and also get different views and perspectives from as diverse groups as possible.

3.3.1 Survey

Primary data for this study was collected using researcher administered Structured questionnaires, 82 adopters representing 85% of the sample size were interviewed, further 29 non adopters identified through referrals from adopters were also interviewed as the control group. Questionnaires were designed in a way that they comprised of closed and open-ended questions that allowed for interviewee flexibility to get as much information.

3.3.2 Focus group discussions

Focus groups comprised between 15-20 members and were conducted in the public places mostly churches or under trees. Six focus groups discussions comprising of four for adopting groups and two for non adopters were conducted. All discussions commenced with the facilitator thanking all the participants for coming, explaining the purpose of the group and the objective of the FGD. Ground rules were also set and participants encouraged participating freely.

3.3.3 Key informants

In-depth interview with selected key informants enabled the researcher capture respondents' perceptions in their own words; the researcher was able to present the meaningfulness of the experience from the respondents' perspective. The four respondents interviewed comprised of people who have a specialised or superior knowledge about the study area and the topic (two government officers and selected two NGO representatives) by virtue of their work.

3.4 Data collection tools

❖ Questionnaire

A pre-planned set of questions comprising of open and closed questions (see appendix1) designed to yield relevant information was used in collection of relevant information. The questionnaire was administered to all respondents, this was done after fully explaining the purpose of the survey and seeking consent from the respondents.

❖ **Focus group discussion guide**

The focus groups were guided by specifically prepared discussion guide (appendix ii). Participants were actively encouraged to not only express their own opinions, but also respond to other members and questions posed by the researcher. This enabled the researcher to yield a lot of information in a relatively short time.

❖ **Interview guide**

Structured interview guide was used during the interviews for key informants. The guide was designed in such a way that it allowed interactive interviewing with informants due to specifically designed open ended questions.

3.5 Data analysis techniques

❖ **Qualitative data**

Qualitative data was analyzed using deductive approach, data was reviewed and coded, research questions were used to group the data, identify common themes and then similarities, differences established and meaning drawn. Quotations were used to illustrate the themes in the report.

❖ **Quantitative Data**

All data collected using questionnaires was cleaned and coded. The purpose for coding was to translate the respondents answers into numbers for subsequent statistical analysis. All the questionnaires was entered into system using SPSS.

Descriptive statistics focusing on frequencies, means and percentages were used to summarize the farmer's adoption/non adoption behaviour and to characterize adopters/non adopters of the technology. Induction and deductive reasoning was used to draw conclusions and recommendations.

Data was analysed using SPSS, examination of variables by cross tabulation was done. Emphasis was made to explain relationship between variables and also differences on one variable to the other. Pearson's coefficients correlations were then run to establish relationships between various variables and adoption.

CHAPTER FOUR: DATA ANALYSIS, INTERPRETATION AND DISCUSSION

This chapter presents analyses and discusses the research findings from the survey questionnaire and interviews (see **Appendices i and ii**) of this study as described in section 3.4 of the research methodology. The results are divided into three sections; Section one gives general demographic data of the respondents, in section two, factors that affect adoption and non adoption are discussed according to the respective categories; Perceptions and attitudes, socio-economic and administrative context. Finally, Pearsons correlation coefficient was computed to establish relationship between socio-economic variables and adoption, further comparison with similar studies was used to draw conclusion.

4.1 Demographic characteristics

The respondents comprised of 58% male and 42% female for adopting group and 55% male and 45% female for non-adopting group. There were more men interviewed than women for both groups, this was explained by the fact that most households are headed by men who were readily available during the survey visits and further confirmed during the focus group discussions. Furthermore, in a conservative cultural society like Tharaka, women are more preoccupied with farm work and other reproductive roles.

Marital status is important in this study as it helps to determine the decision making structure in households, 81% of the respondents were married, 15% single, 3% divorced and 1% separated as shown in figure 2 below. The predominant control of decision making by men makes them more likely to adopt technologies than women.

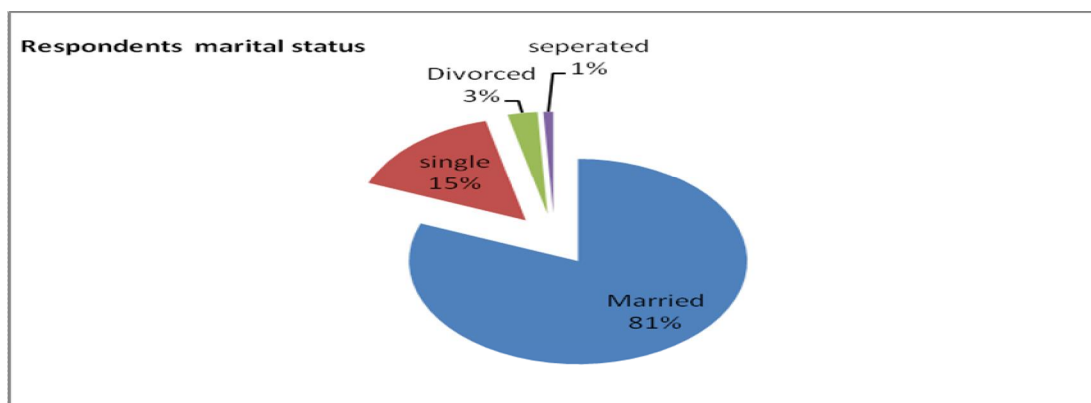


Figure 2: Marital status

The respondents' marital status characteristics in this study is not surprising considering the finding of Igben (1988) that the marital status of the farmers he surveyed ranged between 94 to 99.5% married. Married farmers are likely to be under pressure to produce more, not only for family consumption but also for sale.

The average age of the respondents was 42 years for adopters and 34 years for non adopters. This indicates that there fewer youth who have taken up farming among the adopting group compared to non adopters. There was no significant difference in landholding as the average landholding is less than 2 acres 58% for adopters and 55% for non adopter. Small percentage reported to own more than 5 acres 17% for adopters and 15% for non adopters, this implies that majority of the respondents are small scale farmers.

The respondents comprised 82 adopters and 29 non adopters giving a total of 111 respondents, 74% of the adopters were practising farming, 14.5% were practising both farming and other activities with 11.5% not engaged in business only as shown in Table 4.2 below. This implies that majority of the respondents relied on farming as main means of livelihood; only 44.5% of non adopters were engaged in other livelihood activities. This is expected as main source of livelihood in Kenya is agriculture, the mainstay of country's economy.

Table 4.2 Respondents economic activities

	Frequency	Percentage (%)
Respondents engaged in farming	82	74
Respondents engaged in both farming and business	16	14.5
Respondents engaged in business only	13	11.5
Total	111	100

Certain agricultural practices were very common among the farmers in the sample. Most of the adopters were members of farmers groups and kept small livestock, Farmers irrigate using either surface irrigation 9%, drip irrigation 3%, most farmers chose the sprinkler irrigation over the others 88.1%. From the group discussions, discussant's

reported that the choice of irrigation type was influenced by water pressure, extension officers, cost and donors interest.

4.2 Perceptions and attitudes

From the discussions the two groups had mixed perceptions on irrigation, 86% of adopters agreed irrigation was good compared to 24% of non adopters. From the focus group discussions, adopting group discussantø were unanimous in accepting that there is need for irrigation to supplement rainfed agriculture, they felt that it was the mandate of the government to ensure that they have irrigation. Where else reaction was mixed among non adopters with upto 86.3% of the surveyed non-adopters citing cost related obstacles to adoption. Majority of those who had not adopted also had a perception that those who had adopted were receiving or had received external support which was not necessarily true.

Adopting farmers had a positive attitude towards new farming technologies with majority, 98% being either being the first or among the first to start new innovations (within 1-2 years) only 2% had never used any new technology in the last three years. Whereas for non- adopters only 3% indicated to be among the first ones to adopt any new technology, 25% reported to wait for other farmers to adopt before making a decision and 72% reported to never adopt new innovations as shown in figure 3 below.

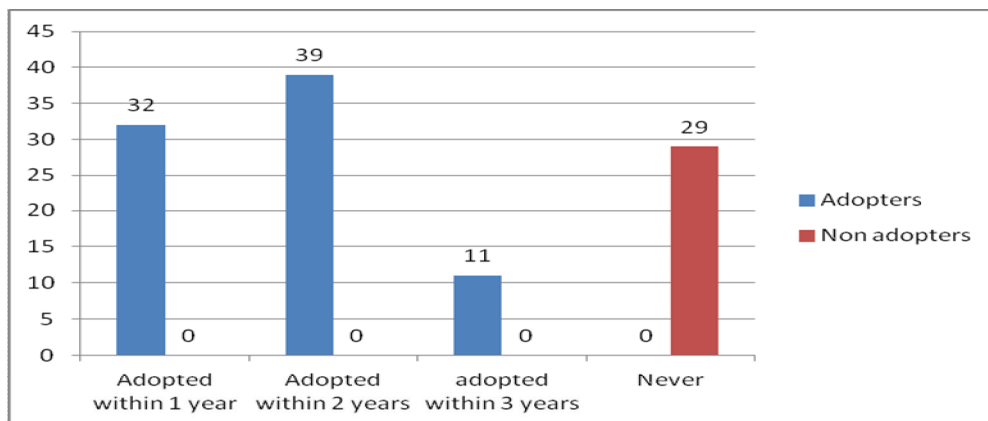


Figure 3: Adoption patterns

The findings indicated that adopting farmers were more proactive in embracing new ideas/technology adoption having practised a new innovation in the last three years. Hundred percent of farmers who had adopted irrigation agreed that it had the potential to improve the production whereas 85% of non adopters disagreed and 15% were not sure.

“Since I started using irrigation my yields have increased and my family has enough food even when rains are low”-a farmer practising irrigation farming in Kamatangu irrigation group

Various reasons were cited for non-adoption; 27% of non adopters cited that the canal was not enough, 54% cited water pressure as low whereas 19% said it was expensive. On the other hand adopters cited the following reasons for adoption;

Table 4. 3 Adoption reasons

Reasons for adoption	Frequency	Percentage (%)
Diversify risk	23	29
Eradicate poverty	17	21
Increase Incomes	25	30
Food shortage	12	14
Reduce water fetching distance	5	6
Total	82	100

The results in table 4.3 above indicates that majority of adopters were more interested in increasing agricultural productivity, food security and incomes. This is not surprising because the study area receives low rainfall and is prone to drought and famine. Irrigation technology therefore provides a viable coping strategy.

4.3 Social factors

4.3.1 Age.

Age was important in this study as it influences access to land and decision making process. Although respondents indicated exact age during the survey this was clustered for ease of analysis as shown in table 4.4. Results indicated that majority of the respondents 69% were between 30- 65 years, this category of farmers is economically active among the population. Those with less than 20 years representing 6% are still in college and rely on parents for support, where else majority of those between 20-30 years

(30%) have not yet settled down on farming as main means of livelihood due to preference for off-farm opportunities in employment and business for both groups.

Table 4.4. Age of respondents and adoption

Age (Y-variable)	Adoption (X-variable)	
	Freq	Percentage (%)
less than 20	3	6
between 20 -30	23	30
between 30- 65	69	62
above 65	5	2
Total	111	100

For verification, a scatterplot with Y axis representing adoption (dependent variable), whereas X axis represented age (independent variable). Respondents were asked to indicate the exact ages and clustered as in table 4.4 for ease of analysis. Discussants during the FGDs cited preference for white collar jobs to farming as a reason why majority of young people were not involved farming, this age bracket was found in main centers and towns. The groups also confirmed the low participation of the respondents above 65 years was due to the fact that since the respondents comprised of households in groups, majority of this age bracket lacks physical ability and energy requirements for participation in groups e.g carrying out trench excavation, laying of pipes and related farm labour demands.

The relationship between age and adoption was investigated using correlation analysis to get Pearson's correlation coefficients (r) value. Results in table 4.5 show that there was a weak, negative non-significant correlation between age and adoption, Pearson's r-value=-0.010, n=111, p-value=0.920. This implies there was no association between age does and farmer's decision to adopt irrigation in the county. This can be explained by the fact that the irrigation technology was available to everybody within the county who was able to meet the other conditions.

Table 4.5 Correlation between age and adoption

	Sig. (2-tailed)	Pearson's r-value	N
Age of the respondent	.920	-.010	111

These findings are not consistent with (Omobolante, 2007; Adesina et al.1995), who in similar study found age to positively influence the adoption of cassava and soya bean in Nigeria and sorghum in Burkina Faso.

This study also measured age in relation to duration of stay as shown in table 4.6 within the target area, this was necessary to establish whether the farmers' period of stay had an impact on irrigation technology adoption due to cosmopolitan nature of the area. Results indicated that 12% of the respondents had stayed in the area for less than 5 years, 20% for between 5-10 years where else 68% had stayed for over 10 years which is longer than the oldest irrigation scheme.

Table 4.6: Duration of stay and adoption

Duration of stay (X variable)	Adoption (Y variable)	Percentage
>5 years	10	12
5-10 years	16	20
10-15 years	15	18
15 -20 years	17	21
20-25 years	18	22
Above 25 years	6	7
Total	82	100

Adoption (dependent variable) was plotted along Y axis whereas number of years one had stayed in the area(independent variable) was along X axis on scatterplot to check for outliers as presented in table 4.6.

To establish relationship between this two variables coefficients correlations analysis was carried out. The results in table 4.7 indicate a weak, positive non-significant relationship, r-value=.109, p-value=0.27. n=111. Positive r value indicates that as numbers of residence years increased also the adoption propability increased. However, the results imply that the period that one has stayed in the study area was not significant to influence decicion to adopt p value>0.05.

Table 4.7 Adoption and duration of stay

	Sig.(2-tailed)	Pearsons r-value	N
Residence years	.109	.270	111

During the focus group discussions some discussants reported to be emigrants from Meru, Mwingi and central Kenya. The human influx is explained by increased population in upper zones and speculation by land investors because of the proposed Great northern by-pass and Grand falls dam.

4.3.2 Education

Formal education in this study was measured by the highest education level attained as shown in table 4.8 below;

Table 4.8 Education levels

Education level	Frequency	Percentage (%)
Primary	56	50.5
Secondary	22	19.8
Certificate	14	12.6
Diploma	10	9.0
Degree	5	4.5
No formal education	4	3.6
Total	111	100

Results show that majority 51% of the respondents had some form of primary school level education and only less than 25% had post-secondary level education. The low transition rate especially from primary to secondary level is explained by high poverty levels and other cultural practises within the sub counties. Studies such as feder and slade (1984) have sought to establish the effect of education on adoption, in most cases relate it to years of formal schooling. Its often believed that higher education gives farmers the ability to perceive, interpret and respond to new information more effectively than thier counterparts with lower education (feder, ibid pg 26).

The results in table 4.9 shows weak, negative, non significant relationship between level of education and adoption of irrigation, r-value= -.187 n= 111 and p-value=0.053.

increase in education led to decrease in adoption r value -.187. The correlation results indicate that education level was not significant in influencing adoption p-value>0.05. Further to verify the direction of relationship, adoption (dependent variable) represented by the Y- axis and education (independent variable) were plotted in a scatterplot.

Table 4.9 Education level and adoption

	Sig.(2-tailed)	Pearson's r-value	N
Education level	-.187	0.53	111

These results are explained by the fact that irrigation promotion targeted all farmers in the groups whereas; education level was not a requirement for membership to groups. From the group discussions participants said that those with higher levels of education preferred white collar jobs to farming and worked outside the community, only 10% of the respondents had diploma and degrees. This means that there is need to make farming not only a profitable enterprise but also attractive to the youth in the county.

These findings are inconsistent with previous studies such as those of (Voh 1979; Chitere & Dourer, 1985) who in their respective studies found that education was a significant factor in facilitating awareness and adoption of agricultural technologies. However, it is consistent with the finding of (Chikwendu et al.,1996) who established that education and information access had a non significant association with adoption of improved technologies for millet production.

4.3.3 Gender

Results in figure 4 show that there was no significant difference in the sex of the respondents among the two groups, male were 59% and 55% of adopters and non adopters respectively, where else female respondents were 41% and 45% of adopters and non adopters respectively.

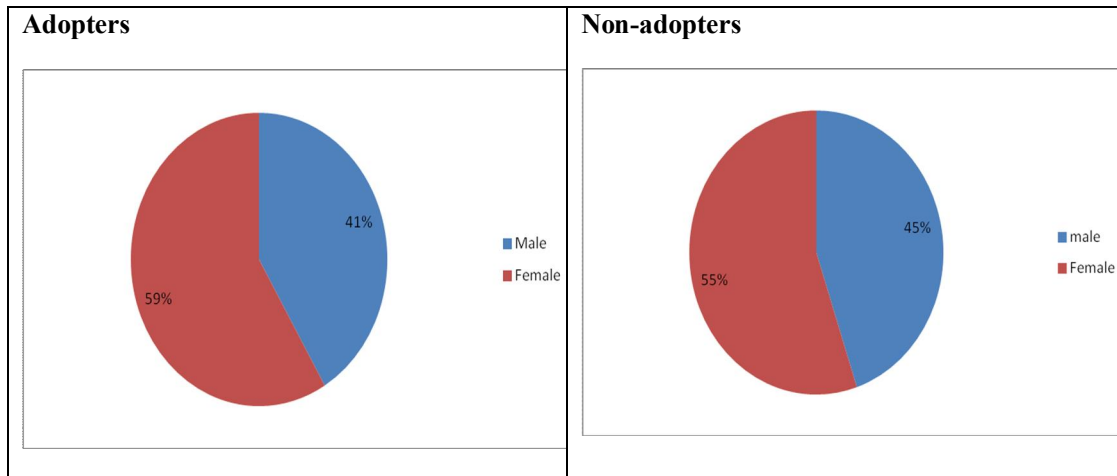


Figure 4: Respondents sex analysis

The similarity in adoption decision making in this study was explained by the fact that in most women-headed households, husbands were working outside the study area hence they had full access to family land, those female farmers are household heads and therefore the final decision makers on farming activities, the same applied to widowed households.

The results agrees with Ojo and Jibowo (2008), who reported that married people are seen as responsible, therefore, their views are likely to be respected within rural communities as they take decision on the use of agricultural inputs.

There exists various studies on gender issues in agricultural production and technology adoption. The results in table 4.10 below indicate negative, non significant correlation at r-value = $-.061$, $n=111$, $p\text{-value}=0.53$ level of significance between sex and irrigation technology adoption. This therefore means that sex does not influence adoption and both males and female have an equal chance to adopt. This was further verified in scatterplot where adoption (dependent variable) was represented by the Y axis whereas gender (independent variable) was represented by X axis.

Table 4.10 Gender and adoption

	Sig.(2-tailed)	Pearson's r-value	N
Gender	.530	-.061	111

These results are not different with a study by Doss & Morris (2001), on the factors influencing improved maize technology adoption in Ghana, they found that sex had no effect where both sexes have equal access to resources such as land, extension and education. Female farmers normally tend to be less curious in trying out new innovations unlike their male counterparts. They would therefore be expected to lag behind male farmers in adopting new agricultural technologies which was not the case in this study.

4.3.4 Membership to farmer groups\cooperatives

According to analysis of respondents in table 4.11, out of the 82 adopters, 88% reported to be members of farmer groups only 12% reported to have adopted irrigation and not members of any group, on the other hand, 93% of non adopters did not belong to any group .

Table 4.11 Membership to groups and adoption

Characteristic	Adopters	
	Freq	%
Membership to groups	72	88
Non group members	10	12
Total	82	100

Membership to organisations such as cooperatives, Common interest groups and other associations has been found to be very important in changing farmers attitudes towards new agricultural practises and thereby enhancing thier adoption of such practises (Ogunluna, ibid), such organisations serve as forums for gaining access to information, credit and other productive inputs.

The correlation coefficient results in table 4.12 indicate a significant relationship at r-value= .205*, n=111, p-value=0.033 between membership to farmers groups, cooperatives and farmers adoption of irrigation. The results indicate that the increase in membership to groups led to increase in adoption. Therefore farmers who belong to groups are more likely to adopt irrigation as opposed to non group members.

Adoption (dependent variable) represents the Y- variable whereas membership to groups (independent variable) represents X variable.

Table 4.12 Relationship of membership to groups and adoption

	Sig.(2-tailed)	Pearson's r-value	N
Membership to farmers groups	.033	.205*	111

The importance of these results emphasises the need to encourage farmers to join groups and initiate different activities together. According to Mr.waiharo sub county agricultural officer, *“When farmers are together they are able to pool resources together, share labour and also make it easy for extension workers to reach them with new information”*.

These results are not unexpected as social participation of the farmers has positive significant relationship with adoption. The higher the number of farmer's organizations/groups a farmer belonged to, the more improved agricultural technologies the farmer would adopt. This could be attributed to the fact that constant interaction and contact with fellow members help farmers to become aware of new technologies. Social group participation enhances access to information on improved technologies, material inputs of the technologies such as fertilizers, chemicals, credit for purchase of inputs and payment of hired labour (Odoemenem et al., 2010). They also found that membership to a social group positively influences technology adoption, as well as knowledge about the technology being crucial to the potential adopters in their adoption decision.

4.3.5 Access to extension services

Average walking distance to the main market is significantly lower for adopters and they seem to have also more access to extension service, media service and official positions. There is also significant difference in terms of household membership in different groups . The correlation coefficient results of the four variables in table 4.13 indicate a significant relationship at p-value< 0.05 between all the factors that influence access to information viz; distance to the market, distance to tarmac, membership to groups and contact with extension agents. In many studies access to extension is often used as access to information.

Adoption (dependent variable) represents the Y- variable whereas access to agricultural information, sources of agricultural information and distance to market centers (independent variables) represents X variable.

Table 4.13 Agricultural information access and adoption

	Sig.(2-tailed)	Pearson's r-value	N
Membership to farmer group	0.033	.205*	111
Sources of agricultural information	.452	-.079	111
Distance to market center	.869	-0.17	111
Distance to tarmac road	.336	.096	111

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

Extension contact as source of information had a significant and positive relationship with technology adoption. It implies that the higher the frequency of contact with extension service providers the higher the intensity of adoption. These results are similar to the findings of Obeta and Nwagbo (1991), which revealed that frequent contact with extension agent is likely to minimize doubts among farmers and increase innovation take up.

Extension workers provide technical backstopping and users information which makes it easier for the contacted farmers to adopt a technology or increase intensity of its use. The influence of extension on the adoption of new technologies is of major importance, access to extension is also linked to infrastructure development as farmers near roads, market centers and town are more likely to receive more extension support. In their study on factors that determined cassava adoption in a range of African countries Udo and Kormawa (2007), found that contact with extension agents and through their access to adequate information was one of the predictor of the decision by farmers to allocate land for cultivation of cassava.

Similar results were also reported by Adessina and Zinnah (1993), in a study of adoption of modern rice varieties, who found that farmers were more likely to adopt a technology if they had been provided with the information by an extension agent.

4.3.6 Sources of agricultural information

Farmers rely on several ways to get agricultural information, Agricultural extension workers constituted the most important source of information to farmers 36%. Findings of the study revealed that 18.9 % of the farmers received their information on irrigation technology from co-farmers. Other sources of information included; NGO/Plan International 18%, seminars 5.4 % only small percentage of 1.8% and 2.7% reported to rely on internet and radio respectively.

Table 4.14: Sources of agricultural information

Source of innovation	Frequency	Percentage (%)
Apprenticeship	21	18.9
None	18	17.2
Seminars	6	5.4
Internet	2	1.8
Radio	3	2.7
MOA	40	36.0
NGOs	20	18.0
Totals	111	100%

Few households own radios or television sets hence limited access to radio or few farmers listening to agricultural programmes broadcast in the study area. This is not surprising considering the poverty levels in the two sub counties. Internet usage is also very low which can be explained by the target area being remote and inaccessible. This finding is consistent with that of Odoemenem & Obinne (2010), who in their also established that extension workers and fellow farmers/neighbours were the most effective source of information on new technology in six LGAs of Benue state.

However, the results in figure 5 indicate only a small percentage of 22% who reported to have visited the government offices to seek any agricultural advice or support. To gain an understanding of why very few respondents were visiting government offices, Farmers were asked to list reasons for not visiting GOK offices.

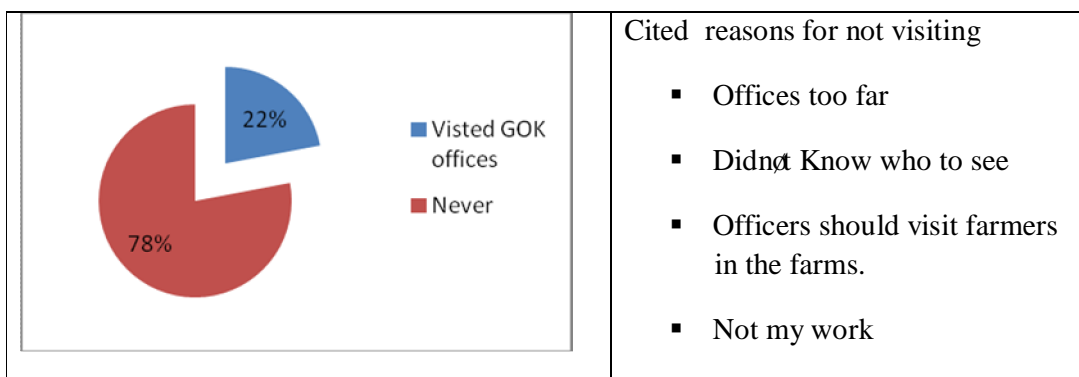


Figure 5: Reasons for failure to source information

Main reasons given included; distance to the GOK offices and lack of information as the main reasons. From the focus group discussions, participants were synonymous that they were not aware of their role in seeking agricultural information from government offices. One discussant said *“long time officers used to come to our farms regularly but they have since stopped, it’s not my work to visit them”*. This is not surprising in country like Kenya where extension service has for a long time been driven by government with farmers being more of recipients hence importance of administrative support.

The tremendous role of agricultural extension agents as information sources in the area was further emphasised by discussants during the FGDs as it influenced both literate and illiterate farmers to accept the technology. Farmers also acknowledged that, contact farmers and/or contact groups receive the technologies information first-hand information from extension agents before other farmers copy.

4.4 Economic Factors

4.4.1 Source of income

Source of income in this study was important as it influences daily decisions on expenditure and investment. Analysis of data in table 4.15 indicated that 85% of the adopters relied on farming as main source of income, 8% had salaried income and 7% cited business as thier source of income, in contrast of 65% of non adopters cited salary as main source of income, 25% business and only 10 % cited farming.

Table 4.15 Sources of income

Sources of income	Adopters		Non adopters	
	Freq	%	Freq	%
Farming	69	85	3	10
Salary	7	8	19	65
Business	6	7	7	25
Totals	82	100	29	100

Analaysis on average monthly income levels in table 4.16 below for both adopters and non adopters shows a significant difference. Adopters had higher incomes averaging Kshs 22,033 compared to non adopters average income of Kshs 16,293.

Table 4.16 Income levels

Income levels (Kshs)	Adopters	Non adopters
	Frequency	Frequency
> 5000	4	5
5000 - 10000	15	8
10000 -15000	12	2
15000 -20000	13	5
20000 -25000	10	1
25000 -30000	8	2
30000 - 35000	4	3
35000 - 40000	6	3
40000 - 45000	8	—
45000 -50000	2	—
> 50000	—	—
Total	82	29
Average income	22,033	16,293

The difference is not surprising because adopting farmers had all year round production with regular income from sales produce. Farmers with high income levels are more likely to be better educated and invest more in information acquisition and will accumulate knowledge that leads to adoption, The significant correlation between income and agricultural innovation as revealed by the present study is consistent with the findings of previous investigations such as Osuji (1983) and Atala (1984).

Income is crucial in agricultural information use because the higher the income of the farmer, the more likely he would seek and obtain information for use. With improved income, the farmer will be better disposed to spend more on recommended farm practices that would further increase his farm earnings. On the other hand, rainfed agriculture is highly risky venture and financial institutions shy away from loaning to small scale farmers. This is illustrated in table 4.17 below that indicates that only 2% of adopters accessed credit compared to 66% of non adopters who were employed. During the FGDs, discussants said that the loans acquired was not necessary used in farming.

Table 4.17 Access to credit

Access to credit	Adopters		Non adopters	
	Freq	%	Freq	%
Farmer who had accessed credit	1	2	19	66
Farmers who have not accessed credit	81	98	10	34
Total	82	100	29	100

To understand if irrigation technology adoption improved incomes respondents, were asked their opinion, 41.7% attributed adoption benefits as increasing incomes. Farmers cited diversified farming as contributing to increased year round production which gave them income especially from the horticultural activities, as indicated in figure 6 next page;

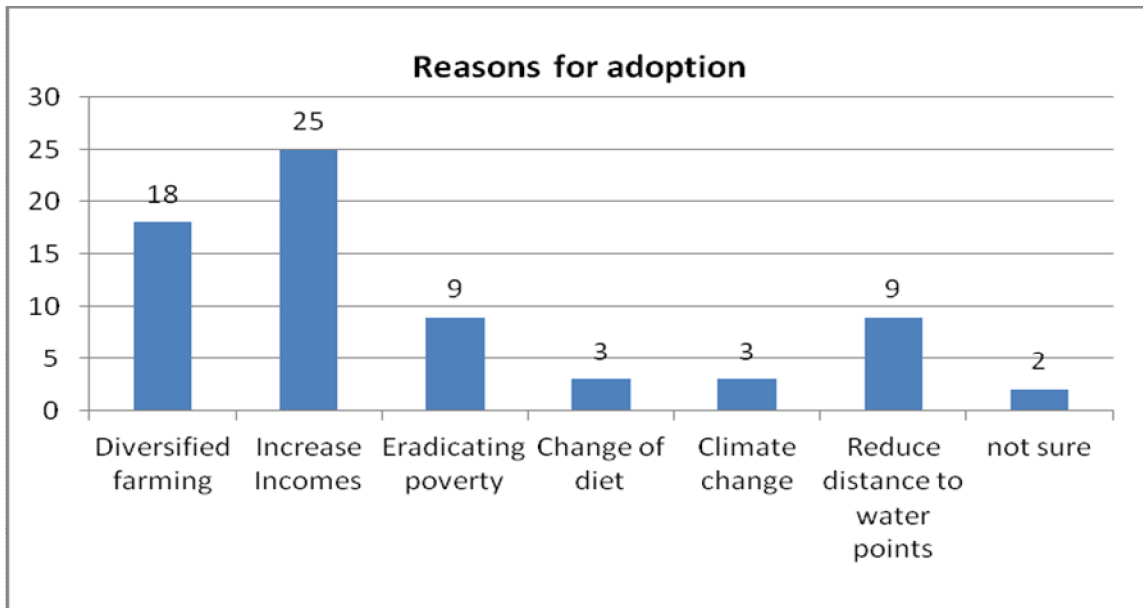


Figure 6: Adoption benefits

To gain further understanding if farmers utilised irrigation for growing marketable crops that could raise income the researcher sought to draw a relationship between marketed crops and most grown crops. The results in table 4.18 below shows that there was a significant relationship between types of crops grown and most marketed crops, $p\text{-value} < 0.05$. This implies that most of the marketed crops were also the most popularly grown crops which the farmers could sell and this led to increased incomes. Most marketed crops (dependent variable) represented by the Y- axis whereas type of crop grown (independent variable) plotted along X axis was also plotted on a scatterplot. This comparison was important to collaborate if farmers were producing for markets leading to increased incomes.

Table 4.18 Correlation between crops grown and crops marketed

	Sig.(2-tailed)	Pearson's r-value	N
Sources of income	0	1	105
Type of crops grown	.182	-.135	99
Most marketed crops	.171	-.142	94

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

During the focus group discussions majority of farmers reported to be having surplus produce for sale e.g Bananas, water melon, tomatoes, and maize. Farmers also reported that increased and guaranteed production year round released family financial burden as farmers were not now spending money on buying food also. The income levels of farmers can influence adoption in several ways. Farmers with high levels of income may be less risk averse (ogunlana, 2004). They can undertake financial risks since they can afford to offset losses from some of their less successful experiments. A study by Feder & Umali (1985), found that farmers with off-farm income were more likely to adopt technologies because the off-farm income provided a buffer if the technology failed.

4.4.2 Farm size

Farm size is one of the important factors that affect the adoption of technologies. Farm size is also used as a proxy for wealth. Majority of the respondents as shown in table 4.19 own less than 2 acres representing 58%, with small percentage of 17% reporting to own more than 5 acres, this confirms that majority of the respondents are small scale farmers.

Table 4.19 Size of land accessed

Land sizes (acres)	Frequency	Percentage
<2	60	54
Between 2.1-5.	28	25
> 5	23	21
Total	111	100

Results in the table 4.20 below show a positive, weak, non significant relationship between size of land owned and adoption of irrigation technology; pearsons coefficient correlation r -value=.003, n = 111, p -value=.984. Overallly the results illustrate that increase in size of land did not lead to increased adoption of irrigation.

For verification, adoption (dependent variable) was plotted on the Y- axis whereas size owned (independent variable) was plotted on X axis to establish direction of the relationship on a scatterplot.

Table 4.20 Size of land owned and adoption

	Sig. (2-tailed)	Pearson's r-value	N
Size owned	.984	.003	58

This is not surprising because in all the irrigation schemes the group members set maximum allowed irrigation acreage per member to 0.25 acres to enable water to reach all other users due to water pressure. Farmers who reported more acreage than this under irrigation had registered multiple family members or were flouting the group by-laws.

The implications of this findings is that irrigation technology can be promoted as a viable option among the small scale farmers. This is inconsistent with the finding by Chitere (1985), who found out that in Central Kenya, adoption of on-farm tree planting was influenced by land size. This is because such technologies require capital investments and if the technology requires substantial amount of initials set-up costs, small scale farmers are not able to afford it. A recent study by Gabre-madhin & Haggblade (2001), in Kenya found that large commercial farmers adopted new high yielding maize varieties more rapidly than small holders. This is because the large farmers can afford high yielding varieties, whilst small-holder farmers after withdrawal of the government subsidies were struggling to buy them.

It was also established that majority of the adopting farmers 39% irrigated between 0.25-0.5 acres and only 11% irrigating above 1 acre as shown in figure 7.

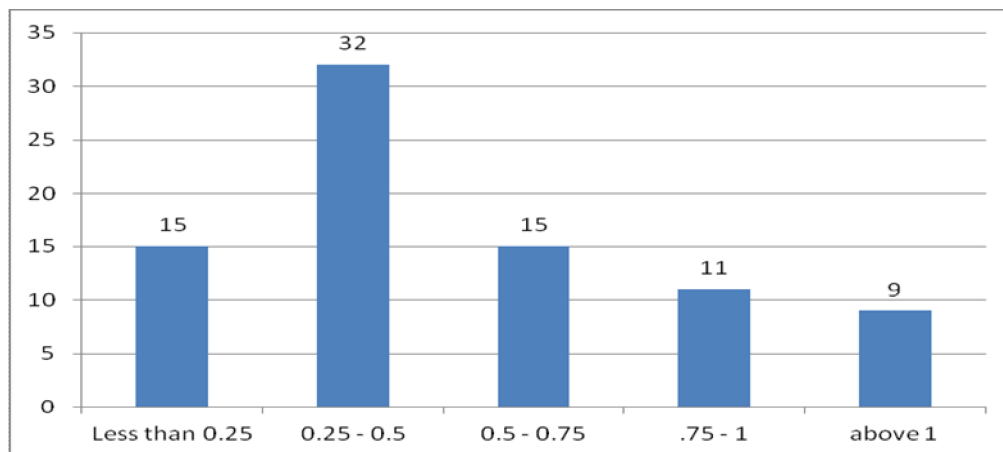


Figure 7: Acreage under irrigation

4.4.3 Land tenure

This study sought to understand the respondent's level of control on the land which is greatly influenced by ownership status as shown in table below;

Table 4.21 Land ownership status

Land ownership status	Adoption (Freq)	Percentage
Own land	60	54
Lease	21	19
Borrow	7	8
Other(e.g communal)	23	30
Total	111	100

Adoption (dependent variable) is represented on the Y- axis whereas land tenure (independent variable) is represented on X axis.

To investigate if land tenure influenced adoption a correlations coefficient analysis was carried out. The correlation results in table 4.22 show positive significant relationship between land tenure and irrigation technology adoption, $r\text{-value}=.233^{**}$, $n=87$, $p\text{-value}=0.030$. Therefore, increase in land security led to increase in irrigation technology adoption. Overall, the more farmers own land, the more likely they are to adopt irrigation.

Table 4.22 Land tenure and adoption

	Sig.(2-tailed)	Pearson's r-value	N
Land tenure	.030	.233	87

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

These results are not surprising as secure tenure provides proper incentive for farmers to make investments in the long-term productivity of their land. A farmer's ownership of land with all due legal rights that include title deed is important to a farmer's investment on the farm since he/she knows that whatever is invested on such land is fully owned. It was established that majority of land respondents who considered themselves as land

owners did not have title deeds but were considered bonafide owners of thier parcels of land as they had no dispute.

The study by Tengnas (1994), found out that in Kenya most farmers find it unacceptable and unattractive to invest in tree production on land that is not legally theirs. This is also supported by Busienei (1991), who found out that the low participation in Agro forestry activities in Ainabkoi division of Uasin Gishu district was due to lack of title deeds. Analysis of land access type shows that 80.7% of the respondents owned land, whereas those who leased or borrowed were 12.5% and 5.7% respectively.

These findings are similar to studies by Feder & Umali, (ibid:26) who concluded that farmers who leased land are less likely to adopt conservation practises than farmers who are land owners. This is beacause the term of lease limits the leaseholders ability to benefit from the conservation technologies whose benefits are long term.

4.4.4 Access to credit

Access to credit was important in this study as it facilitates adoption, analysis of the data in figure 8 shows that access to credit was a very low among the respondents for both groups, only small percentage of 12% reported to have accessed loans in the last three years. However, there were more non adopterø 34% accessing credit compared to 2% of the adopters. This is not unexpected as the target area is not served by any bank. The few banks available are mobile and only visit during market days. This fact is also supported by high poverty levels and lack of collateralals which is a major requirement by banks.

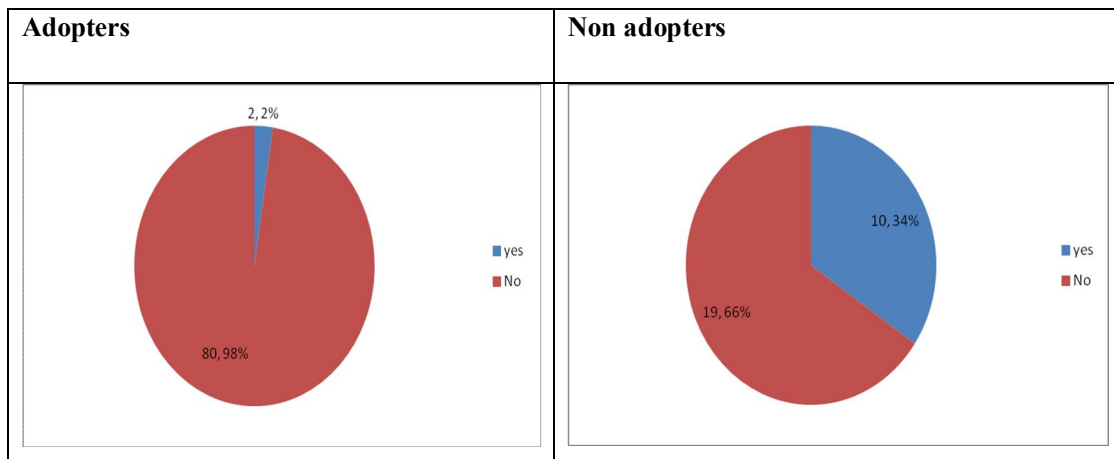


Figure 8: Access to credit

Results in table 4.23 indicate that the main sources of credit were Equity bank and Tharaka nithi SACCO. The SACCO is the only bank with a full time branch located in Marimanti centre.

Table 4.23 Sources of credit

Source of credit	Frequency	Percentage
Equity Bank	3	27
Tharaka Nithi SACCO	6	81
KWFT	2	2
Total	11	100%

Although equity bank has spearheaded financial access among the rural poor this has not taken root in the study area due to poor infrastructure and high poverty levels, On the other hand Tharaka nithi SACCO main clientele is teachers and other salaried government officers and not farmers.

The coefficient correlation results in table 4.24 indicate that there was no significant relationship between access to individual credit by farmers and adoption of irrigation technology, $r\text{-value}=.154, n=111, p\text{-value}=.153$. These results illustrate that access to credit by individual farmers did not necessarily affect irrigation technology adoption in the study area.

Further, to verify the direction of the direction of the relations, Adoption (dependent variable) represented on the Y- axis and credit access (independent variable) along X axis were plotted on scatter plot.

Table 4.24 Credit access and adoption

	Sig.(2-tailed)	Pearson's r-value	N
Access to Credit	.153	.154	111

It is widely expected that the increased access to credit facilities may enable farmers to purchase essential farm inputs such as irrigation facilities and hence ease the resource constraint. However, in this study discussions revealed that irrigation technology was largely donor and GOK driven and farmers relied on this support for necessary capital

investment in construction of intakes and laterals. Community contribution was in the form of labour in excavation of the trenches.

It was observed that some households never extended the piping beyond where it was left by the donors, also maintenance of the scheme was also cited as a challenge after exit of the donors. A substantial amount of the adoption literature has reported on impact of access to credit in relation to adoption of new technologies and a vast amount of this literature shows that the availability of the credit has a positive impact on adoption. This is particularly important in less developed countries like Kenya. This findings are inconsistent to Feder& Umali (ibid:20) in thier review of factors that affect technology adoption study, they highlighted access to credit as being a key determinant on adoption of the most agricultural innovations.

4.5 Administrative factors

External support in this study was important as the technology is a capital intensive. To establish if correlation results in table 4.25 below shows negative, significant relationship between external support and adoption, r-value= -.316,n=111 and p-value=.012. The results mean that the more external support small scale farmers receive the higher the likelihood of adoption of irrigation. Farmers cited grants, donations and subsidies as some of the ways that government can influence adoption.

Adoption (dependent variable) was represented on the Y-axis whereas access to credit (independent variable) was plotted along X-axis for verification.

Table 4.25 External support and adoption

	Sig.(2-tailed)	Pearson's r-value	N
Those who have received ext. support	0.012	-.316	111

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

Government support can affect the adoption of new technologies, governments can use macro-economic policy, trade regulations, input subsidies, regulations and support to extension service deliver, to affect the decision making environment in which farmers choose one practise over another. Moreover, government policy can positively or

negatively impact on adoption of new technology. Government policies which have had a positive impact on adoption include direct support such as price subsidies, credit facilities and, indirect support such as marketing facilities, and input facilities.

As highlighted else where in this report, there exists an elaborate policy framework that promotes agricultural development in Kenya. This policy framework has provided conducive environment for irrigation technology promotion by various actors. Adoption has also been greatly influenced by government and non governmental organisations allocation of funds to establish irrigation project especially the construction of the intake, designing, feasibility studies and piping. Communities role has been trench excavation and laying of laterals to thier farms.

Although in this study farmers did not attribute adoption or non adoption of irrigation technology to policy environment, they cited National Irrigation Board which is government agency and CDF as the main sources of support implying that if this is increased adoption will increase.

Table 4.26 Sources of external support

Source of external support	Frequency	Percentage
MKEPP	8	12.7
Plan	29	46.0
CDF	25	39.7
BAT	1	1.6
Total	63	100%

Study also established access to extension as a significant factor influencing adoption of irrigation technology with farmers citing ministry of agriculture officers were cited as main source of agricultural information (43%).

Significance of the role of Government of Kenya and external support in adoption was further illustrated by analysis of data in figure 9 shows that, only 85% of adopters had contact with extension officers compared to 24% of non adopters. The implication of these findings is that extension visits are important to technology adoption. Increased collaboration of private initiatives with local institutions such as extension service could improve the reach of the technology to farmers.

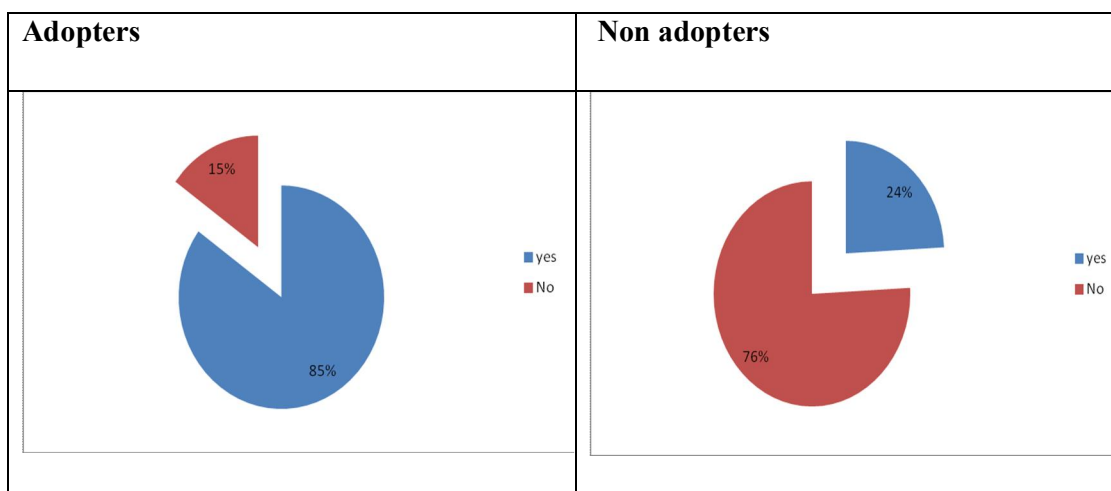


Figure 9: Adoption and external support

Administrative factors which have had negative impact on the adoption of technologies include direct support such as maintaining artificially high exchange rates, maintaining low prices for imported substitutes and removal of direct support such as credit and prices subsidies.

Farmers cited the following as their expected support;

Table 4.27. Kind of farmers expected support

Type of support	Frequency	Percentage
Training	9	15.3
Marketing	2	3.4
Information	1	1.7
Planting materials/seeds	1	1.7
Intake and storage tanks	43	72.9
None	2	3.4
Totals	58	100

According to Mr Musya, the County irrigation officer *“The average cost of intake is 10 million including construction of reservoirs, this cost was hinderance to small scale farmers and thats why all the irrigation projects started were either donor funded or supported by National Irrigation Board with farmers contributing labour”*. Further, before establishment of water intakes there is a mandatory legal requirement to have NEMA and WRMA licenses which puts off farmers since offices are far-off in Meru and

Embu towns 75km and 117 km respectively from Tharaka North and South subcounties. Farmers also cited government bureaucracy in acquisition of this permits as an hindrance.

Political interference in allocation of projects was also cited as a mojour determinant in siting and location of this projects which ultimately affects viability and adoption. During the discussions some farmers said that some local political leaders lobbied to have government projects initiated in thier own areas to woo voters.

The differences in the results of the present study and results of some of the previous ones may be accounted for by the variation in the personal, social, economic, and cultural backgrounds of the farmers who participated in these studies, as well as differences in time and environment.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS.

5.1 Introduction

This chapter contains a summary of the findings, conclusion and recommendations. The summary was drawn from the results based on objectives. It also provides discussions of the findings which were based on literature reviewed in chapter two and interpretation of the results to provide deeper insights. Finally, conclusions are drawn based on summary of findings and recommendations given for further research.

5.2 Summary of the findings

This study was guided by the following objectives; To examine how people perceptions and attitudes influence irrigation technology adoption among small scale farmers; To examine the role of socio-economic context in irrigation technology adoption and to establish if administrative environment influences irrigation technology adoption.

5.2.1 Findings on perceptions and attitudes on influencing irrigation technology adoption.

The study established that people perceptions had a significant influence on adoption. Adopting farmers had a positive attitude towards new farming technologies with majority, 73% being either the first or among the first to start new innovations, 23% had a wait and see attitude or had never used any new technology in the last three years. Upto 86.3% of non-adopters cited cost related obstacles to adoption. Majority of those who had not adopted also had a perception that those who had adopted were receiving or had received external support which was not necessarily true.

5.2.2 Findings on socio-economic factors in irrigation technology adoption

The findings of this study indicate that age, gender, size of land cultivated, years of residence and education level did not have significant relationship with decision to adopt or not adopt irrigation technology with $p\text{-value} > 0.05$. This implies that taken individually this factors did not influence adoption. On the other hand, membership to farmers groups, access to external support, Land tenure and access to extension had a significant relationship with adoption of irrigation technology $p\text{-value} < 0.05$. This implies that this factors influenced adoption decisions. However, the ten socio-economic variables *viz*;

age, Sex, marital status, education level, size of land owned, land access type, distance to the market, access to individual credit and external support when taken together were found to be significant in predicting farmers' adoption of irrigation technology p -value < 0.05 . These factors combined have a reinforcing effect in influencing adoption of irrigation technology.

5.2.3 Findings on administrative environment influence on irrigation technology adoption

In regarding political environment and adoption, this study established significant relationship at $p < 0.05$ significance level between external support and adoption, this means that external support to small scale farmers influences adoption of capital intensive technologies like irrigation. Farmers cited grants, extension service, donations and subsidies as some of the ways that government can influence adoption. Local leadership influence in allocation of projects was also cited as a major determinant in locating projects which ultimately affects viability and adoption.

5.3 Conclusion

Farmers were unanimous that there is need for irrigation to supplement rainfed agriculture, they felt that it was the mandate of the government to ensure that they have irrigation. Majority of adopters were more interested in increasing agricultural productivity, food security and incomes. Non adopters on the other hand cited cost, water availability, and distance from the pipes as main reason for non-adoption. This study established that age, education level, gender and income level treated individually were not predictors of adoption behaviour, however combined they had a significant effect. Land tenure, access to extension, membership to groups and external support had a positive influence on adoption behaviour.

5.3 Recommendations

These recommendations are based on the findings of this study;

Irrigation has a huge potential for increasing agricultural productivity food security and farming community household incomes. However, for this benefits to become a reality there is need for concerted effort to address the entire value chain and not limit focus on infrastructural development only i.e focus on both hardware and soft ware. The current focus on development of irrigation projects funded by the government without considering the socio-economic statuses of the beneficiaries are not likely to be sustainable.

More attention should be paid to the socio-economic conditions of the small scale farmers. Where these conditions remain poor, the farmers are unlikely to be active participants in adoption of agricultural innovations. Economic statuses not only enhance people consumption but also adoption and sustainability of projects. Further economic statuses limits ones access to information, credit and education which are significant in influencing adoption.

There is need to focus on farmer attitudes and perception to ensure that irrigation technology is seen as part and parcel of thier own socio-economic development strategy and not top down initiative to meet donors or government political agenda. Current perception among farmers that irrigation interventions are government/donor owned requires a concerted effort to address otherwise it reverses the benefits achieved. Bottomó up approach where farmers are more proactive in seeking the technology and embracing it to address own challenges need to be promoted.

There is need for more fund allocation by both the county and national government to support irrigation projects in the two subcounties of Tharaka North and South. The two subcounties are classified as ASAL with high drought vulnerability, the county is also affected by food shortage as a result of rainfall failure hence the need to reduce the overreliance on rain-fed agriculture by adopting irrigation. This will cushion farmers by increasing agricultural productivity and houshold incomes.

To increase farmer access to financial services, this study recommends that the county addresses the obstacles that make the subcounties unattractive, this include infrastructural development, the county should focus on developing the roads to open up the area to investors including banks, with development of infrastructure there is need to sensitise farmers on saving benefits, the financial institutions should also develop farmers friendly products, loans should be soft and mode of repayment attractive.

The preference for white collar jobs and general lack of interest in agriculture among the youth is jeopardising the future of agriculture and there is need to develop strategies to have youths take up agriculture as viable livelihood option. This is crucial as an average age of Kenyan farmer is increasing at an indirectly proportional rate as off-farm opportunities. Majority of our youth are unemployed while others are underemployed which forceø them to take up other anti-social activities to eke out living. If this is not addressed, insecurity in this areas even when productivity, devolution of governance structures and incomes increase as result of innovations will be make them unattractive.

There is urgent need to address the information\innovation transfer gap. Farmers need to be sensitised on thier role in seeking for agricultural information from different sources to become more of information seekers than passive recipients and make extension more demand-driven in light of diminishing extension service providers. The private sector also needs to be encouraged to take up the provision of extension services to increase efficiency in the value chains.

5.4 Study limitations and Future research

The data collected and findings in this study did not explore the specific intensity or strength of different variables examined in influencing adoption decisions. Future studies should collect data that measure not only the comparison of variables for technology adoption but also the intensity of those variables. Surveys should collect all economic information that influences the choice of technologies. Such information is important in the adoption studies and in developing comprehensive research and extension programs.

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Appendices

Appendix 1: Questionnaire

**SOCIO-ECONOMIC AND ADMINISTRATIVE FACTORS INFLUENCING ADOPTION
OF IRRIGATION TECHNOLOGY IN THARAKA NITHI COUNTY.**

PART A: GENERAL INFORMATION OF THE SITE

Questionnaire No. [_____]

Name of Enumerator [_____ Tel _____]

Date of interview [___/___/___]

Sub county [_____] Location [_____]

Irrigation scheme [_____]

Name of the Interviewee [_____ Tel _____]

DATA REVIEWED

[_____]; DATE [_____]

SECTION B: RESPONDENTS DEMOGRAPHIC INFORMATION

1. Are you the head of the household? Yes/No
2. If No, What is your relationship to the household head?
 Self wife daughter son Relative other specify
3. What is your sex? Male Female
4. What is your age?
5. What is your marital status
 Married single widow Divorced separated
6. What is the highest level of education did you attain?
 Primary Secondary Cert Diploma Degree other specify
7. What is your ethnic group?
8. What is your religion?
9. How many years have you stayed in this area?

SECTION C: SOCIO-ECONOMIC STATUS

10. Do you practice farming? Yes/ No
11. If yes, do you belong to any farmers group?
12. Do you hold any leadership position in the farmers group or community?
13. What benefits do you get from farmers groups?
 - (i)
 - (ii)
 - (iii)
 - (iv)
14. What are your main sources of agricultural information (*Rank*)
 - (i)
 - (ii)
 - (iii)

15. What are your main sources of income?

16. What is your total monthly income in (Kshs)? *Tick*

Income levels (Kshs)	
> 5000	
5000 - 10000	
10000 -15000	
15000 -20000	
20000 -25000	
25000 -30000	
30000 -35000	
35000 - 40000	
40000 - 45000	
45000 - 50000	
> 50000	

17. What other household assets do you own?

18. How much land (in acres) do you have access to for use?

19. How much of that land is;

(i) Owned

(ii) Leased

(iii) Borrowed

(iv) Any other specify _____

20. Which crops do you grow?

(i)

(ii)

(iii)

(iv)

21. What is the most marketed farm produce?

22. What is the distance in km to the nearest market /trading Centre?

23. What is the distance in Km to the nearest tarmac road? _____

24. Have you received/accessed to credit (including financial & inputs in kind) in the last four years? 1. Yes 2.No

If yes, where did you get it from?

SECTION D: ADOPTION OF IRRIGATION TECHNOLOGY

25. Do you practice irrigation farming?

26. If No what are the reasons (rank)

- (i)
- (ii)
- (iii)
- (iv)

27. If yes when did you start _____ what acreage is under irrigation

28. When you decided to use irrigation did you know anyone who was using irrigation?
Yes\No

if yes how many

29. What were the main reasons for adopting irrigation farming?

- (i) _____
- (ii) _____
- (iii) _____

30. What main benefits have you accrued from practicing irrigation farming?

31. Which crops do you mostly prefer to irrigate (*rank*)

- (i)
- (ii)
- (iii)

- (iv)

32. What type of irrigation do you use

Type	Why
Surface irrigation	
Drip irrigation	
Sprinkler irrigation	
Other specify	

33. What is your opinion about irrigation technology

Irrigation is good 1. Agree 2. Disagree 3. Not sure

34. What are the main constraints encountered in adopting irrigation?

(i)

(ii)

(iii)

(iv)

SECTION E: POLITICAL ENVIRONMENT.

35. Which support on irrigation technology have you received from where?

Institution	Kind of Support

36. Have you received any training from GOK extension staff in the last one year?

37. Have you visited GOK or county offices for any information in the last one year?

38. In your opinion, what kind of support do you expect from the National government

(i)

(ii)

(iii)

(iv)

39. What kind of support have you received from county government?

(i)

(ii)

(iii)

(iv)

SECTION F: PERCEPTIONS AND ATTITUDES

40. Do you practice irrigation technologies you learn or observe from neighbors\others?

41. In the last three years have acquired\started anything on you farm to increase your agricultural productivity?

(i)

(ii)

(iii)

(iv)

42. Please select the statement below that best describes your attitude towards new technology

(i) I am always the first to try new technology and production methods

(ii) I am one of the first to try new technologies and production methods

(iii) I normally wait to see others success with new technology and production methods

(iv) I never try new technologies or production methods

Thank you for participating

END

Appendix II: Focus group guide

FOCUS GROUP: DISCUSSION GUIDE

Introduction and instructions to participants

Welcome and thank you for volunteering to take part in this focus group. You have been asked to participate as your point of view is important. I realize you are busy and I appreciate your time.

Introduction: This focus group discussion is part of my Master of Arts Sociology degree requirement at the University of Nairobi and am interested in establishing your feelings about irrigation and what socio- economic factors influenced your adoption\not adopt. The focus group discussion will take no more than two hours

Anonymity: I would like to assure you that the discussion will be anonymous. The transcribed notes of the focus group will contain no information that would allow individual subjects to be linked to specific statements. You should try to answer and comment as accurately and truthfully as possible. I and the other focus group participants would appreciate it if you would refrain from discussing the comments of other group members outside the focus group. If there are any questions or discussions that you do not wish to answer or participate in, you do not have to do so; however please try to answer and be as involved as possible.

Introductory questions

- First, I'd like everyone to introduce themselves. Can you tell us your name?
- When was this irrigation group formed?
- How many members are you _____M_____F_____
- How was the group started?_____
- Why? _____
- What activities are you involved in_____

Section a: Perceptions and Attitudes

1. How would you describe the farmers attitudes towards irrigation (What did people think/say/do?)

2. What causes the positive/negative reaction?

3. What are the technologies you have been exposed to or adopted in your farms?

(rank)

(i)

(ii)

(iii)

(iv)

4. For each technology (or formerly prioritized technologies):

a) What do you like most about it?

b) What do you like least?

c) What are the main factors hindering adoption by more farmers?

Section b: Social and Economic statuses

5) What types of farmers are mostly adopting irrigation (by gender, age, wealth, land ownership.) Why?

6) What are the most important resources required to adopt irrigation technology (i.e. labor, land, training, capital, and water)?

7) Was there a tendency to share the technology (ies) with certain types of people?

8) If so, who tends to share most with whom, and why?

9) Does this vary by technology Yes\No, if yes why_____

10) Among yourselves or other farmers you have observed, what have been the most useful changes made to the irrigation technology after it was introduced? How has it changed and why?

11) Were there any social innovations that emerged to enable adoption or maximize benefits from irrigation technology, such as shared labor, organization to access inputs, finance etc?

12) Has the introduction or adoption of irrigation had any impact on your livelihood or the community? *both* positive and negative impacts, if any.

Please mention both positive and negative impacts, if any.

Positive	negative

13. What are the most cultivated crops (rank)

(a)

(b)

14) Does membership in group\associations help in irrigation adoption? yes\no Explain_____

15) How often do you meet as a group?

(a) Weekly (b) monthly (c) once a year (d) any other specify

Section c: Administrative environment

15) What are the main sources of agricultural information?

1=Radio 2. Newspaper 3= Internet 4=Government 5= NGOs\FBOs\CBOs 6= Other farmers
7= self-observation 8=others specify

16) Do you receive any support from outside? Yes\No

If yes from where

<i>tick</i>	<i>What kind of support</i>
NGOs	
CDF	
Banks	
GOK	
Others specify	

17) What do you think should be done to increase irrigation technology adoption?

18. Of all the things we have discussed today, what would you say are the most important issues you would like to express about irrigation technology in the county

Thank you for participating. This has been a very successful discussion