

**FACTORS AFFECTING ADOPTION OF IRRIGATION AS A STRATEGY TOWARDS
ENHANCING FOOD PRODUCTION AMONG FARMERS IN KEE WARD, MAKUENI
COUNTY, KENYA**

JOSEPH MWENDWA KATUMO

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DECLARATION

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

Signed Date:
Joseph Mwendwa Katumo
D53S/1033/2014

We confirm that the work in this project was done by the candidate under our supervision.

1. Signed Date
Prof. Robert Arasa
Department of Business, Administration
School of Business and Economics
Machakos University

2. Signed Date
Prof. Charles Ombuki
Department of Economics
School of Business and Economics
Machakos University

3. Signed Date
Dr. Marther Ngigi
Department of Agribusiness
School of Agricultural Sciences
Machakos University

DEDICATION

This research project is dedicated to my dear family: My wife Annet and our two sons Lewis Boltz and Prince Muuo. I also dedicate it to my dad and mum, my brother Moses and my sisters Jane, Emma and Cecilia.

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OPERATIONAL DEFINITION OF TERMS

- Adoption:** It is the acceptance for use of an innovation or technology.
- Commercial farming:** It is the farming, whether on small-scale intensive farming or on large scale, with the sole purpose of producing crops and farm animals for sale, and with the sole intention of making a profit.
- Competitive advantage:** The ability of a firm to outperform its rivals.
- Horticultural farming:** Horticulture is the industry and science of plant cultivation that includes the process of preparing soil for the planting of seeds, tubers, or cuttings, vegetables and fruits
- Irrigation:** Irrigation is the replacement or supplementation of rainwater with another source of water. The main idea behind irrigation systems is that the plants are maintained with the minimum amount of water required.
- Permanent earth dams:** Water dams with a capacity of 200,000m³ which is dependable both for domestic and farming purposes throughout the year.
- Strategy:** It is the pattern of actions and resource allocations designed to achieve the goals of an organization. The strategy an organization implements attempts to match the skills and resources of an organization to the opportunities found in the external environment.
- Strategy implementation:** It is the organization's means of moving from planning work to working the plan. It is simply the process of converting long-term strategic plan into actionable activities.
- Subsistence farming:** It is the self-sufficiency farming in which the farmers focus on growing enough food to feed themselves and their families. The output is mostly for family consumption with little or no surplus for trade.

ABBREVIATIONS AND ACRONYMS

ASAL	Arid and Semi-Arid Land
CSR	Corporate Social Responsibility
GDP	Gross Domestic Product
HELB	Higher Education Loans Board
IT	Information Technology
Km	Kilometres
KWAO	Kee Ward Agriculture Office
KTDA	Kenya Tea Development Authority
LIA	Life in Abundance
MksU	Machakos University
NGO	Non-Governmental Organization
TAM	Technology Acceptance Model
UDP	Utooni Development Programme
UNICEF	United Nations Children’s Emergency Fund

ABSTRACT

The ASAL areas today face the challenge of feeding its population, and thus face malnutrition and hardly go without food aid during drought seasons. The adoption of irrigation holds the key to food security. This research was intended to investigate the factors affecting the adoption of irrigation as a strategy to enhancing food production among farmers in Kee Ward, Makueni County. The research's variables included the level of income, the level of education of the household head, and the availability of training and extension services to the farmers. The study had three specific objectives of the study are to assess the extent to which the level of farmers' income affect the adoption of irrigation, to analyze how the level of education of the farming head affect the adoption of irrigation, and finally to determine the effect of training and extension services on farmers in the adoption of irrigation as a strategy towards enhancing food production. The research design adopted was descriptive in nature, and the sampling technique was a two-stage sampling technique, which involved purposive sampling for the 28 farmers who have adopted irrigation and simple random sampling of another 28 farmers who have not adopted irrigation. A sample of 56 respondents was therefore selected from the target population of Kee Ward's 4,298 farmers. The target population consisted of all the farmers within Kee ward, which included both commercial and subsistence farmers. A self-reporting questionnaire was used to collect data. This included both structured and unstructured questions in order to capture the data appropriately. Data was then analyzed both quantitatively and qualitatively through descriptive and inferential statistical analysis techniques including a multiple regression model according to the objectives of the study. The study found out that those who had adopted irrigation had a higher income compared to those who had not adopted, that most of those who had adopted irrigation had done tertiary education unlike those who had not adopted who majority had done up to form 4, and that agricultural training seminars were hardly organized in Kee ward, and that Kee ward had very few agricultural extension officers. The study recommended that the county and national governments should subsidize irrigation inputs, advance cheap credit facilities to farmers in ASALs, and subsidize education at all levels (including tertiary levels). The study also recommends the county government to employ adequate agricultural extension officers in ASALs, also have demonstration plots in every ward, and also arrange for free farm clinics in ASALs for the farmers to learn.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

1.1.1 The Concept of Strategy

A strategy can be defined as an incorporated and harmonized set of commitments and events which are intended to utilize core competencies so as to increase competitive advantage. It is simply a plan of action which is meant to accomplish a particular goal. It involves formulation, implementation and evaluation of decisions which enable an organization to achieve its objectives (Fred, 2011). According to Haberberg and Rieple (2008), a strategy can simply be regarded as the path taken by an organization which is on its way to becoming an effective and efficient performer. This path can be a set of actions through which a firm develops resources and uses them to deliver services or products in such a way that its users find valuable and gain financial and other objectives and constraints imposed by the stakeholders.

According to Pearce and Robinson (2011), and Haberberg and Rieple (2008), there are three levels of strategies. These are the corporate level, the business level and the functional level. The corporate level strategy comprises of the board of directors, chief executives and executive officers. They are all in charge of achieving the monetary goals of the corporation, as well as achieving of the non-monetary goals like corporate image and social responsibility. At this level, they set objectives and make the strategies that cover all the activities of the businesses in their cooperation and functional areas. Therefore the corporate level strategy is concerned with the domain the industry sector competes in. The business level strategy is made up of the business and corporate managers. They translate the common statements of the course and intents of the organization generated at the corporate level into concrete, functional objectives and strategies for individual business divisions or strategic business units. The business level strategy is therefore concerned with how to compete in a selected market segment. Finally, the Functional level strategy comprises of managers of functional, product and geographic areas. The functional managers develop short-term strategies and annual objectives in areas such as operation, production, finance and accounting, research and development, marketing and human relations.

The utmost responsibilities of the functional managers are in the execution of the strategic plans in the organization. Therefore, they maximize on resource productivity.

1.1.2 The Agricultural Sector and Irrigation in Kenya

According to Republic of Kenya (2010), for many years, the agricultural sector in Kenya has been the backbone of the country's economy. This sector contributes about 25% of the Gross Domestic Product (GDP), and a further 27% through manufacturing, distribution and service businesses. It also contributes to 65% of total export earnings making it the largest contributor to the economy in Kenya. It also accounts for about 80% of national employment, mainly in the rural areas. About half of the country's entire agricultural production is subsistence and is not marketed, and mainly is produced by small-scale farmers in the rural areas (Agriculture in Kenya, 2017). Therefore, according to Republic of Kenya (2015), farming is a very essential economic sector in Kenya even though less than 8 percent of the land is used for crop and feed production, and less than 20% is fit for crop growing. According to Republic of Kenya (2015), the agricultural industry has over the years performed well and this is due to the fact that it is largely private sector driven and has so far been quite lucrative.

About 84% of Kenya is ASAL (Arid and Semi-Arid Lands), which means they are not conducive for rain-fed farming (The Presidency, Ministry of Devolution and Planning, 2015). This implies that man has to modify his land and environment to suit his agricultural activities. Such modification has to come through irrigation among other methods to supplement rain fed farming. In many countries, the scarcity of water has been a serious constraint to production of food and a major cause of poverty and hunger. Improved management of water is a major key to securing food production so as to lighten today's nutritional suffering and also feed an extra 3 billion people by the year 2030 (Purcell, 2014), hence irrigation is a crucial functional level strategy to realize food security for all.

Irrigation in Kenya is at present under the Ministry of Water and Irrigation, having evolved through various ministries since 1974, where prior to 1974, it was a department in the Ministry of Agriculture. Later it was integrated in various ministries which include Ministry of Land Reclamation and Regional Development (1992), Ministry of Water Resources (1998), Ministry of Environment and Natural Resources (2001), Ministry of Water and Natural resources

Management (2003), Ministry of Water and Irrigation (2004), Ministry of Environment, Water and Natural Resources (2013). One of the ministry's strategic objectives is to improve the utilization of land through irrigation and land reclamation (Ministry of Water and Irrigation, 2016).

Kenya's government has supported past large scale irrigation projects since 1950 which include the Coastal region's Bura Irrigation Scheme which started in 1953 and collapsed in 1989 due to poor returns to the farmers, Hola Irrigation Scheme which is also in the Coastal region which failed due to unreliable water supply and pumping problems, Ahero Irrigation Scheme in Western Kenya for growing rice which started in 1966, Pekera Irrigation Scheme in the Rift Valley which started in 1952 with 2000 acres of the Scheme's 25,800 acres was developed for gravity-furrow irrigation where only 1,500 acres is under cultivation. Most currently, Galana irrigation Project in Kilifi and Tana River districts is the largest irrigation project in Kenya, which has 10,000 hectares under irrigated farming and is expected to secure Kenya's food basket (Agra, 2015). In Kenya the total area of land under irrigation is about 80,000 hectares. Small-scale irrigation by both Public and private farmers is still less than 50,000 hectares. This is reasonably small compared to the country's probable potential of more than 300,000 hectares.

1.1.3 Farming, Irrigation and Food Insecurity in Makueni County

Makueni County is generally considered as one of Kenya's ASALs since it receives an annual rainfall of 400mm to 1200mm per annum (Sombroek et al., 1982). The rains range from 800mm to 1200mm per annum on the higher parts and between 400mm to 800mm per annum on the lower parts of the county, where the short rains are received between late October to December and the long rains between March and May. It is therefore classified as between humid on the higher altitudes like Kilungu hills and Mbooni hills, to arid on the lower altitudes of Wote, Kibwezi to Mtito Andei. The temperatures range between 24°C to 33°C in the hot seasons and 18°C to 24°C during the cold seasons (ADS eastern, 2017). Makueni has a total area of 7,440Km² with a cultivable land of area 554,000ha, which is about 74% of its total area. In 1999, it had a total population of 767,000 people and the population density per square kilometer was 103. Agriculture, including livestock, is a major economic activity with crop production contributing only 9% of the total agricultural income. However, it has an irrigated area of 1,866 ha which represents only 0.3% of the cultivable area (MoA, Central Bureau of Statistics, 1999).

This implies that rain-fed agriculture is predominant in Makueni. Irrigation in Makueni County Government is under the county's Ministry of Water, Irrigation and Environmental Services, whose main objectives include general provision of water, irrigation and construction of dams, borehole drilling and water harvesting (Republic of Kenya, 2015). For two years in 2009 and 2010, the rains failed in Makueni County. In 2011, the Government of Kenya declared hunger as a national disaster. In response, the local churches in Makueni, in partnership with LIA Kenya, began serving the immediate needs of most hunger stricken families in the form of maize, beans and soya milk (Life in Abundance, 2015). In a joint press statement on the state of drought and food security in the arid and semi arid counties issued on 23rd February, 2015, the national government in consultation with the County Government held its regular meetings and noted that in most ASAL counties, the short rains perform below par, start late and end early, is less than normal and its distribution in space and time is generally poor. The areas receiving extremely poor rainfall are those in the pastoral zones of the North and Northeast, and the marginal agricultural zones of the Southeast (Makueni, Kitui, parts of Meru and Tharaka Nithi). Also noted is that an estimate of at least 1.63 million people, most in these areas are in acutely food insecure regions and need immediate food assistance over the next six months (Republic of Kenya, 2015)

To beat the food insecurity experienced in the county, the County Government of Makueni has built sand dams at its major rivers including Kaiti, Muuoni, Kikuu and Kala Rivers while medium earth dams of capacity 200,000m³ have been built in each of the six sub-counties alongside two other smaller earth dams of capacity 10,000m³ in each of the 30 wards. These are in addition to other earth dams which existed before the ushering in of the county governments in 2013. This is primarily targeted for domestic purposes and secondarily for irrigation that is aimed at improving food security in the County where successful rain fed agriculture has been a mirage. Major irrigation projects in Makueni include 15 major dams like Kwa Mbila Dam in Kithuki location, Uyi Mega Dam in Masongaleni Ward and Mbooni earth dams in Kee ward among others (Government of Makueni County, 2017).

1.1.4 Irrigation and Food Security in Kee Ward

Kee Ward is situated in the North Western end of Makueni County in Kaiti Constituency. It comprises of Ikalyoni, Makongo, Kitandi, Kivani, Kyamwalye, Mutulani, Nguluni and

Kasunguni Sub-locations, which all have a total population of 21,025 people and covers an area of 81.6km². The temperatures range between 24°C to 33°C during the hot seasons and 18°C to 24°C in the cold seasons. However, Kee Ward is largely an ASAL and does not majorly support rain-fed agricultural farming since its rain per annum is between 400mm to 800mm (ADS eastern, 2017) and can hardly sustain the major staple food of maize and beans among other agricultural activities. Livestock rearing is also at risk due to the low production of pastures. The condition has negatively affected agriculture which is the main economic activity in the region (ADS Eastern, 2014). According to Purcell (2014), large-scale irrigation projects are often unsustainable, but a variety of affordable small-scale techniques can increase the production of food. Kee ward being an ASAL does not require large-scale irrigation projects since it has no permanent rivers to sustain the projects. However, Kee ward has several permanent earth dams which include Mbooni dam in Kyamwalye, Kwa Kasyoki dam in Makongo, Kivaku dam in Ikalyoni, Kivani dam in Kivani, Kitandi dam in Kitandi, Kwa Kakui dam in Watema and Kwa Kalii in Nguluni sublocations. It also has many seasonal dams which cannot sustain irrigation. Their water is therefore used for domestic, livestock and other household uses (KWAO, 2017). Several intervener organizations, both non-governmental and the CDF have initiated and funded irrigation projects for farmers, as shown in table 1.1.

Table 1.1
Irrigation Intervener Organizations in Kee Ward, Makueni County

S/no	Organization	Area of Intervention
1	Africa Harvest	- Environment and soil conservation - Construction of sand dams
2	Utooni Development Programme	- Construction of sand dams
3	CDF	- Construction of both earth dams and sand dams

Sources: Bill & Melinda Gates Foundation, 2013; Utooni Development Organization, 2015

Due to the challenges experienced by farmers in ASAL areas which include unreliable rainfall, changing weather patterns (Sombroek et al., 1982), the intervener organizations in Table 1.4 have in the past years initiated a conducive environment for Kee Ward residents to practice

small-scale irrigation. For instance, Africa Harvest, a non-profit making organization working in Makueni County created awareness in the use of river water for irrigation, and environmental conservation in Kee Ward. It has also build sand dams in Munyuni river of Kee Ward for the farmers as part of its mandate, especially for those adjacent to the river to make farming throughout the year possible irrespective of the season (Utooni Development Organization, 2015).

Secondly, Utooni Development Programme (UDP), a community based non-profit making organization which works with community groups build sand dams across the sandy rivers Kala and Munyuni, the two main rivers in the ward. In Munyuni River, one sand dam was built in 2013. Upon the group's request, UDP donated irrigation pipes and a 10,000 litre plastic water tank to Kithima Self-help Group to make use of the water to irrigate their 1/3 acre piece of land at Kikingo market. Kithima group also build a 4000 litre stone water tank and bought a water generator to help serve the purpose. However, a year after kick-off, irrigation stalled (Utooni Development Organization, 2015). These two are in addition of other two sand dams built by the colonial governments which are still very strong to date.

The CDF of Kaiti constituency between 2007 and 2009 built Mbooni earth dam situated 300m east of Kee market, which is a permanent dam and can hold enough water to support irrigation for over a year without depletion. In addition, the CDF of Kaiti Constituency with the help of Kithima Self Help Group members built a sand dam in Kala River in 2014. This sand dam has never been harnessed for irrigation (KWAO, 2017). Permanent sand dams in Kee ward are built along rivers Kala and Munyuni. Kala River has four sand dams while Munyuni River has six. However, only 15 farmers out of the 184 targeted farmers who are served by the permanent sand dams have adopted irrigation (KWAO, 2017). This means only 8.15% of targeted farmers served by permanent sand dams, have adopted irrigation from the sand dams, as in Table 1.2. Kee ward has seven permanent earth dams with at least one permanent earth dam in each sub-location. Of the 326 targeted farmers served by the earth dams, only 13 farmers (3.99%) have adopted irrigation from them, as summarized in Table 1.2.

In spite of the efforts made by the Makueni County Government and NGO organizations to make Kee more food secure through irrigation, the strategy only seems to be embraced by few farmers, and most of the few farmers have adopted the manual irrigation system using buckets or watering cans (Types of Irrigation, 2012), as summarized in Table 1.2.

Table 1.2
Targeted Farmers and those who have adopted irrigation from permanent water sources in Kee ward.

Water Source	Water Sources	Target population of Farmers served by permanent water source		Targeted Farmers who have adopted Irrigation		Total number of targeted farmers who have adopted irrigation	Percentage of farmers who have adopted irrigation (%)
		Subsistence farmers	Commercial farmers	Subsistence farmers	Commercial farmers		
Sand Dams	<u>1.Kala River</u>						
	- Kwa Stola	37	1	0	1	1	2.7
	- Kiuusini & Kwa Saku sand dams	40	2	2	1	3	7.1
	- Ndivuni	22	0	1	0	1	4.5
	<u>2.Munyuni River</u>						
	- Kwa Katw'iwa	32	1	0	1	1	3.1
	- Utooni	12	2	0	1	1	8.3
	- Kwa Mwongeli	6	4	1	1	2	20.0
- Kwa Nzila, Kwa Musungu & Kiaoni sand dams	23	6	1	5	6	20.7	
Earth Dams	1.Mbooni	45	9	0	6	6	11.1
	2.Kitandi	83	2	0	2	2	2.2
	3.Kivani	67	3	0	2	2	2.86
	4.Kwa Kasyoki	40	2	0	1	1	2.38
	5.Kwa kalii	37	1	0	1	1	5.26
	6.Kwa Kakui	35	1	0	0	0	0
	7.Private Earth Dams	0	1	0	1	1	100
Total		479	35	5	23	28	5.49

Sources: Farming in Kenya, 2015; Google maps - earth-3d.com, 2016; Bill and Melinda Gates Foundation, 2013; KWA0, 2017; World Google Maps Search - maplandia, 2016

Since Kee ward has a total farming family population of 4,298 farm families, only 28 farmers practice irrigation (KWAO, 2017). This represents only 0.65% of the farming families.

1.2 Statement of the Problem

As seen in the background, there is evidence that Kee Ward is purely an ASAL region which faces challenges of unreliable rainfall and changing weather patterns, hence it barely supports its population with agricultural food products throughout the year without food aid, making the region food insecure. There is also evidence that efforts have been made by Kaiti CDF, the County government of Makueni and other intervener organizations to make the ward food secure by building sand dams and earth dams for irrigation. However, in spite of these efforts, only 0.67% of farmers in Kee ward have adopted irrigation (KWAO, 2017), which is quite a small proportion. The purpose of this study was therefore to investigate the factors which affect the adoption of irrigation as a strategy towards enhancing food production among farmers in Kee ward, Makueni County. This study addresses both subsistence and commercial farming with the purpose of improving food security.

1.3 Research Objectives

1.3.1 General Objective

The general objective of this study was to investigate the factors affecting the adoption of irrigation as a strategy towards enhancing food production among farmers in Kee Ward, Makueni County.

1.3.2 Specific objectives

- i. To assess the extent to which the level of farmers' income affect the adoption of irrigation as a strategy towards enhancing food production among farmers in Kee Ward, Makueni County.
- ii. To analyze how the level of education of the farming head affect the adoption of irrigation as a strategy towards enhancing food production among farmers in Kee Ward, Makueni County.

- iii. To determine the effect of training and extension services on farmers in the adoption of irrigation as a strategy towards enhancing food production among farmers in Kee Ward, Makueni County.

1.4 Research Questions

- i. To what extent does the farmers' income level affect the adoption of irrigation as a strategy towards enhancing food production among farmers in Kee Ward, Makueni County?
- ii. How does the level of education of the farming head affect the adoption of irrigation as a strategy to enhance food security in Kee Ward, Makueni County?
- iii. What is the effect of training and extension services on farmers in the adoption of irrigation as a strategy to enhance food security by farmers in Kee Ward, Makueni County?

1.5 Significance of the Study

The implementation of irrigation as a strategy in farming has been a thorny issue in the country, especially among small-scale farmers. A study on such a topic will benefit all the stakeholders in agriculture and the entire country since if the recommendations made are implemented, it will contribute to increase in food production.

This research project is therefore expected to be of significance to the following: First, the Governments, i.e. both the national government and the County governments, who will use the information, availed to adopt irrigation strategy effectively. Secondly, the farmers in Kee Ward, those of Makueni County and the farmers in Kenya will seek the training to improve their skills and knowledge on their irrigation and agricultural practices for greater outputs. Thirdly, dealers in irrigation technology kits who will in turn invest in the ASAL areas to provide efficient irrigation technology kits. Fourthly, the Kenyan population since if the recommendations are implemented, Kenya will be a well fed and healthy nation. Lastly, other researchers will use the study as a reference text.

1.6 Limitations of the study

The study was limited to a small-scale area (only one ward) and so the study scope was not comprehensive since the following hindrances barred the ability of extending to further areas and be able to make a conclusive impact.

Firstly, scarcity of financial resources was a challenge since the researcher was the sole financier of the study. The financial resources were needed for travelling, stationery, photocopy and typing services. The researcher therefore sourced for extra funds from relatives and friends for the exercise. Secondly, inadequate availability of some of the materials for doing the literature review. The researcher therefore had to spend most of his evenings in the library in search of literature material. Lastly, the research area was in the interior of Ukambani's rural and remote areas with transport challenges. The researcher therefore had to create enough time for the research exercise, and also hire boda bodas for easy and fast travelling. Lastly, some of the respondents were semi-illiterate and therefore needed translation and interpretation of some of the items in the data collection tool.

1.7 Assumptions of the study

In this study, the researcher assumed that all the respondents given the questionnaires were able to read and write. The researcher also assumed that the respondents would be cooperative and honest and would give actual information. Finally the researcher assumed that the sampled population would represent the views of the rest of the population in the ward, hence a representation of ASAL areas.

1.8 Scope of the study

The study was carried out in Kee Ward, which is in Makueni County. It has a total population 21,025, where 4,298 are farmers, who comprise of 4,236 subsistence farmers and 62 commercial farmers. The research exercise was undertaken in the month of December, 2017. Kee ward is purely an ASAL. The study was a representative of both subsistence and commercial farming in ASAL areas, a representative of the ASAL wards in Makueni County, and Kenya at large. The variables of study were the farmers' level of income, their level of education, and finally the effect of training and extension services in farming, on how they affect adoption of irrigation.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This section is divided into four sections. The first section reviews the theories underlying adoption of strategies and agricultural technologies, the second section reviews empirical studies relevant to the research work, while the third and fourth sections present literature overview and the conceptual framework respectively.

2.2 Theoretical literature

There are several theories that relate to strategy planning, adoption, implementation and challenges involved in achieving this. Many authors have aimed at providing a guideline to ensure strategic plans which are not only formulated but also fully adopted and implemented. Among the leading theories were captured in this study were diffusion of innovation theory, technology acceptance theory and resource based view.

2.2.1 Diffusion of Innovation Theory

According to Rogers and Shoemaker (1971), diffusion can be defined as the process by communication of an innovation is done through certain channels over time among the members of a societal system. According to Rongers (2003), an innovation could be an idea, a practice, or an object perceived to be new by an individual or other unit of adoption. Therefore, diffusion of innovation refers to the process that happens as individuals adopt a new idea, a product, a practice, a philosophy, among others. The theory of diffusion of innovation asserts that every market has group(s) of customers who differ in their preparedness and willingness to adopt a new product. The innovation product therefore spreads (diffuses) through a market in successive, overlapping waves and not in one straight course. Rogers (Rogers, 1962) in mapping out this process of diffusion emphasized that in most cases not many people are initially open to the new idea and will therefore adopt its use. As 'spread the word' is done by these early innovators more and more people become open to the innovation hence leading to the progress of a critical mass. As time progresses, the innovation diffuse among the population until it reaches a point of saturation.

According to Rogers (1962), the rate of adoption of an innovation or technology simply refers to the number of members of a society who start using the new innovation or technology during a specific period of time. Since it is a relative measure, the rate of adoption of one group is usually compared to the rate of adoption of another group, usually of the whole society. The attributes of an innovation that affect the rate of adoption include the ease at which the innovation can be adopted into daily life, the advantage created by adopting the innovation, the expense associated with trying out the innovation, and finally, the ability of other members within the society to see those who have already adopted the innovation.

There are three components to the theory. The first component is a description of the process that people follow in making a decision about whether or not to adopt an innovation. The second component is a description of the innovativeness of individuals and the spread of innovation through a population. The third component relates to the characteristics of innovations that influence their relative speed of adoption and diffusion (Rogers and Shoemaker 1971; Rogers 1995). The model of diffusion of innovation was the pre-eminent model in the adoption of innovations in agriculture and dominated teaching and research in agricultural extension until relatively recently (Black 2000; Sumberg et al. 2003).

According to Rogers (1962), an adopter category can be defined as a categorization of people within a social system which is based on innovativeness. In his book called *Diffusion of Innovations*, Rogers named five categories of adopters in order to normalize the usage of adopter groups in diffusion research. He classified adopters as the following: innovators, early adopters, early majority, late majority and laggards. In addition to the opinion leaders and gatekeepers who are in a particular society, there are agents of change who may come from without the community. The change agents bring innovations to any new community – firstly through the gatekeepers, then secondly through the opinion leaders, and then to all individuals into the community (Rogers, 1962).

The innovators, who are first in adoption, are social and have the highest social status, are willing to take risks, have a financial liquidity, and they have the closest touch to methodical sources and contact with other innovators. Their tolerance to risks allows them to adopt new technologies or innovations that may finally fail. Their financial resources therefore help to absorb these failures (Rogers, 1962). The early adopters are persons who mainly have the biggest measure of opinion leadership among the categories of adopters. They have a superior social

status, higher monetary liquidity, higher education and are more socially ahead of the late adopters. They are more prudent in choices of adoption than the innovators. They use sensible choices of adoption to help them uphold a vital position in communication (Rogers, 1962). The Early Majority, who are the third in the adoption ladder will adopt an innovation after a considerable degree of time that is much longer than both the innovators and early adopters. Their social status is above average; they are in touch with the early adopters and rarely embrace positions of opinion leadership (Rogers, 1962). The Late Majority are the fourth adopters, and according to Rogers (1962), they usually adopt an innovation after the normal participants. These late adopters approach an innovation with a high degree of uncertainty and adopt an innovation after the bulk of society has adopted it. The Late Majority are cynical about an innovation. Their social status is below average, have little monetary liquidity, are in contact with others in late majority and early majority and they have very little inclination to opinion leadership. Finally, the Laggards are the last adopters to an innovation. They are the last in the grouping as they show the slightest opinion in leadership. They are insensitive to change-agents. They tend to be focused on "traditions" and are oldest among adopters. They have the lowest social status, have the lowest monetary liquidity, and they are only in touch with relatives and close acquaintances.

Since decisions are neither collective nor authoritative, each member of the society faces his/her own decision in regard to innovation, and this follows a 5-step process as given by Rogers. First is the Knowledge stage, where the person is made aware of an innovation but has no information about the innovation. Persuasion is the second stage, where the person forms either a favorable or unfavorable attitude towards the innovation. Those interested in this innovation actively seek its related details. Third is the Decision stage, where the person gets involved in activities that may lead to choose either to adopt or reject the innovation. The individual weighs the merits and demerits of using the innovation, and decides whether to adopt or reject it. Fourth stage is Implementation where the person puts an innovation into use, and lastly, Confirmation step, where the person evaluates the results of an innovation-decision already made (Rogers, 2003).

According to Gibbons (2004), an innovation may undergo failed diffusion. This means that diffusion may not reach 100% adoption due to its own weaknesses, lack of awareness or even due to competition from other innovations. From the perspective of social networks, an unsuccessful diffusion may widely be successfully adopted within certain groups but fail to have

an effect on more distantly allied individuals. Also, at times, an innovation may also fail due of lack of local involvement and participation from the community (Choi, et al, 2010).

Irrigation in Kee ward is an innovation to the group, where the adoption to the next group is expected to happen in overlapping waves, and not in one straight course. Those who have adopted irrigation in Kee ward are in the adopter category. Characteristically, they have a high social status, have taken the risk of adopting the irrigation innovation, and they are in contact with other irrigation innovators. Though irrigation in Kee ward is still in the post knowledge stage and pre-persuasion stage in the Roger's' 5-step process, it is expected to move higher with time as the on-lookers see the progress and benefits of irrigation from the adopters.

2.2.2 Technology Acceptance Theory

According to Suvama and Godavari (2012), technology has pervaded all aspects of human life, including health, agriculture, business, education, entertainment etc. No matter which field technology is applied, it should have positive impact on work in such a way as to improve production. In our day, each country or group strives to adopt the most up-to-date technology because it is seen as an enabler or the mechanism to information dissemination (Oye, et al, 2012).

Unless accepted and adopted, technology can be of little value (Oye et al, 2012). Therefore it is vital to understand technology acceptance because according to Suvama and Godavari (2012), increase in the supply of information is the most significant benefits related with access to the latest technologies. Researchers amusingly seem to be identifying why individuals embrace information technology so that higher processes for designing, evaluating, and predicting how users react to innovative technology can be improved. According to Louho, et al. (2006), technology acceptance is just about how individuals embrace and adopt a technology for utilization. The acceptance to use a technology can be explained as the provable readiness within a user group to use information technology for the tasks it is intended to support. So, acceptance of technology is a function of the involvement of the user in the use of technology. For the success or failure of any technology, its acceptance is critical. Dillon and Morris (2001) argue that the acceptance of technology is a psychological process that can be conceptualized as an outcome variable that users go through when deciding about the technology.

Therefore, the Technology Acceptance Theory (TAM) initially projected by Davis (1989) is an Information Systems theory that models how users embrace and use a technology.

Davis (1989) drew out the two key determinants of TAM which are firstly, perceived utility, which is the level to which an individual believes that the utilization of a system can advance his performance; and secondly, perceived ease of use, which is the level to which an individual believes that the utilization of an information system will be free of effort. These two factors are the perceived usefulness of a technology and the perceived ease of use of the technology. Firstly, the perceived usefulness is the likely benefits from using a certain technology. Secondly, the perceived ease of use is like the perceived behavioral control in the theory of planned behavior. In the TAM model, individuals who see technology as useful and easy to use embrace the technology with ease than those who do not, with usefulness more imperative than the ease of use.

As shown in Figure 2.1, the model points that behavioral intent to use a system with the objective to use serving as a intermediary of real system use is a task of both perceived usefulness and perceived ease of use. Both attitude and perceived usefulness mutually determine the behavioral intent and attitude is determined by both perceived usefulness and perceived ease of use.

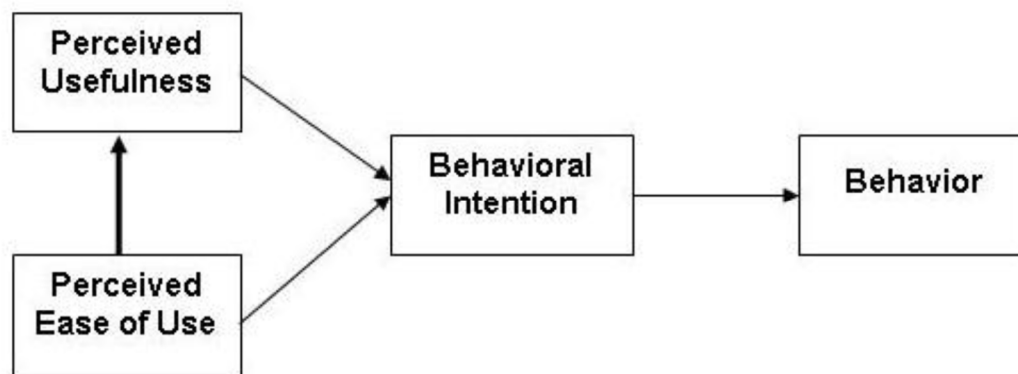


Figure 2.1 Technology Acceptance model

Source: Davis *et al*, 1989

Therefore, from the model, the perceived ease of use of irrigation, and its perceived usefulness will lead to a behavioral intention or attitude, and change the behavior or attitude towards the irrigation technology, hence leading to whether or not to adopt it. Also, according to the TAM theory on how users embrace and use a technology, though embraced by few, farmers in Kee ward have held that irrigation has positive impact in improving food production. According to

Davis (1989), in line with the two key determinants of TAM, i.e. perceived utility and perceived ease of use, those who have seen irrigation as useful and easy to use have embraced it, where usefulness is more imperative than the ease of use.

2.2.3 Resource Based Theory

The resource based theory looks into the reasons why organizations in the same industry vary in their performance over given time. This theory asserts that the difference in the performance is attributed to the differences in the firm's internal capabilities that yield to competitive advantage for the organizations. According to Wheelen and Hunger (2012), a capability refers to a firm's capacity to make use of its resources. It consists of business processes and routines that direct the dealings among resources to turn inputs into outputs. Through a firm's continued use of resources, the capabilities of the firm become stronger and very difficult for the competitors to comprehend and imitate. Therefore as a source of competitive advantage, Hitt, et al, (2005) argues that a capability should neither be so simple imitable, nor so complex that it defies internal steering and control. When capabilities and resources are the firm's source of competitive advantage over its rivals, then this is said to be the core competency for the firm. It is an important internal activity that a firm performs better than other internal activities which are equally or less competitive. These may include expertise in building internal and external networks and systems that enable good after-sales services, speeding new or next generation products to the market, e-commerce, speed and agility in responding to new markets and innovativeness in developing popular product features (Thompson and Strickland, 2003).

The resource based theory provides two important assumptions that explain firm resource heterogeneity and firm resource immobility. These are that the resources that firms have are not similar and that these resources are largely immobile and can't be easily moved, therefore in such an atmosphere competitive advantage can then easily be created (Barney, 1986). Hitt, et al, (2005) argues that the theory holds that there are four main attributes of resources that lead to competitive advantage, i.e. being rare, non-substitutable, valuable, and costly to imitate. Resources are considered to be valuable if they permit an organization to take advantage of opportunities and or neutralize threats in its outside environment. Resources are rare if they are possessed by few. Resources are said to be costly to imitate if other firms cannot obtain them, or are at a cost disadvantage in obtaining them as compared to the firm that already possesses them.

Lastly, resources are said to be non-substitutable if they have no equivalents. When these four attributes are met, then the capabilities and resources are said to become core competencies. In such a situation, the firm has the potential to exploit an opportunity in the market, thwart competitive threats, conceive, adopt and implement the strategies that improve efficiency.

This theory holds that resources are the firm's major determinants of performance, and they may contribute to the firm's sustainable competitive advantage. According to Ireland, et al (2013), the concept of resources includes all the inputs into the production process of the firm, which include finances, equipment, capital, skills of employees, gifted managers, patents among others. According to Pearce and Robinson (2005), this theory suggests that organizations differ in essential ways because each firm has a sole package of resources, which mainly are tangible, intangible and organizational assets. The firm's tangible assets are the material and monetary means the organization uses to offer value to its consumers. They include the production services, unprocessed materials, financial assets, computers and real estates, and are found in the organization's balance sheet. The intangible resources include brand names, reputation of the organization, original self-esteem, technological information, patents and trademarks, and accumulated knowledge within the organization. The firm's capabilities are the skills, which are the ways of combining assets, people and processes, which an organization uses to convert inputs into outputs.

However, according to Hitt et al, (2005), since a major characteristic of a resource is that its competitors find it hard to imitate, many resources can either be substituted or imitated over time. Therefore it is not easy to attain and maintain a competitive advantage based on resources, and the advantage will not last for long.

According to Pearce and Robinson (2005), the resource based theory is used in internal analysis of the firm. The firm must recognize and assess its assets to discover those that offer the basis for future competitive advantage. Pearce and Robinson (2005) give four guidelines to the internal analysis. Firstly, disaggregate the resources by breaking them into more particular competencies, rather than keep on with extensive categorizations. Secondly, utilize the functional perspective. This involves looking at different practical areas of the organization, disaggregating tangible and intangible resources as well as the firm's capabilities that they possess and can begin to unearth vital value-building resources and actions that serve additional analysis. Thirdly, look at the firm's processes and combinations of assets. This involves taking a creative gestalt look at what

competencies the firm possesses that might generate competitive advantage. Fourthly, use the value chain approach to unearth the firm's capabilities, actions and processes that are valuable potential sources of competitive advantage.

Since the resource based theory only focuses inside the firm, each farm unit is seen as a complete organization, and these organizations vary in their performance over time due to differing internal capabilities. These capabilities are their sources of competitive advantage. The farms differ in essential ways because each of them has sole package of resources, which mainly are tangible, intangible or organizational. Since for the adopters to reach a competitive edge and creative advantage over the other farmers, their resources are rare, non-substitutable, valuable and costly to imitate. This has made the adopters take up the innovation of irrigation.

2.2.4 Factors Affecting the Adoption of Irrigation

Adoption of irrigation as a strategy towards food production can be influenced by various factors. One of the major factors that affect the adoption of irrigation is training of the farmers. Robbins and Judge, (2013) argues that training is intended for upgrading and improving an employee's practical skills which is important for new technology and new structural designs in the firm. They further argue that illiteracy implies that there is nearly no hope of competing in a global economy. Training can take two forms, namely on-the-job training which takes place as one is doing the job, and off-the-job training which is accomplished outside the work setting (Schesmerhorn, 2001). According to Torrington, et al (2011), training increases awareness of the regulations, hence improving on self-confidence and self-discipline. There will be innovative working dealings or new tools from time to time. Also training reduces the threat of safety offences, unreliability or neglect. Training which is compensated for by the employer is a very good deal and is less probable of raising job mobility than that which is paid for by the employee or the government (Torrington, et al, 2011).

Level of income is another factor affecting adoption of irrigation. Income can be defined as the money received in duration of time in exchange for services or labour, from sale of properties or goods, or as a profit from monetary investments (The American Heritage Dictionary, 2005). The level of income is the amount of money the household head earns and distributes adequately to meet the needs of the family. It answers the question of "how enough is the income to meet the

family's needs?" the level of income of the household head is a major determinant to financing irrigation, hence its adoption.

Availability of agricultural extension services is another factor affecting adoption of irrigation. Agricultural extension is the assistance given to farmers to assist them to recognize and evaluate their production problems and to become aware of the opportunities for improvement. The extension worker is an adviser, a technician, a change agent, a middle man operating between agricultural institutions and the farm families; he is the contact person with the farmers in the village and helps farmers in the productivity of their farms and improvement of their living standards (Adams, 1994). Training and extension information is acquired through informal sources like the media, visits, extension personnel, farm organizations and meetings, and also through formal education. Reliable, consistent and accurate information is needed for effective adoption of irrigation. According to Adams (1994), farmers get assistance to recognize and examine their problems in production, and therefore they become more aware of the room and opportunities for improvement. Seeing good results in a neighbor's farm is more persuasive than seeing good results on a research station.

The level of education is another factor affecting the adoption of irrigation. According to Asadullah and Rahmsn (2009), education is likely to improve efficiency in all areas of activities together with agriculture. For instance, a positive gain to education come when educated farmers are better managers, take up modern farm inputs and have a preference to risky production technologies. Also, according to Kalirajan and Shand (1985), the level of non-formal education is also a significant factor in adoption of irrigation and other technologies. The behavior of individuals ultimately determines the success or failure of organizational endeavors and top management concerned with strategy and its adoption must realize this (McCarthy et al, 1986). Education courses undertaken during a career are mainly on part-time basis. Such educational courses provide worth for both the employee and the employer. Also, consultancy courses, which have a length ranging from hours within a day to several weeks and are run by consultative or professional bodies from all corners contribute to the farmers' educational value.

The adoption of an agricultural innovation is an action, and is accompanied by the intention to use the innovation for as long as the innovation offers an advantage over alternative practices.

Adoption includes the invention, reinvention, modification and adaptation of a technology or practice, but excludes trialing prior to implementation. The agricultural innovation may be a new discovery, a recent invention, or may have long been known to the producer (Rogers, 1995). The rate of adoption refers to the number of people who begin using a new technology or innovation during a specified period of time in a society. It is a relative measure, meaning that the rate of adoption one group is compared to the rate of adoption of another, often of the entire society.

2.3 Empirical literature

Several studies have been done in the field adoption of strategies and related areas.

In his study, Tumuti (2013) did a study by analysing the factors influencing adoption of information communication technology by community based organizations (CBOs) in Kenya, where he did sampled his study as Thika District. The objective of his study was to survey the factors which influence adoption of Information Communication Technology by CBOs in Kenya. The study limited its scope to those CBOs found in Thika District. The study used a descriptive survey design with a target population of 28 CBOs based in Thika District. The number of respondents was 84, three from each CBO. The research instrument used in the study was the questionnaire which was developed based on the specific research objectives. The data was organized and analyzed using descriptive and inferential statistics. The quantitative data was analyzed using mean, mode, median and analysis of variance. Quantitative data was presented by application of statistical techniques which include frequency distribution tables and graphs. The qualitative data was analyzed using content analysis. His study established that most of the CBOs in Thika district had computers or laptops; 100% indicating they owned computers and 14.7% indicating they owned laptops. Thus indicating CBOs in Thika district had adopted ICT to a certain level. The operating systems that the CBOs were running included Windows 2000, 2003, XP, Vista and 2007. The CBOs used computers mostly for work related tasks which include; report writing 66.7% and applying for donor funding 52.9%. The CBOs also indicated to have adequate peripheral devices which included; printers 76.5%, copiers 14.7%, scanners 8.8% and web camera 2.9%. All the CBOs had basic cell phones, 67.4% of the CBOs had 3G Cell phones and 5.9% had landline telephones. Only 11.8% or 3 out of the 28 CBOs had project management software on their computers. The study recommended that CBOs should offer their employees proper ICT training, budget for ICT needs, encourage employees to have an open attitude towards change and to create and implement effective ICT policies.

Muhammad-Lawal, et al (2013) did their study on the determinants of adoption of irrigation technology by small-holder farmers in selected local government areas in Kwara state, Nigeria. The objective of their study was to look into the factors affecting the adoption of irrigation technology in selected local government areas in Nigeria. The research design used was descriptive, where a questionnaire was structured and used to collect data from 117 respondents. The major variables examined were gender of the household head, level of education of the farmers, the size of the farm, the household size, access to credit and the farming experience of the farmers. Descriptive statistics and logistic regression model were the major analytical tools employed to analyze data collected. Results of analysis revealed that gender of the household head, level of education of the farmer and access to credit are the major determinant of adoption of irrigation technology in the study area. The study therefore recommended that government should design adult education programmes for farmers in the rural areas to enhance their adoption of improved technologies. Credit should also be made available to the farmers through the establishment of low interest credit schemes accessible to the farmers with little or no collateral. The need for the government to raise awareness on the benefits of irrigation farming is also recommended.

Njuguna, (2013) did his study on the assessment of the role of social capital in the adoption of agriculture innovation among smallholder farmers, where he did a case of tissue culture (TC) banana in Kenya. The objective of his research was to look at the influence of social capital on adoption of technology, where the study used the case of adoption of TC banana technology by small holder farmers in Maragua and Murang'a districts of Central Kenya. The questionnaire, observation recording form, key informant interviews and focus group discussion were used to collect primary data, while secondary data were obtained from organizations that had participated in the TC project implementation. The study found out that social capital greatly increased TC adoption. Network density, trust and group leadership indicators had significant influence on TC adoption. The study showed that network density indicator was mobilized through extension agents, third party introduction, group leaders, individuals, inheritance, media, exhibitions, field days and agricultural shows and influenced adoption by increasing access to resources, removing the barrier to information, reducing the time for decision making and creating opportunity for referral to partners who could provide additional resources. Trust was cultivated through regular face-to-face meetings and joint activities. It served as a lubricant to the

relationship between the TC adopters and their network partners and was an important component in building and maintaining the ties. Group leaders were elected through a democratic process and provided vision, encouragement, and forged links with external partners. The other social capital indicators considered in this study which included, network depth, joint activities, group decision-making, cohesion/solidarity, rules, norms and group meeting attendance had no significant relationship with TC adoption. The study recommended that smallholder adopters of agricultural innovations in groups should be treated as entrepreneurs who should be supported to build networks founded on trust with strong leadership. The study also recommended the use of the framework for further conceptual and empirical evaluations to assess if the three indicators are applicable in the adoption of other technologies, taking into account the fact that some aspects of these studies were technology-specific.

Wanjala (2011) did his study on the factors affecting the adoption of Star French beans varieties by horticultural export growers in Naivasha. The objective of his study was to highlight the main factors that affect the adoption of Starkeyres star French bean varieties in the export horticulture sector in Kenya since its launch in 2008. Descriptive research design was adopted where the population under study were two major export companies and two minor companies, two individual growers in the Star French bean growing areas in Naivasha, and two export processing pack house at the Jomo Kenyatta International Airport in Nairobi. The questionnaire was the data collection instrument, where the results were analyzed using percentages, cross tabulations, frequencies, mean scores, and presented in bar graphs, tables and pie charts. The study showed that the adoption of the French beans seed is the delicate balancing act of having the right seed price, quality seed, yield potential, being above the competition and having a variety with the desirable post harvest attributes as per the customer satisfaction. The study recommended for more players to invest in technology to improve on the genetic germ plasm, the seed industry players to focus on quality controls and inculcate it into day to day activities of its operations. Also, the government needs to allocate enough resources to spur research in French beans, and also needs to improve its quality regulation organization to ensure a level playing ground for multinational and other small companies.

However, all these studies, though important, have not looked into the factors affecting the adoption of irrigation as a strategy to enhance food production, which my study will focus on.

2.4 Literature overview

Tumuti (2013), Muhammad-Lawal et al (2013), Njuguna, (2013) and Wanjala (2011) as outlined in the empirical literature did their studies on adoption of strategies. They studied the factors as mentioned and made their recommendations. Of the factors under their study include network density, trust, group leadership, gender of the family head, size of the farm, family size, farming experience, pricing, seed quality, yield potential, availability of other varieties of seeds and post-harvest quality traits. However, all these studies, though important, have fallen short of identifying and studying the effect of training and extension services as a factor affecting the adoption of strategies. Also, none of these studies were done in ASAL and food insecure regions, and neither of them was done with a purpose of improving food security of their areas of study. Therefore, this study will investigate into the factors affecting the adoption of irrigation as a strategy to enhance food production by farmers in Kee Ward, Makueni County.

While there is evidence of studies by other researchers in the field of adoption of strategies, it is evident that most of the studies conducted fall short of identifying the factors affecting the adoption of irrigation as a strategy to enhance food security more so in the ASAL areas. In effect, this study sought to address the issues that other researchers fell short of addressing exhaustively.

2.5 Conceptual Framework

From the reviewed literature, it is clear that adoption of irrigation can be influenced by the level of farmer's income, the level of education of the lead farmer in the family, and the existence of training and extension services to the farmers. These variables are conceptualized to be related as shown in figure 2.2.

The level of income can be defined as the amount of money the household head earns and distributes adequately to meet the family's needs. It answers the question of "how enough is the income to meet the family's needs?" The level of income of the household head is a major determinant to financing irrigation, hence its adoption. According to Neubert, et al. (2007). The low cost technologies are used by unfortunate small rural families and for home farming in suburban areas. They usually range from bucket irrigation and drum kit irrigation to rope & washer pump systems, to more advanced treadle pumps and manually operated force pumps.

Independent variables

Dependent Variable

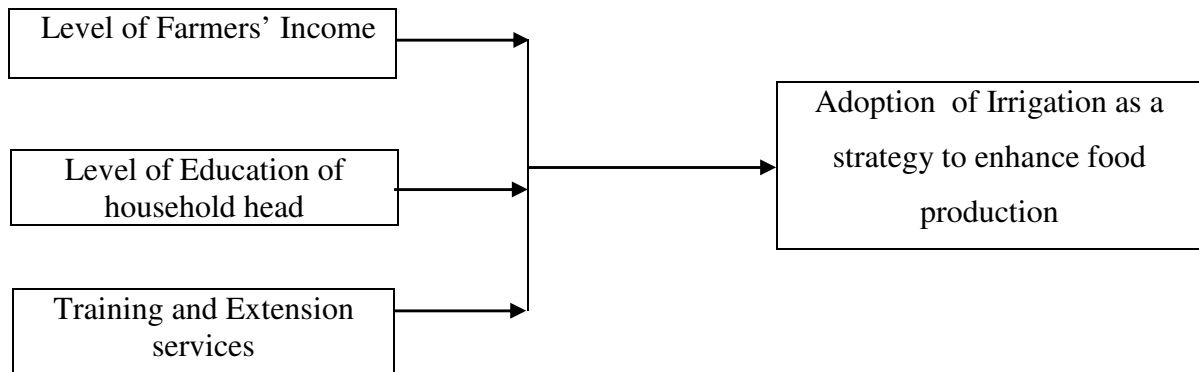


Figure 2.2 Conceptual framework

The level of education refers to the educational stage one has progressed in the education ladder. The level of education ranges from lower primary level to tertiary level. These levels include lower primary, primary, secondary and college/university levels; whereas educational attainment is the highest level of schooling that a person has reached (Level of Education, 2017). Both non-formal and formal educations are key drivers to adoption of irrigation. Intermediate and higher education in agriculture play a decisive role in rural development and sustainable agricultural production. Formal education is a key to innovativeness; hence it plays a leading role in food production and rural development.

Training is the formal and systematic modification of behavior through learning which occurs as a result of education, instruction, development and planned experiences (Armstrong, 2001). According to Torrington et al (2011), training increases consciousness of the rules, hence improving on one's self-discipline and self-confidence. Since there will be new working equipment and procedures from time to time, training will decrease the risk of safety offences, unreliability and even negligence. Agricultural extension is the support given to farmers to aid them in identifying and analyzing their production shortfalls and to help them be aware of the opportunities for development. An agricultural extension worker is an adviser, a technician, a change agent, a middle man operating between agricultural institutions and the farm families, and helps farmers in the productivity of their farms and improvement of their living standards (Adams, 1994). Training and extension information is gotten from informal sources like the media, farm organizations, farm meetings, agricultural extension personnel and farm visits, and

through formal education. Reliable, consistent and accurate information is needed for effective adoption of irrigation.

Adoption of irrigation is the acceptance for use of the irrigation technology to replace or supplement rain water with another source of water.

2.6 Research Gap

From the empirical literature reviewed, Muhammad-Lawal, et al (2013) did their study on the determinants on adoption of irrigation technology by small-holder farmers in Nigeria. Wanjala (2011) did his study on the adoption of Star French beans varieties by horticultural export growers in Naivasha. Njuguna (2013) did his study on the assessment of the role of social capital in the adoption of agriculture innovation among smallholder farmers, among others.

Though these studies dealt with adoption of strategies in agriculture, none of them addressed both subsistence and commercial farming in the ASALs. Also, none of them investigated the influence of agricultural extension services on uptake of irrigation as a strategy towards food production. Also, none of them was done with the purpose of improving food security in the area under study. This study will therefore look into the factors affecting adoption of irrigation in Kee Ward which is purely an ASAL. It will also give its findings and its recommendations that will give the interventions leading to adoption of irrigation strategy hence leading to improvement of livelihoods of people in ASAL areas.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the methodology which was used in the study. It adopted the following structure: Introduction, research design, target population, sampling procedure, data collection instruments, data collection procedure, pilot testing and data processing and analysis criteria.

3.2 Research Design

This study used descriptive research design because of the nature of the variables that were at hand to give data needed for quantitative analysis. According to Kothari (2004), descriptive research studies are concerned with describing the characteristics of a particular individual, or of a group. They are concerned with specific predictions, narration of facts and characteristics concerning individual, group or situation. It allowed the use of primary data collected and gave room for application of the study results in the area of irrigation.

3.3 Target Population

The target population of this study was all the farmers within Kee Ward, who number about 4,298 farmers (KWAO, 2017), who include 62 commercial farmers and 4,236 subsistence farmers.

3.4 Sampling Procedure

From the target population, the study applied a two stage sampling to select the respondents of the study. First, since the number of all the farmers who have adopted irrigation in Kee ward is 28, purposive sampling technique was applied since they had the desired characteristics for the research exercise. According to Saleemi (2011), the researcher exercises his ruling in the choice of the items which are sampled and then includes them in the sample which he thinks are most typical of the population with regard to the characteristics under investigation. The 28 farmers who had adopted irrigation therefore formed part of the sample. Secondly, the study randomly sampled out from all the 8 sub-locations a total of 28 farmers who had not adopted irrigation to counter-match the number of farmers who had adopted irrigation. According to Saleemi (2011), every item of the population is given a fair chance of being included in the sample in the simple

random sampling. The study therefore had a sampling frame of 56 farmers who became the respondents in the research exercise, as detailed in table 3.1.

Table 3.1

Target Population and Sample size of Farmers in Kee Ward

Sub-location	Subsistence who have adopted irrigation	Commercial who have adopted irrigation	Total famers adopted irrigation	Sample of farmers who have not adopted irrigation	Total Sample Population
Makongo	0	2	2	4	6
Ikalyoni	0	0	0	4	4
Kivani	0	2	2	4	6
Kyamwalye	0	6	6	3	9
Kitandi	1	8	9	3	12
Nguluni	0	1	1	4	5
Kasunguni	3	3	6	3	9
Mutulani	1	1	2	3	5
Total	5	23	28	28	56

Source: Bill and Melinda Gates Foundation, 2013

KWAO, 2017

3.5 Data Collection Instruments

Questionnaires were used to collect data, where the questionnaires contained both open-ended questions and closed ended questions. Mugenda and Mugenda (2003) describe the questionnaire as easy to administer, permit a greater degree of response and are easy to analyze because they are in direct usable form. Kothari (2004) terms the questionnaire as the most appropriate instrument due to its capacity to collect a large amount of data in a reasonably quick period of time. It also guarantees privacy of the source of information through anonymity while ensuring

standardization (Churchil, 2003). It is for these reasons that the questionnaire was the most appropriate instrument for this study.

3.6 Data Collection Procedure

An introductory letter to carry out the study was obtained from Machakos University. Also, a research permit was sought from the National Council for Science and Technology through the Ministry of Education, Science and Technology at their Makueni County offices. The questionnaires were then delivered to the respondents to collect data from them as they went about their normal daily duties. The respondents filled in the questionnaires in the presence of the researcher as he monitored the process of data collection to ensure that involuntary people do not fill in the questionnaires. From the farms, the researcher administered the research tool to the farmers in each sampled farm. Only one member from each farm participated in the research exercise, preferably the lead farmer.

3.7 Pilot Testing

Pilot study of a selected sample (5 respondents) from outside Kee ward was carried out a week prior to the data collection exercise. The purpose of the pilot testing exercise was to test the validity and reliability of the questionnaire. According to Mugenda and Mugenda (2003), validity is the degree to which results obtained from the analysis of the data actually represent the phenomenon under study, while reliability is the measure of degree to which a research instrument yields similar results under consistent conditions. Another purpose of the pilot testing was to remove any irrelevant question items in the questionnaire and focus it to collect the right information.

After the pilot testing, the research tool was adjusted appropriately. The results of the pilot testing were however discarded since they would not be used in the study. A week after the pilot study, the research tool was administered to the target population.

3.8 Data Processing and Analysis

Data was processed by coding the answered questionnaire for categorization which is necessary for efficient analysis. Also, classification and tabulation was done for further and easier analysis. Since the study was based on descriptive method and adopted descriptive statistical methods of data analysis, the data was analyzed using percentages, cross tabulations, frequencies, mean

scores, standard deviation and a regression model. The processed data was then presented in pie charts, line graphs, bar graphs, tables and histograms.

The regression model adopted is a multiple regression model since it involves more than one variable, and was used to examine the relationship between the dependent variable with the independent variables.

The general multiple regression model adopted was:

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \dots + \beta_nX_n + \epsilon$$

Where:

Y = the dependent variable which is a function of k independent variables X_1, X_2, \dots, X_n

ϵ = the random-error term which is added to make the model probabilistic rather than deterministic

β_0 = the Y-intercept

$\beta_1, \beta_2, \dots, \beta_n$ = the coefficient which determines the contribution of the independent variable X_1 .

$X_1, X_2 \dots X_n$ = the independent variables.

Source: McClare and Sucich, (2009)

Since there were three independent variables and one dependent variable, the regression model became:

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \epsilon$$

Where:

Y = Adoption of Irrigation as a Strategy (dependent variable)

X_1 = Level of farmers' income (1st independent variable)

X_2 = Level of education of farmers (2nd independent variable)

X_3 = Training and extension services (3rd independent variable)

CHAPTER FOUR

RESEARCH FINDINGS

4.1 Introduction

This chapter reports the findings of the research study as they relate to the research questions in the questionnaire. The responses from both the open ended and the closed ended items were all summarized in tables, pie charts and graphs using frequencies. Analysis of the data was done using percentages, cross tabulations, frequencies, mean scores, standard deviation and a multiple regression model.

4.2 Response Rate

From the respondents, both the farmers who had adopted irrigation and those who had not, a 100% response rate was recorded. This was attributed to the fact that the researcher and his assistant had the respondents fill in the questionnaires in front of them and did not leave the respondents with the research tools to fill later. Therefore, the filled questionnaires were collected immediately. The respondents also sought clarification on some questions from the researcher where necessary and therefore they were able to answer all the question items. According to Mugenda and Mugenda (2003), a response rate of 50% is sufficient for analysis and reporting, a rate of 60% is good and a response rate of 70% and above is excellent. Therefore, the response rate of this research exercise was excellent.

4.3 Characteristics of the Study Sample (Demographic Data)

This section presents the findings on the demographic details of the respondents. These include the type of the farming, the age of the respondent, the gender and number of years in active farming.

4.3.1 Type of farming

The respondents were required to state the type of farming they are engaged in. From the findings, of those who had adopted irrigation, 14.3% of them were subsistence farmers while 85.7% were commercial farmers. For those who had not adopted irrigation, 85.7% were subsistence farmers while 14.3% were commercial farmers. This is as presented in figure 4.1.

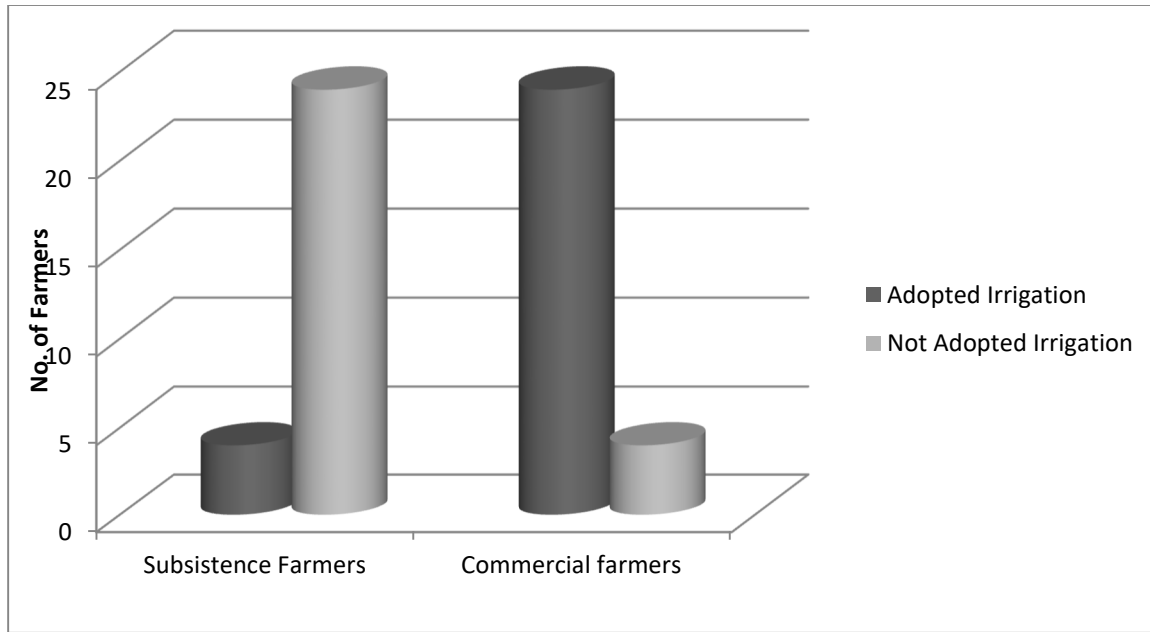


Figure 4.1: Type of farmers

4.3.2 Age of the respondents

The respondents were required to indicate their age. The results are as presented in figure 4.2. From the findings, for those who had adopted irrigation, 21.4% of them were between 31 and 40 years, 60.7% were between 41 and 50 years, and 17.9% were between 51 and 60 years. The mean age of those who had adopted was 45.14 years, while the modal age was between 41 and 50 years.

For farmers who had not adopted irrigation, 21.4% were between 18 and 30 years, 14.3% were between 31 and 40 years, 21.4% were between 41 and 50 years, 25% were between 51 and 60 while 17.9% were those above 60 years. The mean age of those who had not adopted irrigation was 45.54 years, while the modal age was between 51 and 60 years.

For the farmers who have adopted irrigation, the modal class (41 – 50 years) implies that these farmers are in the prime of their life, are youthful and are financially stable. Also this may imply that they are investing for their retirement period.

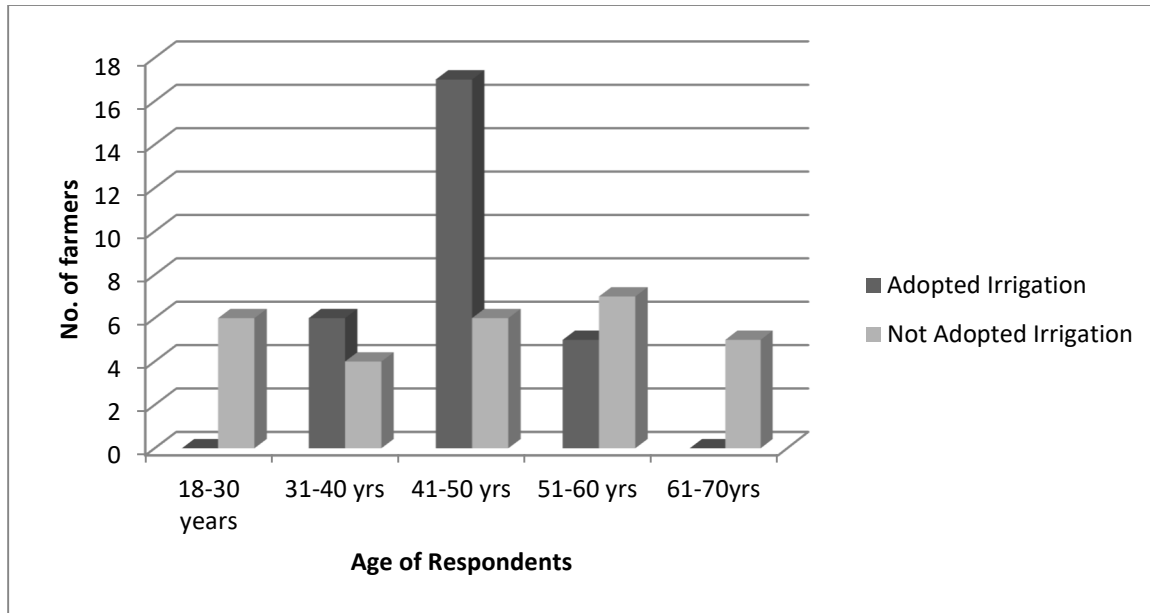


Figure 4.2: Age of the Respondents

4.3.3 Gender of the respondents

The respondents were also required to indicate their gender. The results are as presented in figure 4.3. In both cases (those who had adopted irrigation and those who had not adopted), according to the findings, 67.9% were male while 32.1% were female. From Fig. 4.3, it is clear that most farmers were males as opposed to females. This is perhaps explained by the fact that in most households, males are the heads.

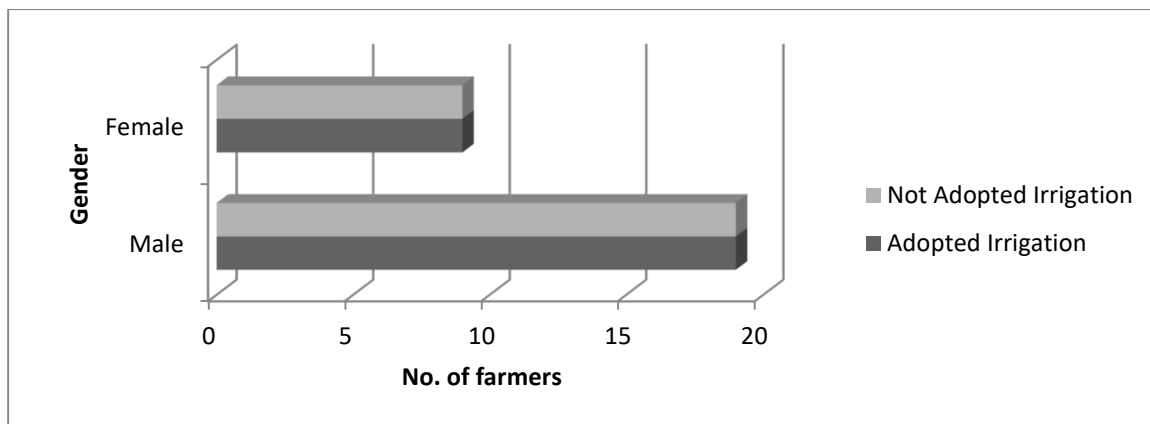


Figure 4.3: Gender of Respondents

4.3.4 Number of years in active farming

The respondents were required to indicate the number of years in active farming. The results are as indicated in figure 4.3. From the findings, for those who had adopted irrigation, 25% had at most 5 years in farming, 42.9% of them had farmed for between 6 and 10 years, 10.7% of them had farmed between 11 and 15 years, 7.1% of them had farmed between 16 and 20 years, and 14.3% of them had farmed between 21 and 25 years.

For those who had not adopted irrigation, 17.9% of the farmers had done farming for at most 5 years, 21.4% of them had farmed between 6 to 10 years, 35.7% of them had farmed between 11 and 15 years, 10.7% of them had farmed between 16 and 20 years, 10.7% of them between 21 and 25 years, and 3.6% had farmed for over 25 years.

The majority of adopters practicing farming in less than 10 years may perhaps be explained by the fact that they are educated and innovative, and want to venture into farming.

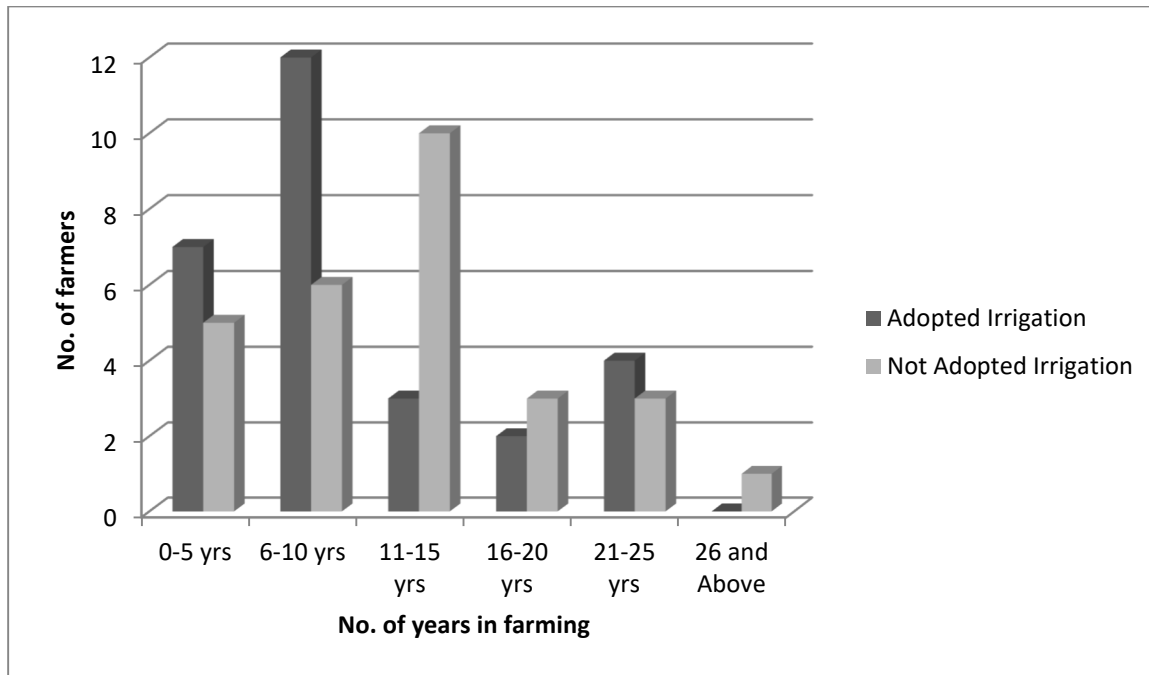


Figure 4.4: Number of years in active farming

4.3.5 Adequacy of water for irrigation

The respondents were required to indicate whether they had enough water to carry out irrigation or not. The results are as indicated in figure 4.4. From the findings, of those who had adopted irrigation 89.3% of them had enough water to do irrigation while 10.7% of them didn't have

enough. For those who had not adopted irrigation, 46.4% had enough water near them to carry out irrigation while 53.6% did not have.

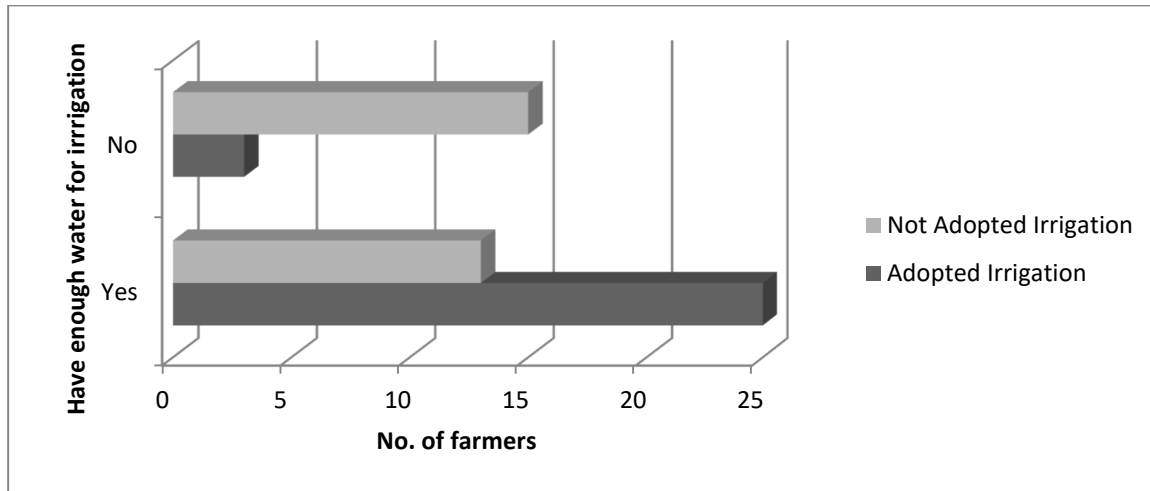


Figure 4.5: Adequacy of water for irrigation

4.3.6 The Source of Water

The respondents who admitted to having enough water for irrigation were required to state the water source near their farms. The results are as indicated in table 4.5. Those who had adopted irrigation, 46.4% were close to sand dams while 53.6% were close to permanent water dam (whether public or private water dam). For those who had not adopted irrigation, 46.4% were close to a water source, where of the 46.4%, 76.9% of them were close to sand dams, 15.4% close to permanent water dam and 7.7% close to water well. From the findings it implies that there is a relationship between proximity to the water points and adoption of irrigation.

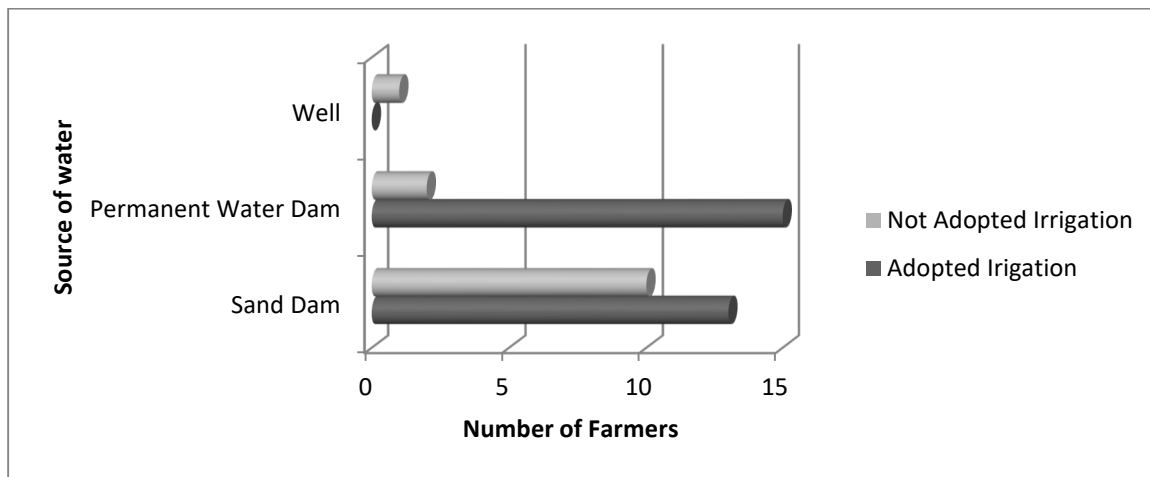


Figure 4.6: Source of water

4.4 Research Findings and Discussion

This section presents the findings of the study and discussion of the same objective wise.

4.4.1 Farmers' Level of Income and adoption of Irrigation

The first objective of the study was to assess the extent to which the level of farmers' income affects the adoption of irrigation as a strategy towards enhancing food production among farmers in Kee Ward, Makueni County. The findings of the study are as shown.

4.4.1.1 Main Source of Income

The respondents were required to indicate their main source of income. The results are presented in figure 4.6. From the findings, for those who had adopted irrigation, 85.7% of the farmers were salaried workers while 14.3% were on wages. On the other hand for those who have not adopted irrigation, 21.4% of the farmers were salaried while 78.6% earned their living on wages.

The salaried workers have a steady and non-fluctuating source of income, hence the reason for the large number of adopters.

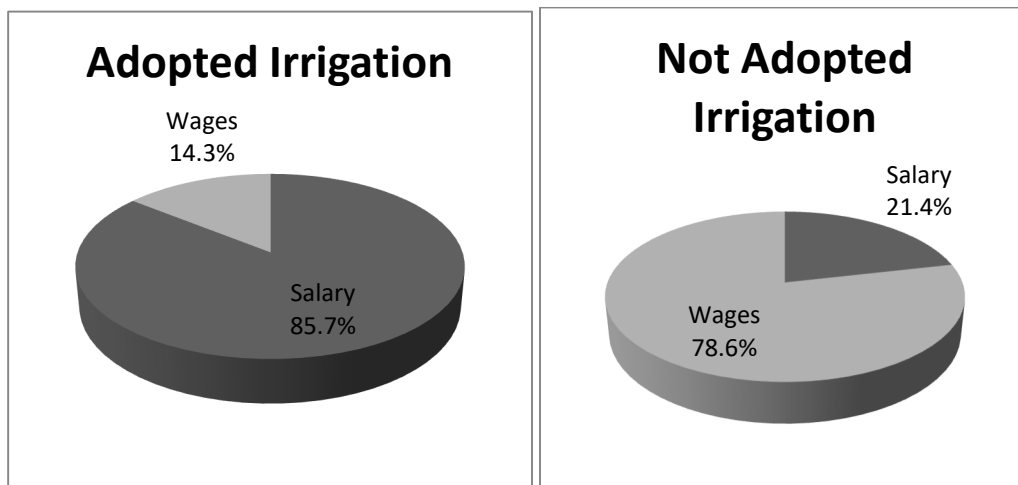


Figure 4.7: Main Source of Income

4.4.1.2 Extra sources of income

The respondents were asked to indicate whether they have any extra source of income apart from their salaries or wages. Of those who had adopted irrigation, 89.3% of them had other sources of income, while 10.7% depended on their salaries/wages only. Of those who had not adopted irrigation, 7.1% of them had extra sources of income, while the rest (92.9%) did not have an

extra source of income to supplement their source of main source. The results are illustrated in figure 4.7.

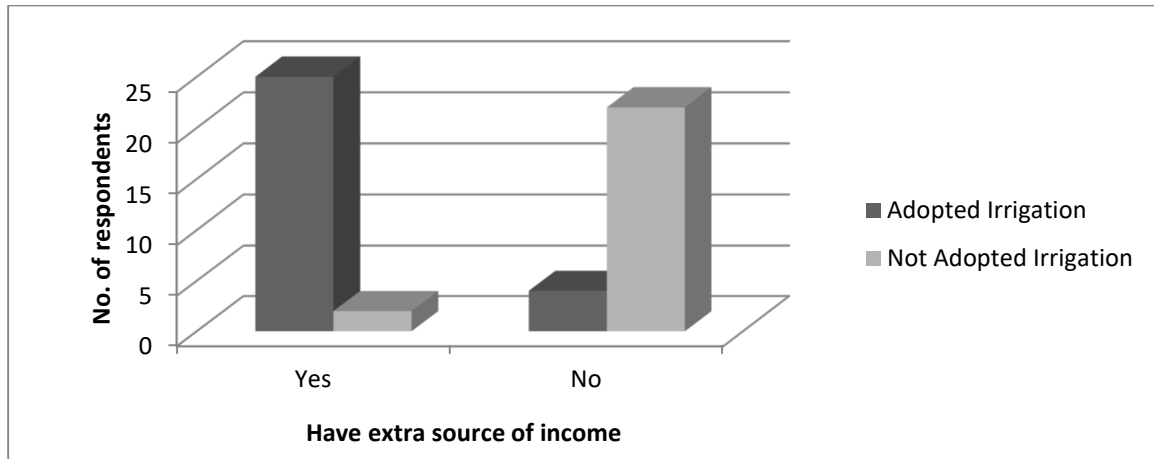


Figure 4.8: Extra Sources of Income

Since majority of the adopters have a high source of income and they too have an extra source of income then this explains the reason why they have taken up the innovation. Most of the non-adopters have limited source of income.

4.4.1.3 Level of Income

The respondents were asked to indicate the level of their income they earn. The results are presented in figure 4.8. From the findings, for those who had adopted irrigation, 14.3% of the farmers earned between Ksh. 15,000 and 30,000, 25% others earned between Ksh. 30,001 and Ksh. 45,000, while the rest (50%) earned an income of above Ksh. 45,000. For those who had not adopted irrigation, 46.4% of the farmers earned less than Ksh. 15,000, 25% earned between Ksh. 15,001 and 30,000, 21.4% earned between Ksh. 30,001 and 45,000, while 7.1% had an income of above Ksh. 45,000.

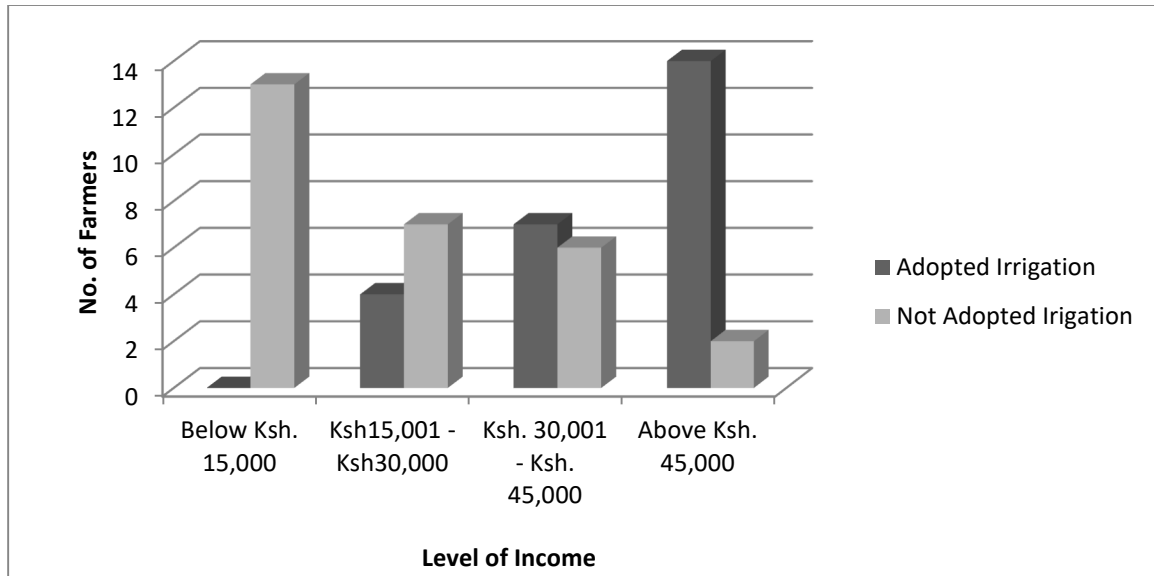


Figure 4.9: Level of Income

Most of the adopters have a high source of income, where for most of them, the income from irrigation supplements their main source of income since most of them are commercial farmers.

4.4.1.4 Income and Family Needs

The respondents were required to indicate whether their income was sufficient to meet their family’s needs. The results are presented in figure 4.10. All the adopters of irrigation (100%) admitted that their income was enough to meet their family’s needs. For those who had not adopted irrigation, 7.1% indicated they earned enough for their families while the rest (92.9%) indicated that their income was not enough.

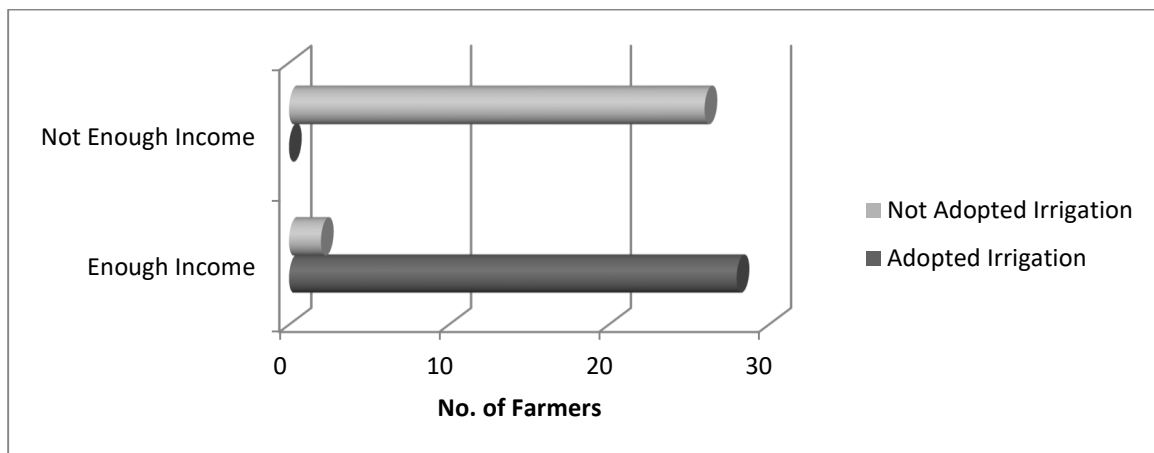


Figure 4.10: Enough Income for Family

The adopters had enough income since the income from their irrigation projects supplemented their income, hence probably the reason their income was enough to meet their family needs.

4.4.1.5 Income and Irrigation system

The respondents were requested to give their opinion on whether their income can run or buy an irrigation system. All those who had adopted of irrigation admitted that their income is enough to buy or run an irrigation system, while all those who had not adopted irrigation indicated that their income is not enough to buy or run an irrigation system. This can be attributed to the levels of income of the adopters and non-adopters respectively. This indicates that the level of income affects adoption of irrigation.

4.4.1.6 Income savings towards irrigation

The farmers were required to indicate whether they make any savings towards buying or running an irrigation system. The results are presented in figure 4.11. From the findings, majority of those who had adopted irrigation made some savings towards running and maintaining the irrigation system, while those who had not adopted irrigation none of them made savings towards buying an irrigation system. The findings show that there is a relationship between the amounts of income saved by the farmer and adoption of irrigation. Adoption of the irrigation innovation comes along with maintenance of the same, hence the reason for savings made towards maintaining the irrigation system.

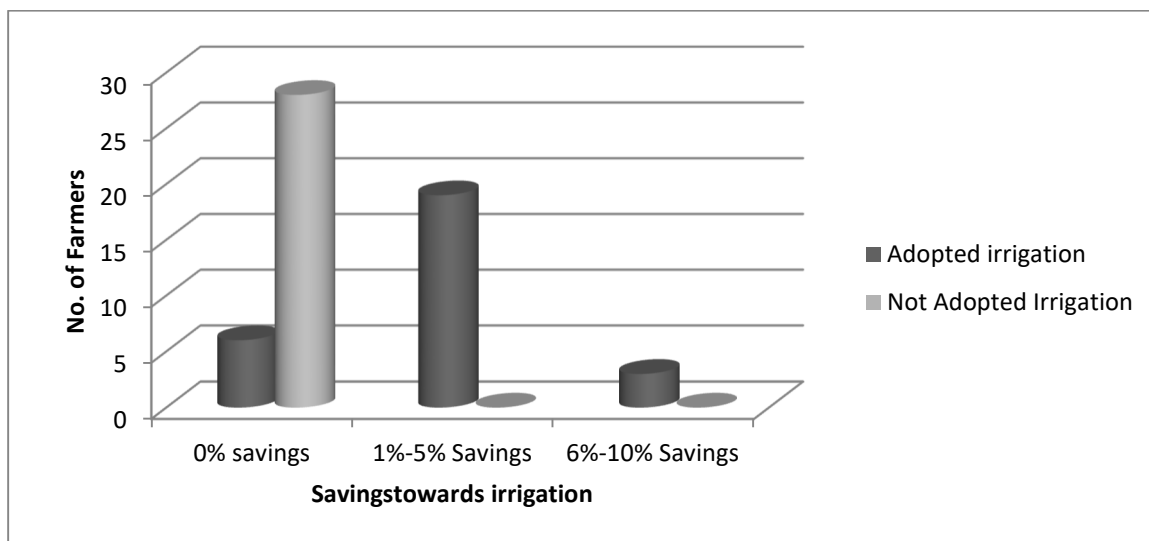


Figure 4.11: Savings towards Irrigation

4.4.1.7 Effect of Level of Income on adoption of Irrigation

The respondents were required to indicate whether the farmer's level of income has an effect on adoption of irrigation. The results are presented in figure 4.12. From the findings, all those who had adopted irrigation indicated that a farmer's level of income has an effect on his adoption of irrigation. However, of those who had not adopted irrigation, 92.9% of them indicated that the level of the farmer's income affects his adoption of irrigation, while 7.1% of them were for the contrary opinion.

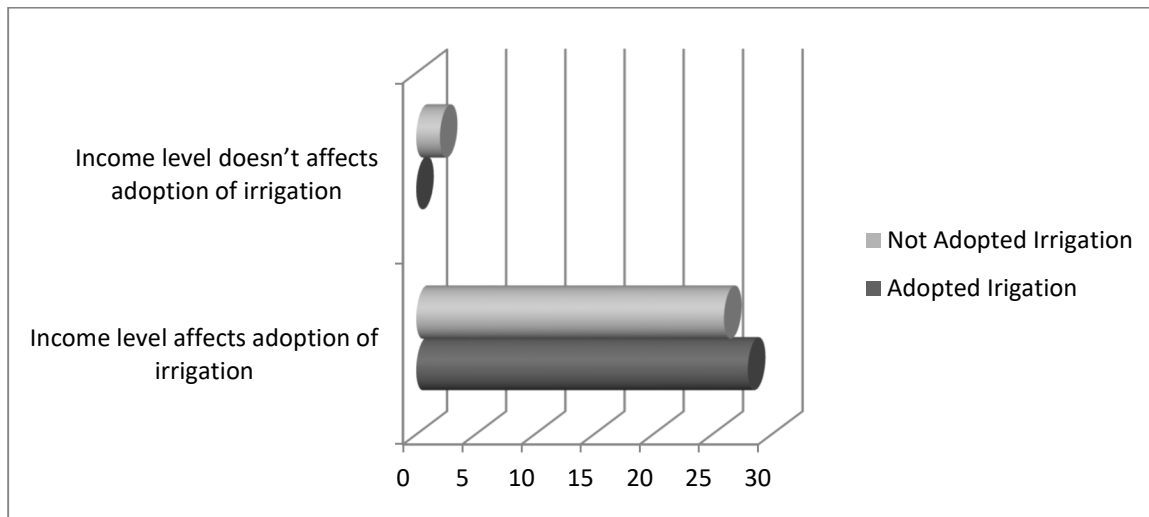


Figure 4.12: Effect of Level of Income on adoption of irrigation

4.4.1.8 Access to Credit Facilities and Adoption of Irrigation

The respondents were asked to indicate whether they had access to credit facilities in their region. The results are presented in figure 4.13. From the findings, all those who had adopted irrigation admitted that they have access to credit facilities. However, of those who had not adopted irrigation, 60.7% of them indicated that they had access to credit facilities, while the others 39.3% indicated that they didn't have access to credit facilities in their region. This therefore implies that access to credit facilities affects adoption of irrigation.

From the findings, there is an implication that the non-adopters were non-committal to credit facilities, probably with the fear that they may not repay fully their loans, hence the reason for their non-adoption of irrigation.

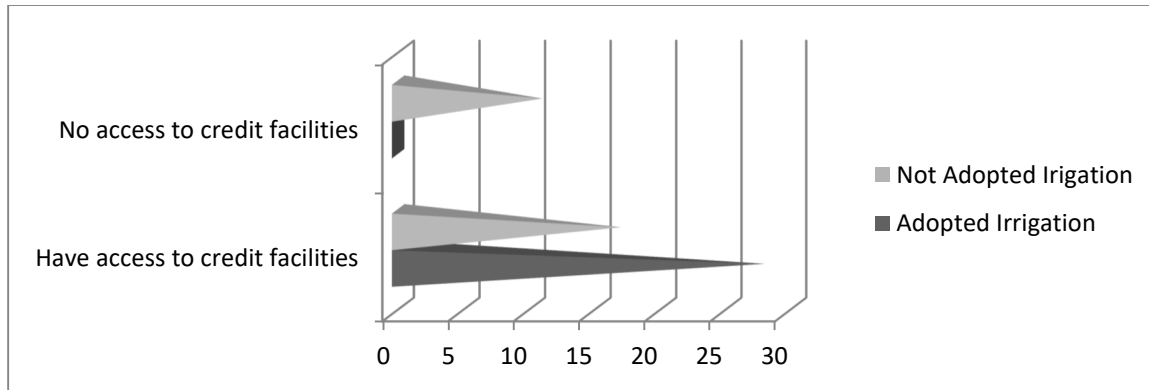


Figure 4.13: Access to credit facilities

4.4.1.9 Boosting Farmers' Income Levels

The respondents were required to suggest measures which should be taken to boost the level of income of farmers so that they all adopt irrigation. The results were presented in table 4.1.

Table 4.1

Boosting levels of farmers' income to adopt irrigation

Measure to be taken	Adopted	Not adopted
County government build dams & bore holes near them	82.1%	71.4%
NGOs & well wishers build dams & bore holes	14.3%	17.9%
Merry go-round to buy irrigation kits	3.6%	10.7%

From the findings, Majority of the farmers suggested the county government can help boost their income levels by initiating the irrigation projects for them if it builds dams and bore holes near them. Kee ward farmers believe the county government has the responsibility of ensuring irrigation in the ward is adopted by building dams and bore holes for them.

4.4.2 Farmers' Level of Education and Adoption of Irrigation

The second objective of the study was to analyze how the level of education of the farming head affects the adoption of irrigation as a strategy towards enhancing food production among farmers in Kee Ward, Makueni County. The findings of the study were as follows.

4.4.2.1 Highest Level of Education and Adoption of Irrigation

The respondents were required to indicate their level of education. The results are presented in figure 4.14. From the findings, for those who had adopted irrigation, 25% of them had done their education up to secondary level, 28.6% were certificate holders, 35.7% were diploma holders and 25% were degree holders. In short those who had gone to at most secondary level were 10.7% while those with tertiary education were 89.3%. For those who had not adopted irrigation, 7.1% had done their education up to primary level, 60.7% to secondary level, 17.9% were certificate holders, 10.7% were diploma holders and 3.6% were degree holders. In short those who had gone to at most secondary level were 67.9% while those with tertiary education were 32.1%.

From the findings, basic education, though important, cannot enable one to make some informed decisions like adopting innovations such as adoption of irrigation. The adopters probably have embraced the innovation since they have the basics on adoption of the irrigation technology, and also have learned from others.

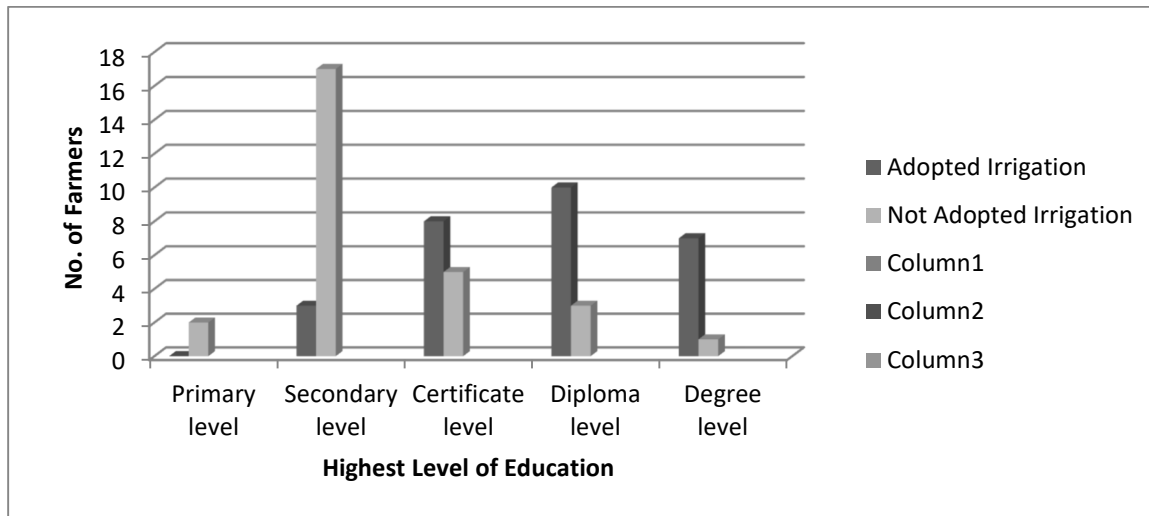


Figure 4.14: Highest Level of Education

4.4.2.2 Educated on Irrigation

The respondents were required to indicate whether the topics on irrigation were adequately covered during their education. The results are presented in figure 4.15. From the findings, for those who had adopted irrigation, 14.3% agreed that the topics on irrigation were well covered, while the rest (85.7%) indicated that they were not. For all those who had not adopted irrigation, they all admitted that the topics on irrigation were not covered adequately. Though education on

irrigation is important in adopting irrigation, from the findings it is clear that the level of education is critical. However, from the findings, there exists a big gap in training on irrigation within the ASALs. This implies that training on various agricultural practices is missing in Kee ward.

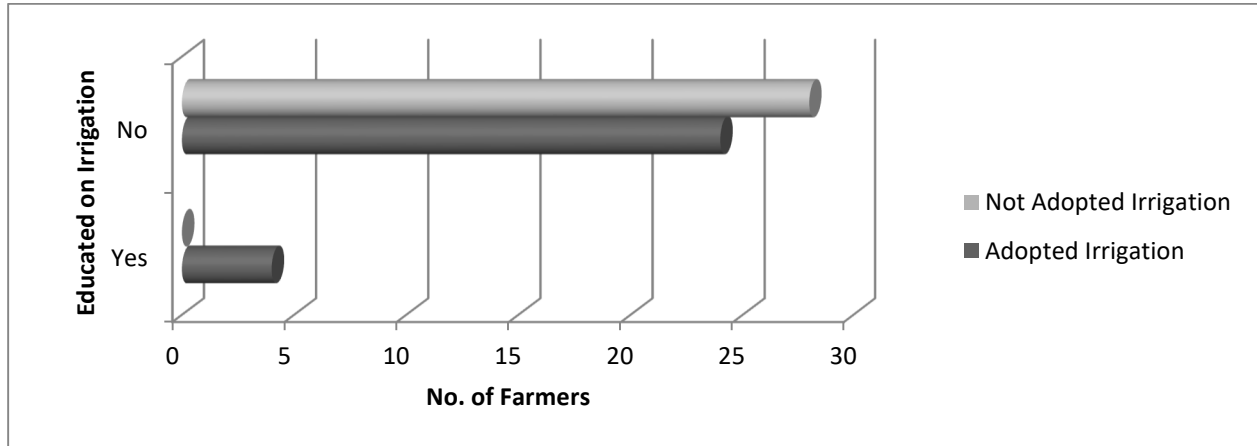


Figure 4.15: Educated on irrigation

4.4.2.3 Level of Education in Adoption of Irrigation

The respondents were required to indicate whether their level of education would help them adopt irrigation. The results are presented in figure 4.16. From the findings, 92.9% of those who had adopted irrigation indicated that it is important in adopting irrigation, while the rest (7.2%) indicated that it is not necessary. Of those who had not adopted irrigation, 82.1% of the respondents indicated that their level of education would be sufficient for them adopt irrigation, while the rest (17.9%) indicated that it would not be necessary.

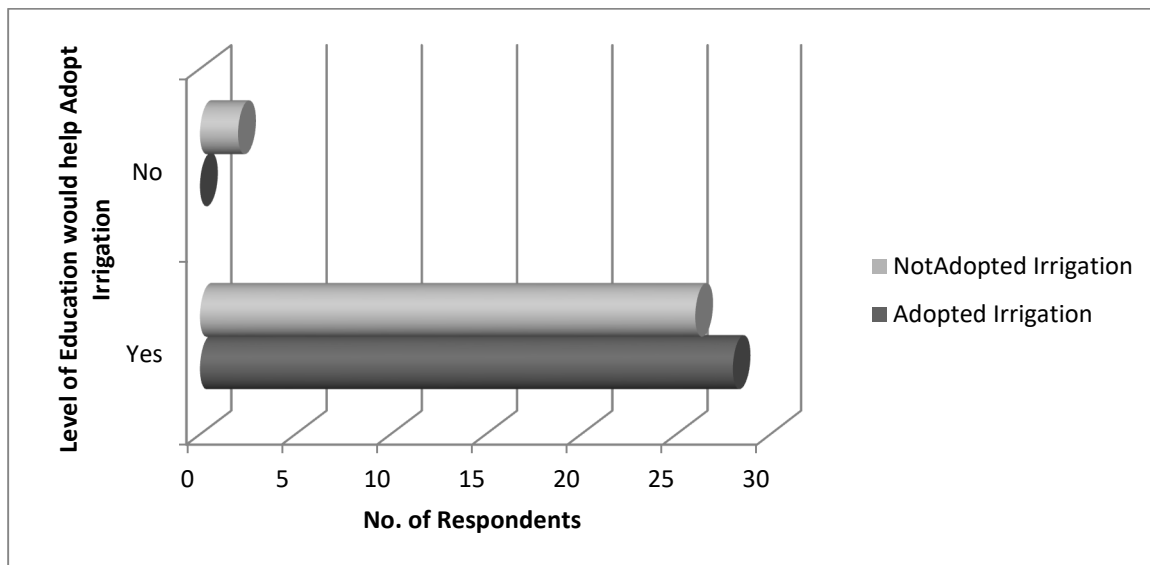


Figure 4.16: Level of Education in Adoption of Irrigation

From the findings, there is an indication that there is need to sensitize the farmers on the sufficiency of their education irrespective of the level since with basic education they can venture into many innovations.

4.4.2.4 Effect of Farmer’s Level of Education and Adoption of Irrigation

The respondents were required to indicate whether adoption of irrigation can be affected by the farmer’s level of education. The results are presented in figure 4.17. From the findings, all the respondents who had adopted irrigation agreed adoption of irrigation can be affected by the farmer’s level of education, while 92.9% of those who had not adopted admitted that irrigation is affected by a farmer’s level of education, and the rest (7.1%) indicated it does not.

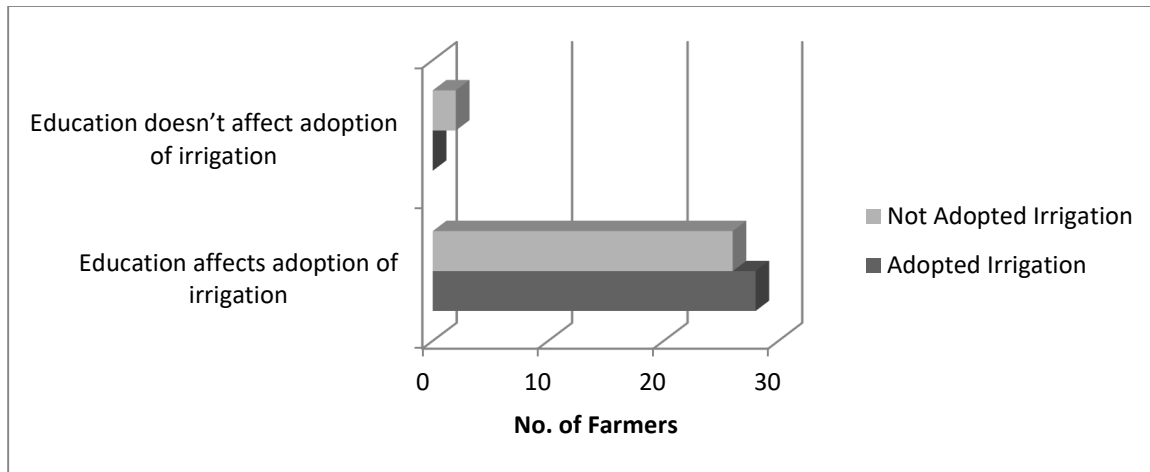


Figure 4.17: Adoption of irrigation and farmers level of education

The farmers know that the level of education affects the adoption of irrigation. More educated farmers in ASALs easily get into irrigation more easily with presence of water around them.

4.4.2.5 Influence of Farmer’s Level of Education on Adoption of Irrigation

The respondents were requested to indicate their level of agreement with the following on the influence of the level of education on adoption of irrigation. The results were as shown in Table 4.1 and Table 4.2. From the table both experience in farming and the farmers’ level of education has an effect on the adoption of irrigation in a direct proportion. This means that more experienced and more educated farmers adopt the technology with more ease than inexperienced and less educated farmers.

Table 4.2
Influence of Farmer's level of education on Adoption of Irrigation for those who have Adopted Irrigation

Statement	Strongly Agree	Agree	Somewhat Agree	Disagree	Strongly Disagree	Mean	Standard Deviation
Knowledge gained from my studies in school has an impact on adoption of irrigation	3	18	4	3	0	2.107	1.113
Skills and experience I have gained in farming are helpful in adopting irrigation	5	20	3	0	0	1.929	0.530
The level of a farmer's education affects the level to which he adopts irrigation	12	13	3	0	0	1.679	0.658
Education and skills earned during my education process are helpful in adopting irrigation	5	17	6	0	0	2.036	0.626

Table 4.3
Influence of Farmer's level of education on Adoption of Irrigation for those who have not Adopted Irrigation

Statement	Strongly Agree	Agree	Somewhat Agree	Disagree	Strongly Disagree	Mean	Standard Deviation
Education and skills earned during my education process are helpful in adopting irrigation	3	18	4	3	0	2.25	0.785
Skills and experience I have gained in farming are helpful in adopting irrigation	5	13	7	0	2	2.214	1.081
The level of a farmer's education affects the level to which he adopts irrigation	3	12	10	2	0	2.321	0.889
Knowledge gained from my studies in school has an impact on adoption of irrigation	10	6	6	5	0	2.143	1.187

4.4.2.6 Ways of improving Literacy Levels

The respondents were required to indicate what could be done to increase literacy levels. All the respondents responded that the national government should make education free at all levels, including at tertiary levels. From the findings free education is the best way of increasing the level of education in ASALs since it provides a level ground for the rich and poor alike to access education.

4.4.3 Training and Extension Services and Adoption of Irrigation

The third objective of this research exercise was to determine the effect of training and extension services on farmers in the adoption of irrigation as a strategy towards enhancing food production among farmers in Kee Ward, Makueni County. The findings are as below.

4.4.3.1 Attendance of Training and Adoption of Irrigation

The respondents were required to indicate whether they had attended any training on adoption of irrigation system. The results are presented in Figure 4.18.

From the findings, 17.9% of the respondents who had adopted irrigation indicated that they had attended training on irrigation, while 82.1% respondents did not. Of those who had not adopted irrigation, 10.7% of the respondents had attended training on irrigation while the rest (89.3%) had not.

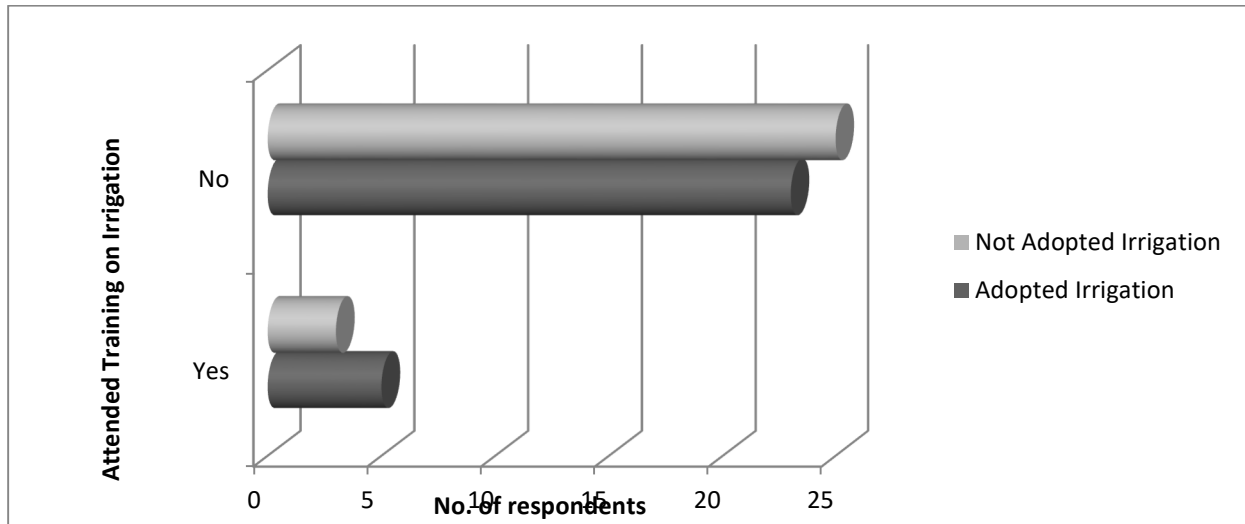


Figure 4.18: Attended training on irrigation

Since majority of the respondents had attended no training on irrigation, there exists a training gap on irrigation, perhaps because it is an ASAL area with water challenges.

4.4.3.2 Training Policy and Adoption of Irrigation

The respondents were requested to indicate whether their farms had adopted any training policy, and none of the farms, both for those who had adopted irrigation or who had not, had adopted a training policy for their farmers. This indicates that a training gap is existent in all the farms within Kee ward.

4.4.3.3 Necessity of Training

The respondents were required to give their opinions on whether training of farmers is necessary, and all the respondents, both those who had adopted irrigation and those who had not, indicated that training of the farmers is necessary. This implies that training of farmers on any technology like irrigation is quite necessary.

4.4.3.4 Agricultural Extension Officers' Visits and Adoption of Irrigation

The respondents were required to state if agricultural extension officers have ever visited their farms. The results were presented in figure 4.19. From the findings, 60.7% respondents of those who had adopted irrigation indicated they had been visited by agricultural extension officers, while 39.3% indicated they had not been visited. For those who had not adopted irrigation, only 3.6% indicate they had been visited while 96.4% were not visited.

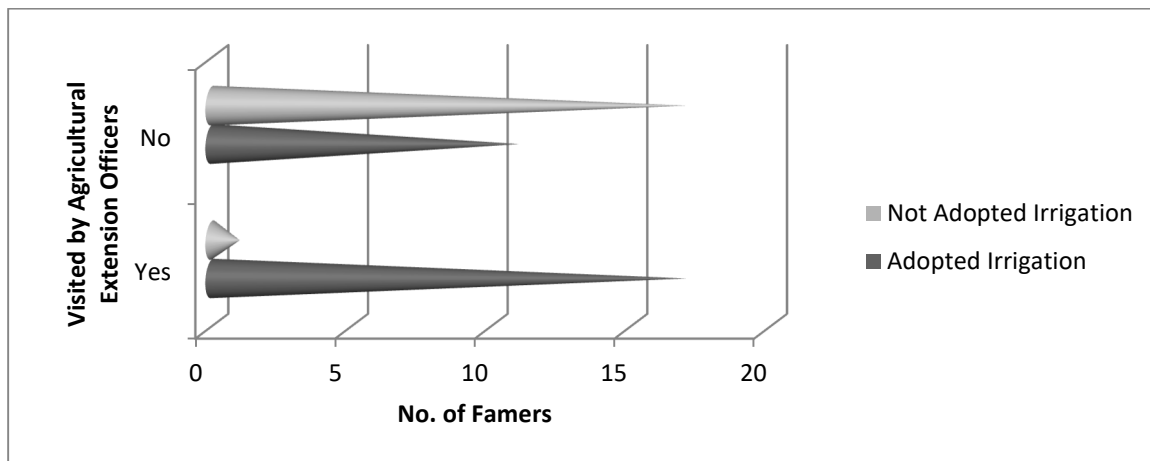


Figure 4.19: Visit by Agricultural Extension Officers

In Kee ward visit to the farms by agricultural extension officers is done majorly to the farms where agricultural activities are more pronounced. This is evident from the adopters of irrigation who have received visits from the officers.

4.4.3.5 Influence of Agricultural Extension Officers on Adoption of Irrigation

The respondents were requested to indicate their level of agreement with the following statements on the influence of agricultural extension officers on adoption of irrigation. The results were as shown in Table 4.3. From the findings, agricultural extension officers can make Kee ward a rich agricultural land through their visits, advices and directions on erecting irrigation systems in the farms

Table 4.4

Influence of Agricultural Extension Officers on Adoption of Irrigation for respondents who have adopted irrigation

Statement	Strongly agree	Agree	Somewh at agree	Disagree	Strongly disagree	Mean	Standar d
Agricultural extension officers make visits to my farm	1	6	9	7	5	3.321	1.104
Agricultural extension officers have been advisors in the running of my farm	1	6	9	5	7	3.393	1.175
Agricultural extension officers in Kee ward are key technicians during installation of irrigation systems	2	8	7	6	5	3.143	1.216
The agricultural extension officers in Kee ward have helped to improve the productivity of the farm	2	7	9	8	2	3.036	1.052
Kee Ward has adequate agricultural extension officers to effectively offer agricultural guidance	0	0	8	17	3	3.821	0.601

Table 4.5: Influence of Agricultural Extension Officers on Adoption of Irrigation for respondents who have not adopted irrigation

Statement	Strongly agree	Agree	Somewhat agree	Disagree	Strongly disagree	Mean	Standard deviation
Agricultural extension officers make visits to my farm	2	4	1	14	6	3.667	1.186
Agricultural extension officers have been advisors in the running of my farm	0	4	9	9	5	3.556	0.956
Agricultural extension officers in Kee ward are key technicians during installation of irrigation systems	6	15	1	3	2	2.259	1.142
The agricultural extension officers in Kee ward have helped to improve the productivity of the farm	1	4	14	4	4	3.222	0.988
Kee Ward has adequate agricultural extension officers to effectively offer agricultural guidance	0	2	12	11	2	3.481	0.739

4.4.3.6 Ways of Improving Training of Farmers

The respondents were required to suggest ways in which training of farmers could be improved. The results were presented in table 4.8. From the findings, majority of them indicated that it can be done by the county government employing more agricultural extension officers, having demonstration plots in various places, and occasionally arranging for free farm clinics.

Table 4.6
Improving Training of farmers

Ways of improving training	Adopted	Not adopted
Employing more agricultural extension workers	53.6%	71.4%
Having demonstration plots	35.7%	3.6%
Have free farm clinics	10.7%	7.1%
No response	0	17.9%

From the findings, agricultural extension officers will freely train and advice the farmers on irrigation. Also demonstration plots will motivate the farmers to make their farms better as they learn more.

4.5 Inferential Statistics

Regression analysis was used to determine the relationship between the dependent variable and the independent variables. The regression model adopted was

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \mathcal{E}$$

Where:

- Y = Adoption of Irrigation as a Strategy (dependent variable)
- X_1 = Level of farmers' income (1st independent variable)
- X_2 = Level of education of farmers (2nd independent variable)
- X_3 = Training and extension services (3rd independent variable)

4.5.1 Results of Regression Analysis

Table 4.7

Model Summary

Model	R	R Square	Adjusted R Square	Std error of the estimate
1	0.965 ^a	0.931	0.911	4.729

- a. Predictors: (Constant), Level of farmer's income, level of farmer's education, training and agricultural extension services

The adjusted R squared in Table 4.5 is the coefficient of determination which shows the variation in the dependent variable with respect to changes in the independent variables. From the findings, the value of the adjusted R square was 0.931. This means that there was a variation of 93.1% on the independent variables at 95% confidence interval. R, which is the correlation coefficient, shows the relationship between the three independent variables under study. The findings in Table 4.5 show a correlation coefficient of 0.965. This implies that there is a very strong positive correlation relationship between the three variables under study.

4.5.2 Regression Equation and the Predictor Relationship

A multiple regression model was adopted which was analyzed mathematically using SPSS software and then mathematically expressed as in Table 4.8. The regression model adopted determines the importance of each of the three independent variables in regard to adoption of irrigation as a strategy to enhance food production in Kee ward, Makueni County.

Table 4.8
Regression Coefficients

Model	Unstandardized coefficient		Standardized Coefficients Beta	t	Sig.
	β	Std error			
Constant	33.422	13.594	-	2.460	0.43
Level of farmer's income	-3.340	0.773	0.527	-4.320	0.003
level of farmer's education	0.094	0.021	0.558	4.569	0.003
Training and agricultural extension services)	-0.96	0.067	-0.257	-1.112	0.065

Dependent variable: adoption of irrigation as strategy of enhancing food security.

The established multiple linear regression equation is as shown.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \mathcal{E}$$

$$Y = 33.422 - 3.34\beta_1 + 0.094\beta_2 - 0.96\beta_3$$

Where:

Constant = 33.422, shows that if the level of farmer's income, the level of farmer's education, and training and agricultural extension services were all zero rated, then adoption of irrigation rating would be 33.422.

$\beta_1 = -3.34$, means that one unit change in the level of farmers' income would result in 3.34 decrease in adoption of irrigation.

$\beta_2 = 0.094$, implies that one unit change in the level of farmers' education would result in 0.094 increase in adoption of irrigation.

$\beta_3 = -0.96$, means that one unit change in the level of farmers' training and agricultural extension services would result in 0.96 decrease in adoption of irrigation.

4.5.3 Analysis of Variance (ANOVA)

The Probability value (p-value) in a statistical hypothesis test is the probability of getting a test value which is as extreme as or more extreme than the observed value if the null hypothesis (H_0) is true. A comparison of the p-value is made with the actual significance level of the test, and if it is smaller, then the result is significant, and the smaller the p-value is the more convincing it is to reject the H_0 . From the ANOVA findings in table 4.7, the p-value is 0.001 (less than 0.05). This implies that there is a correlation between the independent variables and the dependent variable.

Table 4.9
ANOVA

	Sum of Squares	df	Mean Squares	F	Sig.
Regression	2105.435	2	1052.717	47.067	0.001 ^b
Residual	156.565	7	22.366	-	-
Total	2262	9	-	-	-

- a. Dependent variable: Adoption of Irrigation
- b. Predictors: (Constant), Level of farmer's income, level of farmer's education, training and agricultural extension services

The ANOVA analysis was intended to investigate whether the variation in the independent variables (Level of farmer's income, level of farmer's education, training and agricultural extension services) explain the observed variance in the study of the outcome (Adoption of Irrigation). From the results, the independent variables significantly explain the dependent variable ($F=47.067$, $p=0.001$). In this study, the dependent variable is adoption of irrigation in Kee ward while the independent variables are the level of farmer's income, level of farmer's education, training and agricultural extension services.

4.5.4 Discussion

From the Regression analysis results, the R squared, the coefficient of determination, which is 0.931 tells the variation in the dependent variable due to changes in the independent variables. Specifically it means that 93.1% of the variations in adoption of irrigation are explained by the variations of the three independent variables. R is the correlation coefficient which shows the relationship between the study variables. From Table 4.5, there was a very strong positive relationship between the variables under study since the correlation coefficient R is 0.965. Also, since the study was on the dependence and independence relationship between the study variables, the multiple regression model adopted was used to determine the significance of each of the variables with respect to their effects on adoption of irrigation in Kee ward, Makueni County. From Table 4.6, the constant of 33.422 shows that if the level of farmer's income, level of farmer's education, training and agricultural extension services were zero rated, the rate of adoption of irrigation would be 33.422. $\beta_1 = -3.34$, means that one unit change in the level of farmers' income would result in 3.34 decrease in adoption of irrigation. This implies that the level of the farmer's income has an effect on the adoption of irrigation. It therefore implies that the farmers' level of income has an effect on the adoption of irrigation. On the second variable, $\beta_2 = 0.094$ implies that one unit change in the level of farmers' education would result in 0.094 increase in adoption of irrigation. This implies that the level of the farmer's education has a positive impact on adoption of irrigation. This concurs with Muhammad-Lawal, et al (2013) who studied on the determinants on adoption of irrigation technology by small scale farmers in Kwara

state, Nigeria. They found a strong positive relationship between the farmers' level of education and adoption of irrigation technology. This explains the reason most adopters in irrigation have some basic education for installation and operation of water generators, water pipes and such irrigation accessories. On farmers' training and agricultural extension services, $\beta_3 = -0.96$, means that one unit change in the level of farmers' training and agricultural extension services would result in 0.96 decrease in adoption of irrigation. This implies that training and agricultural extension services have an impact on adoption of irrigation. This therefore indicates that visits by agricultural experts like the agricultural extension officers have an influence in the adoption of irrigation in Kee ward, Makueni County.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the findings of the study as drawn from the previous chapter. It has adopted the following structure: Summary of the findings, conclusions made based on the findings, policy recommendations also based on the findings, and finally, areas suggested for further research winds up the chapter. The overall objective of the study was to investigate the factors affecting the adoption of irrigation as a strategy towards enhancing food production among farmers in Kee Ward, Makueni County. This study therefore documents the possible solutions towards the adoption of irrigation.

5.2 Summary of the Findings

5.2.1 Level of Farmer's Income and Adoption of Irrigation as a Strategy Towards Enhancing Food Production

The first objective of the study was to determine the extent to which the level of the farmer's income affect the adoption of irrigation as a strategy towards enhancing food production among farmers in Kee Ward, Makueni County. The study revealed that the level of the farmer's income influence adoption of irrigation. The study further revealed that of those who had adopted irrigation, most of them had more than one source of income and hence had a large income compared to those who had not adopted irrigation, hence their income was enough adopt an irrigation system. This included salaries among other sources of income. However, on the other hand, most of those who had not adopted irrigation had single source of income mainly from wages, and generally had a low income and therefore a main reason for not adopting an irrigation system.

All those who had adopted irrigation pointed out that their income was enough to buy and or run an irrigation system with majority of them saving towards maintaining the irrigation system. However, all those who had not adopted irrigation didn't have enough income to buy and or run an irrigation system, and also none of them made any savings towards procuring an irrigation system.

To enhance adoption of irrigation, majority of the respondents suggested that the county governments should play the leading role in initiating irrigation projects for small scale farmers, by funding drilling of permanent bore holes and building more permanent water dams. This should be in addition to other inputs such as provision of irrigation kits.

5.2.2 Level of Education of the Farming Head and Adoption of Irrigation as a Strategy Towards Enhancing Food Production

The second objective of the study was to determine how the level of education of the farming head affects the adoption of irrigation as a strategy towards enhancing food production among farmers in Kee Ward, Makueni County. The study established that the level of education of the lead farmer influences the adoption of irrigation. Most of the respondents who had adopted irrigation had done post-secondary education even though they pointed out that the topics on irrigation were not adequately covered. On the other hand, most of those who had not adopted irrigation didn't have tertiary education, and that topics on irrigation were not covered during their studies.

All the respondents however agreed that their level of education would help them adopt irrigation, and that irrigation is affected by the farmers' level of education. Also most of the respondents in both categories agreed that education skills and knowledge gained during their education would be helpful for them to adopt irrigation.

To enhance adoption of irrigation, majority of the respondents suggested that the national government should subsidize education in all tertiary institutions (both colleges and universities) just as currently in primary schools, or be highly subsidized so that all Kenyans including the poor have access to tertiary education, which will in turn lead to enhanced food production and food security.

5.2.3 Training and Extension Services on Farmers in Adoption of Irrigation as a Strategy Towards Enhancing Food Production

The third objective of the study was to determine how training and agricultural extension services affect the adoption of irrigation as a strategy towards enhancing food production among farmers in Kee Ward, Makueni County. The study established that training and agricultural extension services have an influence on the adoption of irrigation. The study found out that

training seminars are hardly organized in the ward, and that Kee ward has few agricultural extension officers. The study further revealed that none of the farmers had plans to train their farmers, though they admitted it is quite important. Majority of the respondents agreed that Kee Ward has agricultural extension officers, that the extension officers would be helpful in improving productivity in their farms and that the extension officers would be effective in offering agricultural guidance towards adoption and installation of irrigation and enhancement of food security in the ward.

To enhance adoption of irrigation, majority of the respondents suggested that the county government should employ more agricultural extension workers, have agricultural demonstration plots in every sub-location and also arrange for free farm clinics especially in the ASALs.

5.3 Conclusions

The study revealed that the farmer's level of income is statistically significant to the adoption of irrigation. The level of income had significant negative relationship with adoption of irrigation since the regression coefficient of the level of income β_1 is -3.34 . This implies that the more the income, the more they will adopt irrigation, hence an increase in food production. The study therefore concludes that farmer's level of income is strongly related to adoption of irrigation.

The study also revealed that the farmers' level of education is also significantly related to the adoption of irrigation. The level of education had a significant positive relationship with the adoption of irrigation with a regression coefficient β_2 of 0.094 . This therefore implies that the more educated farmers are most likely to adopt irrigation than less educated farmers. This study therefore concludes that the level of the farmers' education is positively related to the adoption of irrigation.

Finally, the study found out that training and extension services is significantly related to the adoption of irrigation. Training and extension services had a significant relationship with the adoption of irrigation with a regression coefficient β_3 of -0.96 . This implies that the farmers who had access to on-the farm-training, seminars and extension services will likely adopt irrigation than those who did not. The study therefore concludes that the access to training and agricultural extension services is related to the adoption of irrigation.

5.4 Recommendations

The study investigated on the factors affecting adoption of irrigation as a strategy towards enhancing food production among farmers in Kee ward, Makueni County. Based on the findings, recommendations were made to Kee Ward, and also the ASAL areas in Makueni and other counties to improve on food production among farmers.

On the farmers' levels of income, this study recommends that the County government and the National government should subsidize irrigation inputs and also advance cheap credit facilities to all farmers in ASAL areas in order to initiate the efforts of low income farmers to food production and security within the county and country.

On the farmers' level of education, this study recommends the national government to finance education at all levels up to undergraduate levels, just as it has done to primary education. Education policies should be drafted and implemented by both the national and county governments, which should include agricultural education (including the household heads) in the ASALs.

On training and agricultural extension services, this study recommends the employment of more agricultural extension officers, and agricultural education visits to be made to both adopters and non-adopters of irrigation. The study also recommends for the training of small scale farmers, especially in ASAL areas be done as a priority. This can be done by the county government, the central government and Non-Governmental organizations who should draft training programmes to sensitize farmers on irrigation, even using the available resources. In this the war against food insecurity in ASALs will be greatly won.

The study also recommends building of more permanent earth dams and sand dams. Both the county government and the national governments should invest more in water management by allocating more financial resources in the ASALs than in the agriculturally rich areas. This will completely wipe away the dependence of rain-fed agriculture for food reliance since most farmers will embrace irrigation to supplement rain-fed farming.

5.5 Suggestions for Further Research

The study explored on the effects of the farmer's level of income, the level of education of the lead farmer and training and extension services on farmers in adoption of irrigation as a strategy towards enhancing food production among farmers in Kee Ward, Makueni County. The study established that there exists a positive relationship between the level of education and adoption of irrigation. Since most ASALs have similar characteristics, for better insight on the same, this study recommends a study to be done to find out the effects of illiteracy and semi-literacy levels of education on food production in ASALs. This study also suggests investigations and further research on adoption and implementation of the most efficient methods of irrigation in ASALs.

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APPENDICES

APPENDIX I: LETTER TO THE RESPONDENTS

Dear Respondents,

I am a postgraduate student studying Masters of Business Administration in the School of Business, Entrepreneurship and Management Sciences at Machakos University. I am presently conducting a research on the factors affecting the adoption of irrigation as a strategy towards enhancing food production among farmers in Kee ward, Makueni County. The purpose of this letter is to kindly request you to fill in the questionnaire. Note that the information you provide will be treated with highest confidence and at no time will your name or that of your organization be referred directly. This information will be used for academic purposes only.

Thank you.

Yours Sincerely,

Joseph Mwendwa Katumo

D53/1033/2014

APPENDIX II: QUESTIONNAIRE

SECTION A: PERSONAL DETAILS

1. Type of farm Subsistence
 Commercial
2. Age of respondent (years) 18 – 30
 31 – 40
 41 – 50
 51 – 60
 61 and above
3. Gender Male Female
4. Number of years in active farming
5. What are the products of your farm.....
.....
6. Is there any source of water enough for irrigation in or near your farm?
 Yes No
7. If yes in (6) above, what is the source of the water?
 Sand dam
 Permanent water dam
 Private water dam
 Well (Public or private)
 Any other source (indicate)
8. Has your farm adopted an irrigation system? Yes
 No

SECTION B: LEVEL OF INCOME

9. What is the main source of your income?

Salary

Wages

Other source (Specify)

10. Do you have any other source(s) of income? Yes

No

11. How much is your income in a month?

Ksh. 15,000 and below

Ksh. 15,001 – Ksh. 30,000

Ksh. 30,001 – Ksh. 45,000

Ksh. 45,001 and above

12. Is your income enough to cater for all your and family’s basic needs?

Yes No

13. Is your income enough to buy and/or run an irrigation system for your farm?

Yes

No

14. What percentage of your income do you save towards adopting an irrigation system for your farm? Kindly indicate/approximate.

15. In your own assessment, do you think the adoption of irrigation in your farm can be affected by one’s level of income? Yes

No

16. Are there credit facilities in your region you can access to fund or enhance irrigation in your farm? Yes

No

17. In your opinion suggest measures that can be taken to help farmers boost their income levels through irrigation in your area.

SECTION C: LEVEL OF EDUCATION

18. What is your highest level of education? Kindly indicate.

19. During your education, were the topics on irrigation adequately covered to enable you adopt an irrigation system?
 Yes No
20. Do you think the level of your education helps you to adopt an irrigation system in your farm? Yes
 No
21. Do you think adoption of irrigation can be affected by a farmer’s level of education? Yes
 No
22. To what extend would you agree/disagree with the following statements in relation to education and adoption of irrigation? (Tick your opinion on a scale of 1 – 5, where 1=Strongly agree, 2=Agree, 3=Somewhat agree, 4=Disagree, 5=Strongly disagree)

Statement	1	2	3	4	5
Education and skills earned during my education process are helpful in adopting irrigation					
Skills and experience I have gained in farming are helpful in adopting irrigation					
The level of a farmer’s education affects the level to					

which he adopts irrigation					
Knowledge gained from my studies in school has an impact on adoption of irrigation					

23. In your opinion what should be done to increase literacy levels?

.....

SECTION D: TRAINING AND EXTENSION SERVICES

24. Have you attended any training that is helpful in adopting an irrigation system? Yes No

25. If yes in (22) above when was the last time you attended the training?

26. If yes in (22) above, was the topic on irrigation covered? Yes

27. Has your farm formulated any training policy? Yes
 No

28. If yes in (25) above, how often do you and/or the employees of your farm go for training in a year?

Once in a year

Twice to four times

More than four times

Other (specify)

29. If yes in (25) above, how many employees are trained in a year?

30. In your opinion, is training of employees in your farm necessary?

Yes

No

31. Have agricultural extension officers ever visited your farm? Yes
 No

32. What is your assessment of the following statements in relation to agricultural extension officers (Tick your opinion on a scale of 1 – 4, where 1=strongly agree, 2=agree, 3=somewhat agree, 4=disagree, 5=strongly disagree)

Statement	1	2	3	4	5
Agricultural extension officers make visits to my farm					
Agricultural extension officers have been advisors in the running of my farm					
Agricultural extension officers in Kee ward are key technicians during installation of irrigation systems					
The agricultural extension officers in Kee ward have helped to improve the productivity of the farm					
Kee Ward has adequate agricultural extension officers to effectively offer agricultural guidance					

33. Kindly suggest ways in which training of farmers can be improved in Kee ward.

Thank you very much