

**HINDRANCE TO ADOPTION OF DRIP IRRIGATION BY SMALL-SCALE
FARMERS IN KITUI COUNTY, KENYA**

By

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Award of the Degree of Master of Science (Environmental Education) in the
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DECLARATION

This thesis Report is my original work and has not been presented for the award of a degree in any University.

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DEDICATION

I dedicate this thesis to my parents Robert and Agnes for giving me education at early age. To my wife Christine and children Daniel, Nicodemus, Raphael and Anthony for their encouragement and support.

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I thank the Almighty God for blessing me with good health of mind and body throughout the study period. I would like also to sincerely thank my supervisors Prof. Michael.K. Koech & Dr. Richard Kerich for their great efforts in giving me the required scholarly advice during my research work. I would like also to thank Dr. Stephen Chege for the scholarly advice in this thesis. Lastly, I thank the Kenyatta University librarians for their support with the books and academic resources to facilitate this research work. May God bless you all.

ABSTRACT

Climate change and its associated impacts has caused a huge gap in the availability affordability and the provision of water resources. Globally, the availability of water has been exacerbated by rapid population growth, industrialization and urbanization which has increased the demand for clean available and affordable water. To ease this scarcity, rainwater harvesting rainwater and drip irrigation technologies have been touted as viable strategies towards improved crop productivity and food security in arid and semi-arid regions. In this respect, research was necessary to determine the factors hindering the adoption of drip irrigation in Kitui County, Kenya. Specifically, the study sought to find out how associated costs, access to credit to farmers, farmers' knowledge, and water availability affected the adoption and non- adoption of drip irrigation in the County. The study used a descriptive exploratory research design to target small holder farmers. It employed probability and non-probability sampling, to obtain 60 farmers from a total population of 200 farmers who were using drip irrigation in Kitui County and 60 farmers from the total population of 155farmers who were both using furrow and drip irrigation which was derived from 2022 farmers using Nassiumas's (2000) formula. Structured questionnaires and scheduled interviews and secondary sources were used to obtain data, which was coded in excel before being exported to SPSS for statistical analysis, while descriptive statistics and inferential statistics specifically the t-test were used for further analysis. Results were presented using tables, Pie-charts and graphs. The study established that, farmers using drip irrigation obtained significantly higher perceived cost scores ($M = 28.50$) compared to those not using drip irrigation ($M = 23.66$), $t(113) = 7.159$, $p < .001$. Similarly, drip irrigation adopters had significantly higher levels of knowledge about the technology ($M = 37.05$) compared to those not using drip irrigation ($M = 34.76$), $t(113) = 2.446$, $p < .016$. On the other hand, adopters and non-adopters of drip irrigation did not differ significantly in their perceptions of credit accessibility and water availability. These findings suggest that efforts to reduce costs and enhance farmer education about drip irrigation could significantly improve adoption rates. Accessibility to credit and water, while important, were not identified as primary hindrances in this study. To address the barriers identified, the study recommends that financial assistance programs, such as subsidies or low-interest loans, be developed to help farmers manage the initial investment costs of drip irrigation systems. Additionally, comprehensive training programs should be implemented to enhance farmers' technical knowledge and skills related to drip irrigation.

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ABBREVIATIONS AND ACRONYMS

AIAP:	Association of Irrigation Acceleration Platform
ASAL:	Arid and Semi-Arid Lands
FAO:	Food and Agricultural Organization
IFAD:	International Fund for Agricultural Development
KIPPRA:	Kenya Institute for Public Policy Research and Analysis
KNBS:	Kenya National Bureau of statistics
NACOSTI:	National Commission for Science Technology and Innovation
NGOs:	Non- Governmental Organizations
SDG:	Sustainable Development Goals
SPSS:	Statistical Package for Social Sciences

DEFINITION OF TERMS

Access to credit: In this study refers to the ability of small-scale farmers in Kitui County to obtain finances for investing in drip irrigation. It includes two components: Credit availability which relates to the existence and accessibility of credit options, loans, or financial support mechanisms available to farmers; and cost of credit, which refers to the economic implications associated with accessing credit, including interest rates, repayment terms, and overall affordability (World Bank Group, 2019).

Adoption of drip irrigation: Refers to the extent to which small-scale farmers in Kitui County have implemented and actively utilize drip irrigation systems in their agricultural practices. It includes the installation and consistent use of drip irrigation technology for crop cultivation (World Economic Forum, 2024).

Costs associated with drip irrigation: Refers to the economic barriers hindering the adoption of drip irrigation among smallholder farmers. It encompasses both initial investment costs, including expenses related to equipment purchase and installation, and operational costs related to the ongoing use and maintenance of drip irrigation systems (World Economic Forum, 2024).

Drip Irrigation Technology: Refers to the modern irrigation method that involves delivering water directly to the plant's root area in a controlled manner, usually using a system of pipes, tubes, and emitters (World Economic Forum, 2024).

Farmers' knowledge: Refers to the level of awareness and technical expertise small-scale farmers in Kitui County have regarding drip irrigation technology. Awareness refers to the degree to which farmers are cognizant of the existence, benefits, and potential drawbacks of drip irrigation. Technical knowledge refers to farmers' understanding of the technical aspects, operation, and maintenance requirements associated with drip irrigation systems (Febria, Farmer Knowledge, 2022).

Financial resources: Refer to the capacity of farmers to mobilize and utilize funds for the adoption and maintenance of drip irrigation systems (Bhatia&Ghanem, 2019).

Water availability: Refers to the assessment of water-related factors influencing the extent to which smallholder farmers adopt drip irrigation (American Geoscience Institute, 2024)

CHAPTER ONE: INTRODUCTION

1.1 Background and Focus of the Study

Globally, irrigation plays an important role in enhancing agricultural productivity, particularly in regions characterized by scarce and erratic rainfall. In regions that experience low rainfall, agricultural sector predominantly relies on rainfed farming, the implementation of efficient irrigation techniques becomes imperative for ensuring food security and sustainable agricultural development (Mume, *et al.*, 2023). Irrigation not only reduces the risks associated with climate variability but also contributes significantly to the overall enhancement of crop yields, revenue generation, and livelihoods of farmers in these regions (Mume, *et al.*, 2023). Irrigation has proved to be a crucial factor in ensuring food security in regions characterized by low and erratic rainfall. In arid and semi-arid regions, where rainfed farming is often inadequate to meet the needs of a growing population, the adoption of irrigation technologies has contributed to sustainability of agricultural activities and improving livelihoods (Golla, 2021).

Globally, several examples highlight the transformative impact of irrigation on agricultural productivity and food availability. For instance, in Israel, the successful implementation of advanced irrigation systems, including drip irrigation, has enabled the country to transform its arid landscapes into productive agricultural zones. The Negev Desert, which receives minimal rainfall, has become a hub for high-value crop cultivation through the efficient use of water resources (Food and Agricultural Organization, 2020). The Israeli experience underscores how strategic irrigation practices contribute not only to increased crop yields, but also to the diversification of crops, leading to enhanced food security (Winslow, 2023).

Similarly, in India, where monsoon-dependent agriculture is prevalent, the expansion of irrigation infrastructure, particularly through the construction of canals and the promotion of modern irrigation technologies, has been instrumental in stabilizing agricultural production. The Green Revolution in the 1960s and 1970s, fueled by the adoption of widespread irrigation, led to a significant increase in cereal production, transforming India from a food-deficient nation to a self-sufficient one (Daisy & Giridhara, 2021). The benefits of irrigation extend beyond crop production to income generation and poverty alleviation. In China, the South–North Water Transfer

Project, one of the world's largest water diversion schemes, aims to address regional water imbalances and support agricultural development in water-scarce northern regions. This massive infrastructure project highlights the strategic role of irrigation in securing food resources and sustaining the livelihoods of millions (Xuet *et al.*, 2023). Studies done by Domenech (2015) and Nonvide (2020) gave a positive correlation between irrigation and food security, showcasing how efficient water use through irrigation technologies contributes to increased crop yields, improved nutrition, and overall economic development. These two studies point to the importance of irrigation as a solution for dealing with the impact of climate variability and ensuring a stable and secure food supply, especially in regions with low and unpredictable rainfall.

In Africa, there are an estimated 33 million small-scale farms, producing around 70 percent of Africa's food supply (Giller *et al.*, 2021). Despite this, people in rural areas account for 90 percent of people living in poverty in sub-Saharan Africa (Dixon & Gulliver, 2021). Limited access to training, seeds, finance and markets plus the changing climate and extreme weather events are just some of the challenges smallholder farmers face. But if we invest in rural people and their food systems, agriculture has the power to reduce poverty. In fact, according to the International Fund for Agricultural Development (IFAD), (2023) growth from agriculture can be up to 11 times more effective at reducing extreme poverty than any other sector (Farm Africa, 2023).

In Kenya, a number of obstacles have impeded attempts to modernize the irrigation subsector. The situation and difficulties facing Kenya's irrigated agriculture have not been overlooked. A study done by Association of Irrigation Acceleration Platform (AIAP), (2024) found out that, as of 2018, 222,240 ha, or 16 percent of the 1.34 million ha of irrigation potential, were covered by the developed irrigation schemes. The furrow system is used in the majority of large-scale irrigation projects. Modern irrigation systems are used by smallholder irrigation projects, private and commercial farms. The three main obstacles to the development of irrigation are institutional, socioeconomic, and technical. Water scarcity, poor water quality, and inadequate water infrastructure are the main technical obstacles. The primary socio-economic obstacles are the exorbitant expenses associated with contemporary irrigation systems, insufficient credit facilities, and market accessibility. Among the institutional

difficulties of irrigation development is bright through climate change adaptation strategies such as solar-powered irrigation systems and rainwater harvesting (Association of Irrigation Acceleration Platform (AIAP), 2024).

In Kenya, efforts to modernize the irrigation subsector have faced a range of challenges. A study done by Association of Irrigation Acceleration Platform (AIAP), (2024) found out that, as of 2018, only 222,240 ha, or 16 percent of the 1.34 million ha of irrigation potential, were covered by the developed irrigation schemes. The furrow system is used in the majority of large-scale irrigation projects. Modern irrigation systems are used by smallholder irrigation projects, private and commercial farms. Previous studies and sectoral reports such as AIAP (2024) have highlighted a number of challenges facing the sector. These include issues related to water scarcity and infrastructure, high costs of irrigation technologies, and institutional issues. However, the reports are based on findings that are general in nature, and did not fully capture the unique realities of different counties. This underscored the need to carry out a localized study in Kitui County to examine how these and possibly other factors interact to influence the adoption of modern irrigation technologies like drip irrigation.

1.2: Statement of the Problem

Kitui County heavily relies on rainfed agriculture, and small-scale farmers face persistent challenges associated with irregular rainfall patterns and water scarcity. The dependence on rainfed farming exposes farmers to climate-induced shocks, impacting crop yields, livelihoods, and overall food security. Recognizing the potential of drip irrigation to address these challenges, this study sought to investigate the hindrances preventing the widespread uptake of drip irrigation among smallholder farmers in Kitui County. The primary problem revolves around the limited integration of drip irrigation despite its proven benefits in water optimization and enhanced agricultural productivity. There is therefore need to understand the specific barriers that hinder the adoption of drip irrigation in the region. While drip irrigation holds promise as a water-efficient solution, the factors impeding its integration among small-scale farmers remain largely unexplored. This lack of knowledge about the unique challenges faced by farmers in adopting drip irrigation inhibits the development of targeted interventions to address these issues.

The study therefore set out to determine the influence of selected factors on the adoption of drip irrigation in Kitui County, Kenya. The selected factors included costs associated with drip irrigation, access to credit, farmers' knowledge about drip irrigation, and water availability. Examining the influence of these factors is crucial for developing context-specific strategies that can overcome the identified barriers and facilitate the successful adoption of drip irrigation. Addressing these challenges has the potential to not only enhance the resilience of small-scale farmers to climate variability but also contribute significantly to the managing of water sustainably in the region, ultimately supporting the goal of achieving food security in Kitui County.

1.3: Research Questions

The following research questions were used in achieving the specific objectives of the study.

1. What is the influence of costs associated with drip irrigation on adoption and non-adoption of drip irrigation technology among small-scale farmers in Kitui County?
2. Is accessibility to credit related to the adoption or non-adoption of drip irrigation?
3. What is the influence of the level of knowledge among small-scale farmers on the adoption and non-adoption of drip irrigation technology?
4. Is the availability of water related to the adoption of drip irrigation among small-scale farmers in Kitui County?

1.4: Objectives of the Study

1.4.1: General Objective

The key objective of this research was to determine the influence of selected factors on the adoption of drip irrigation in Kitui County, and specifically Kitui County, Kenya.

1.4.2: Specific Objectives

The specific objectives of the study were:

1. To investigate how the costs associated with drip irrigation influence adoption and non-adoption of drip irrigation technology among small-scale farmers in Kitui County.

2. To find out how accessibility to credit influences the adoption or non-adoption of drip irrigation.
3. To establish how the level of knowledge among small-scale farmers influences the adoption and non - adoption of drip irrigation technology.
4. To find out how the availability and challenges of water influence the adoption of drip irrigation among small-scale farmers in Kitui County.

1.5: Research Hypotheses

- H0₁: The costs associated with drip irrigation have no significant effect on adoption of the technology by small-scale farmers in Kitui County.
- H0₂: The accessibility of credit has no significant effect on the adoption of drip irrigation in Kitui County.
- H0₃: The level of knowledge among small-scale farmers in Kitui County regarding drip irrigation has no significant influence on their decision to adopt the technology.
- H0₄: Water availability has no significant effect on the adoption of drip irrigation among small-scale farmers in Kitui County.

1.6: Significance of the Study

The study could be of significance for various stakeholders, including farmers, policymakers, researchers, and development practitioners in the following ways:

The study focuses on the main barriers that impede the adoption of drip irrigation; a technology crucial for sustainable agricultural practices. By establishing these obstacles, the research may contribute to the long-term viability of farming in ASAL regions, promoting resilience in the face of climate variability.

Successful adoption of drip irrigation can lead to increased agricultural productivity and crop yields. This, in turn, contributes to enhanced food security in Kitui County by ensuring a more reliable and diversified food supply for local communities.

The findings from this study can empower small-scale farmers by providing insights into the specific challenges they face regarding drip irrigation adoption. The research findings may be used to come up with interventions and support mechanisms to enable farmers to make informed decisions and enhance their capacity to adopt sustainable farming practices.

Policymakers at the local, regional, and national levels may benefit from evidence-based recommendations to be generated by the study. Such recommendations can inform policy decisions related to financial support mechanisms, credit accessibility, and educational programs aimed at promoting drip irrigation adoption and sustainable water management.

The study could contribute to the present body of knowledge by clarifying barriers specific to the adoption of drip irrigation. This research may add valuable insights to the broader literature on sustainable agriculture, water resource management, and smallholder farming in arid and semi-arid regions.

Non-Governmental Organizations (NGOs), development agencies, and extension services can use the study findings to design interventions and capacity-building programs. By aligning interventions with the identified hindrances, these organizations can better support small-scale farmers to overcome challenges and adopt drip irrigation effectively.

1.7: Conceptual Framework

The conceptual framework (Figure 1.1) shows that farmers knowledge, water shortage, technical support services and farmers experience are related and do affect the dependent variable namely adoption of drip irrigation.

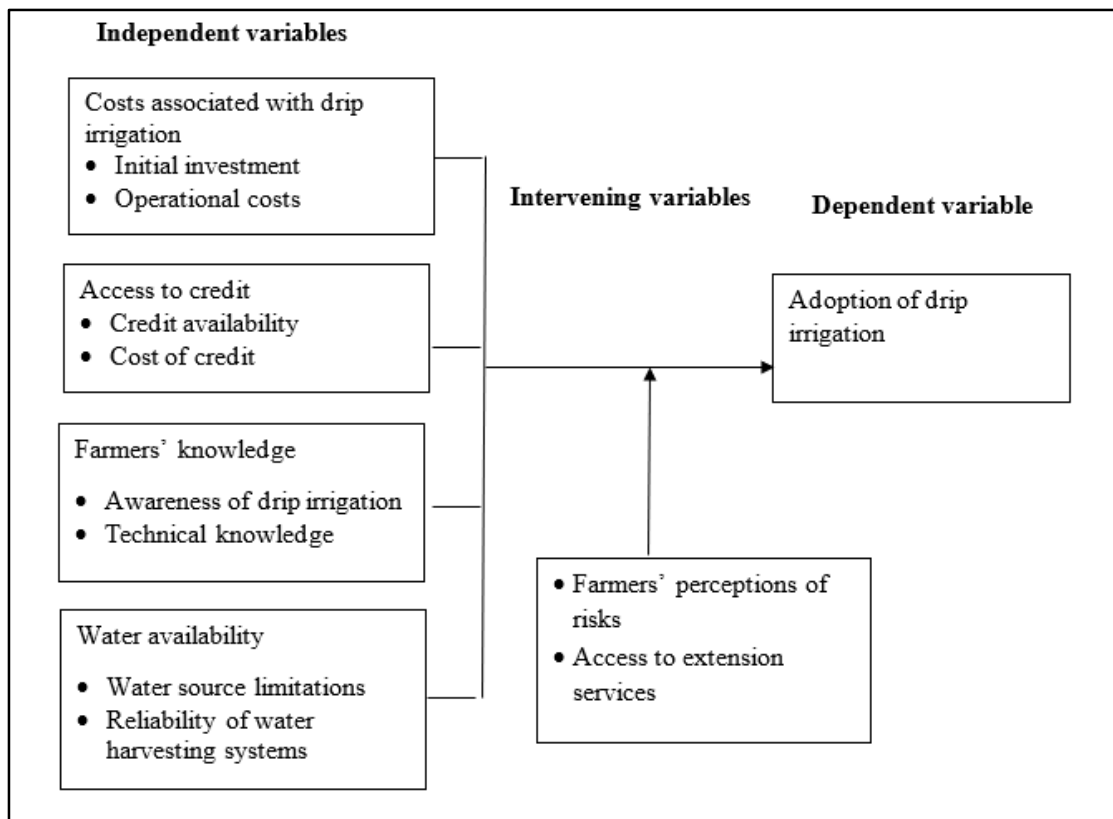


Figure 1.1: Factors influencing adoption of drip irrigation among small scale farmers in Kitui County

Source: Researcher, 2024

The conceptual framework presented in Figure 1.1 shows the factors shaping the adoption of drip irrigation among small-scale farmers in Kitui County, Kenya. The independent variables of the study included the financial challenges associated with drip irrigation adoption, including initial investment and operational costs. This category extends to access to credit, considering both the availability of finance and the cost implications associated with securing credit for drip irrigation. Farmers' knowledge forms another independent variable, measured through awareness of drip irrigation and technical knowledge. The final independent variable, water availability, focuses on the limitations in water sources and the reliability of water harvesting systems.

The dependent variable of the study was the adoption of drip irrigation. This relates to the degree to which small-scale farmers in Kitui County have incorporated drip irrigation technology into their agricultural practices. The intervening variables of the study are also presented. Farmers' perceptions of risks serve as a mediator, capturing

subjective assessments and beliefs regarding the risks associated with adopting drip irrigation. This variable may influence the relationship between financial challenges, knowledge, and the actual decision to adopt. Access to extension services forms another intervening variable, representing the availability and utilization of agricultural extension services that provide information, training, and technical support for drip irrigation. This variable may mediate the impact of knowledge levels on the adoption decision, facilitating a bridge between awareness and practical implementation.

The independent variables within the framework directly influence the dependent variable of drip irrigation adoption. The study argues that, high costs, limited credit access, insufficient knowledge, and water scarcity can act as barriers to adoption. Intervening variables, namely farmers' perceptions of risks and access to extension services, play a mediating role. Farmers' risk perceptions may shape their willingness to adopt despite hindrances, while access to extension services has the potential to enhance knowledge and alleviate perceived risks.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This section provides a review of theoretical and empirical literature in relation to the study. The empirical literature is provided for each of the objectives guiding the research.

2.2 Theoretical Framework: The Innovation-Decision Process

The current study integrates the modified version of Rogers Innovation - Decision Model (Kalamwa, 2003). It is important to study the factors that influence an individual's adoption because it is context-specific. The political and institutional structure is more important in the developing countries like Kenya than in the developed countries. Factors such as profitability, affordability, convenience, and safety are among the important factors' farmers must take into consideration before implementing drip irrigation. The definitions in the heuristic were made more suitable and relevant for the farmers' knowledge.

The process consists of four phases: the knowledge phase, the persuasion phase, the decision phase, and the adoption phase (Wu *et al.*, 2015). Knowledge is a necessary component of the adoption model. The innovator may have a rough understanding about the innovation at this stage. Initial information research is carried out before acquiring information. Finding out how farmers learn about using of affordable drip irrigation is crucial as it establishes the factors that determine uptake of the technology in the semi-arid regions of the country. Information is crucial to make use of low-cost drip irrigation system. Farmers who make decisions without adequate consideration and research. In short, these communities are likely to fail to comprehend the understanding expertise of the technology development (Kalamwa, 2003).

The individual is interested in the innovation and he is actively seeking information. The individual asks from trusted sources information about advantages, disadvantages and consequences of the new idea. The person may decide whether or not to adopt a controversial innovation because of persuasion in the case of drip irrigation, it is important to look into the effectiveness of demonstrations in speeding the trial process. Considering this option may include adopting the innovation or just rejecting

it. Implementation is the fourth stage in the traditional innovation decision-making process. It can be noticed when there is a shift toward experimentation and innovation.

2.3 Irrigation and Small-Scale Farming

Agriculture plays a crucial role in both the livelihoods of people and the economies of developing countries in Sub-Saharan Africa, accounting for around 60 percent of the workforce. The vast number of the workforce is focused on sustainable agriculture. Food security in a country has an immensely measurable influence on her population's survival. Almost 80 percent of Africa's population lives in rural areas as farmers, and almost 70 percent of African poor work mainly in agriculture (Glazebrook *et al.*, 2020). If individuals are excluded from other sectors' markets due to production issues, the impact will differ from the shortages experienced in the agricultural sector. The cost of labor and new tech employed in agriculture is a critical component of food safety in developing economies.

In Kenya, agriculture is a major livelihood for citizens who live in Kenya and other African countries. In Kenya, about 76 percent of the people are dependent on subsistence farming and the 52 percent of her workforce engage in small-scale farming. Subsistence farming generate about 75 percent of the agricultural production and 70 percent of the marketable produce of the country. These numbers demonstrate just how important farming is for Kenya's economy (Global Scientific Journal, 2023). Farms, totaling only three hectares, take up 60 percent of arable land, make up for 75 percent of total production, and 70 percent of productivity sold. Smallholder agriculture serves a major part in improving the outcome of Kenyan economy. It accounts for at least 24 percent of the Gross Domestic Product (Mwangi & Crewett, 2019). The progress for several years has been very dismal for poor small-holders.

There is high consensus among scholars that irrigation has an important effect on development and alleviating poverty in Sub-Saharan Africa. Irrigation is seen as the missing key to expanding the agricultural sector. First, irrigation make farmers to cultivate high-value crops, which lead to better yield harvest production. One way to enhance water utilization performance and maximizing returns is by using drip irrigation. Water received from rainfall and collected in affordable tanks can also be used in drip irrigation (Global Scientific Journal, 2023). Several people regard drip

irrigation as an expensive system and this view seems justified in part due to cost to the farmers.

Irrigation plays a crucial role in global agriculture, especially in regions characterized by scarce and erratic rainfall. Small-scale farmers, often reliant on rainfed agriculture, face numerous challenges due to climate variability, necessitating the implementation of efficient irrigation systems. These challenges can be successfully addressed by adopting irrigation technology in order to overcome the risks associated with climate variability by ensuring stable and increased agricultural productivity. According to Reynolds (2023), irrigated agriculture contributes significantly to global food production, accounting for over 40 percent of the total food supply. In regions with unreliable rainfall, irrigation provides a dependable water supply, allowing farmers to diversify crops, increase yields, and achieve multiple cropping cycles within a year (Nikolaou *et al.*, 2020).

The role of irrigation in enhancing food security extends beyond mere crop yield improvements. According to Mupaso, Makombe and Mugandani (2023), irrigation contributes to poverty reduction by providing a reliable source of income for farmers, reducing vulnerability to climate shocks, and creating employment opportunities in the agricultural sector. Consequently, the adoption of appropriate irrigation systems becomes imperative for sustaining agricultural development, particularly for small-scale farmers in rain-scarce regions.

2.4 Drip Irrigation System

Drip irrigation is an efficient farming approach with modern technology being highly more effective than classical methods (Kaur & Misra, 2019). Drip irrigation system is a cost-effective way of delivering water to plants. Drip irrigation is a water-saving technique with highly precise control over how much water is being used (Fan *et al.*, 2020). The provision of water, fertilizer, gas and heating have a substantial impact on the crop's growth and produce (Global Scientific Journal, 2023). This technology is widely used throughout China's arid and semi-arid regions, particularly for growing of jujube (Ye and Liu, 2019). Agricultural production is of great importance since water is a scarce resource. Recent research has indicated that efficient use of water serves as a key measure of water-saving irrigation practices. Water utilization efficiency

describes the relationship for both plant consumption of water and its productivity. During a drought, plants survive better than when under water.

Irrigated agriculture must manage competition between crop sectors for limited water resources. The adoption of micro-irrigation has had significant impacts on crop production, quality and use of water. Subsurface drip irrigation reduces drainage water and soil evaporation (Moyo *et al.*, 2020). Unfortunately, the issue of leakage still appears in this way. Moisture irrigation involves the flow of water out of moisture pores as a function of the soil water potential and the applied pressure. The sprinkler system can supply 80–90 percent of the water used by the crops. It is a form of water recycling scheme. Drip irrigation systems may feature timed daily injections of water to plants. This method keeps constant soil moisture levels for crops as wells (Nikolaou *et al.*, 2020). Nevertheless, drip irrigation can be functioned using fixed water resources that do not differ greatly in quantity or quality and are also subject to deliver. However, the effectiveness of frequency is greatly affected by such things as the cultivar, soil, and climate. Arid regions have simpler irrigation systems while humid regions have relatively complex technologies in use.

Cropping methods in a given region could affect the perception of the appropriateness of drip irrigation (Dawit *et al.*, 2020). When crops are grown in countries such as Malaysia and India where elevated horticultural, sapling, and grape crop yields are grown, growers have an obviously false perspective that drip irrigation is more costly than other forms of irrigation systems. The fact that producers of conventional apples are not willing to change may be an obstacle to management improvement. If this crop is grown in regions of economically scarcer water, drip irrigation might be a viable choice. During the early 1982, drip irrigation was regarded as an effective, cost effective, irrigation system option for American farmers. The elements of drip irrigation systems can also be customized to the type of project and the size of the project. The drip irrigation does have low cost compared to other irrigation (Dawit *et al.*, 2020). Newly adopted drip irrigation technique will be thwarted by the dearth of decent knowledge, trained equipment suppliers and technicians (Wang & Cheng, 2020).

2.5 Drip Irrigation among Small-Scale Farmers

In rain-scarce regions like Kitui County, where water availability is a limiting factor, the adoption of water-efficient irrigation technologies becomes crucial. Drip irrigation has emerged as a promising and sustainable solution to address water scarcity challenges in agriculture (Nikolaou *et al.*, 2020). In contrast to conventional irrigation techniques like flood and furrow irrigation, which often lead to water waste and uneven distribution, drip irrigation provides a controlled and accurate delivery of water directly to the plant roots. This method not only conserves water but also enhances nutrient absorption by crops, reduces weed growth, and minimizes soil erosion.

Drip irrigation offers several advantages that make well-suited for small-scale farmers in rain-scarce regions like Kitui County. First, it maximizes water efficiency by supplying water straight to the plant roots, reducing evaporation and runoff losses. This aspect is crucial in areas where water is a scarce resource and needs to be managed judiciously to sustain agricultural activities. Secondly, drip irrigation supports sustainable agriculture by promoting water conservation and soil health. The controlled release of water prevents waterlogging, salinity issues, and nutrient leaching, thereby preserving the long-term fertility of the soil (Karimzadehet *al.*, 2023). This is especially significant for small-scale farmers who often operate on limited land resources and need to maximize the productivity of their plots. Moreover, drip irrigation systems are adaptable to various crop types and can be customized to fit different farm sizes, making them suitable for the diverse agricultural practices found in Kitui County (Karimzadehet *al.*, 2023). The potential for increased yields, improved crop quality, and reduced dependency on erratic rainfall positions drip irrigation as a valuable tool for enhancing the resilience of small-scale farmers to climate-related challenges.

2.6 Factors Related to Adoption of Drip Irrigation System

The uptake of drip irrigation systems among smallholder farmers is undoubtedly a critical determinant of sustainable water management and enhanced agricultural productivity. However, despite the advantages of farming through drip irrigation, the widespread embracing of this method among smallholder farmers has been shown to face several challenges. Understanding these hindrances is crucial for developing

policies and interventions that can facilitate the successful integration of drip irrigation in the agricultural practices of small-scale farmers. In a study conducted in China, Yang *et al.*, (2023) found that one of the primary barriers to the uptake of drip irrigation by smallholder farmers is the initial costs associated with adoption. Drip irrigation systems often involve purchasing specialized equipment such as pipes, emitters, filters, and pumps. The financial burden of acquiring these components can be prohibitive for farmers with limited capital.

Small-scale farmers also often face challenges in accessing credit and financial support. For instance, a study done by Seroteet *et al.*, (2023) in South Africa showed that, in the absence of adequate finance, smallholder farmers struggle to invest in climate-smart irrigation technologies like drip irrigation. In addition, the South African study found that lack of awareness and technical knowledge about drip irrigation systems posed significant challenges (Seroteet *et al.*, 2023). Small-scale farmers may be unfamiliar with the benefits of drip irrigation or may lack the necessary skills for its proper installation and maintenance. The maintenance of drip irrigation systems also requires technical know-how and periodic investments. Small-scale farmers may face challenges in accessing timely maintenance services and spare parts, leading to system inefficiencies and reduced effectiveness over time. Strategies for ensuring ongoing technical support and maintenance services are crucial to sustaining the adoption of drip irrigation technology (Badiane& von Braun, 2018).

Kitui County, is characterized by semi-arid conditions and recurrent water scarcity, small-scale farmers face challenges in sustaining agricultural activities (Nyaga, 2019). The region heavily relies on rainfed agriculture, subjecting farmers to the uncertainties of irregular rainfall patterns. The resulting subsistence farming practices exacerbate vulnerability to climate-induced shocks, impacting both crop yields and household incomes (Mutunga, 2022). The study aimed to address these issues by identifying the barriers hindering the widespread uptake of drip irrigation among small-scale farmers. Water scarcity, coupled with the financial constraints of subsistence farmers, poses a significant impediment to the adoption of this water-efficient technology. The factors that influence adoption of drip irrigation are discussed below, with a specific focus on financial challenges, access to credit, farmers' knowledge, and water availability.

2.6.1 Financial challenges and adoption of drip irrigation

The adoption of drip irrigation systems is directly linked to financial challenges faced by small-scale farmers. Studies emphasize the substantial financial implications associated with the initial investment and operational costs of drip irrigation. For instance, Wainaina (2021) highlighted that the high upfront costs of purchasing and installing drip irrigation infrastructure often act as a barrier for smallholder farmers. The researcher noted that the low uptake of drip irrigation can be mainly ascribed to high cost of purchasing the necessary equipment (such as piping, water tank, pump, and drip tape). Initial investment requirements, including the purchase of equipment, installation, and infrastructure development, often serve as formidable hurdles for small-scale farmers. Research by Serote, *et al.*, (2023) emphasizes that the capital-intensive nature of drip irrigation technology can deter adoption, particularly in resource-constrained agricultural settings.

Studies suggest that the high upfront costs may result in a delayed return on investment, impacting farmers' willingness to embrace drip irrigation (Sinha, 2020). These costs encompass the procurement of drip lines, emitters, filters, and other essential components, constituting a significant portion of the financial burden for farmers. Addressing these financial challenges requires innovative approaches, such as subsidized equipment or financial support mechanisms, to alleviate the initial financial burden on small-scale farmers and incentivize the adoption of drip irrigation. However, even with subsidies sometimes uptake of drip irrigation is still low. For example, Malik, *et al.*, (2018) established that despite concerted efforts by the government and the donor community to subsidize the initial cost for farmers, there was still low uptake of the technology by Indian farmers.

In addition to initial costs, the operational expenses associated with drip irrigation, including maintenance and purchase of consumables, contribute to the overall financial burden (Ali, *et al.*, 2020). Research conducted by Yang *et al.*,(2023) highlighted those ongoing expenses related to system maintenance, energy requirements, and consumables contribute to the overall financial burden for farmers. The sustainability of drip irrigation adoption is contingent on the ability of farmers to cover these operational costs efficiently.

The operational costs extend to regular checks, repairs, and replacement of components, requiring continuous financial commitments from farmers. United Nations Environmental Programme (2018) found that while the water efficiency of drip irrigation is lauded, farmers must weigh the benefits against the recurring operational expenses. Consequently, strategies to enhance the economic viability of drip irrigation adoption should not only address initial costs but also incorporate mechanisms to manage and reduce long-term operational expenditures. Since the benefits outweigh the investment costs associated with drip irrigation, it is important for farmers to have access to affordable credit for procurement of this irrigation technology, and this issue is discussed next.

2.6.2 Access to credit and adoption of drip irrigation

Accessibility of finances is a crucial enabler of uptake of drip irrigation technologies among small-scale farmers. Limited credit availability has been identified as a significant barrier, hindering farmers from making the necessary upfront investments in drip irrigation systems (United Nations Environmental Programme, 2018). Research by Tinsley and Agapitova (2018) emphasizes that smallholder farmers with restricted financial resources often face challenges in obtaining affordable credit to finance the acquisition of drip irrigation infrastructure.

Studies suggest that the accessibility of credit plays a major role in overcoming financial barriers and enabling the uptake of drip irrigation. A study done in Pakistan by Ullah *et al.*, (2020) revealed that there was a positive correlation between credit availability and farmers' ability to invest in water-efficient technologies. Moreover, the timely availability of credit is crucial, as delays in securing funds may deter farmers from capitalizing on favorable conditions for implementing drip irrigation practices.

The cost of credit, including interest rates and repayment terms, is a critical factor influencing farmers' decisions regarding the adoption of drip irrigation. High-interest rates and stringent repayment conditions can exacerbate financial burdens, rendering credit less accessible and less appealing to small-scale farmers. According to (Chandan & Gupta, 2021) the affordability of credit significantly impacts the economic feasibility of adopting drip irrigation. Innovative financing mechanisms and policies that address the cost of credit have been identified as instrumental in

facilitating drip irrigation adoption. Subsidized interest rates, flexible repayment schedules, and government-backed credit programs are proposed strategies to make credit more affordable for small-scale farmers, encouraging them to invest in water-efficient technologies (Jacquemot, 2023). Such interventions not only reduce the financial burden on farmers but also contribute to creating an enabling financial environment for sustained adoption.

2.6.3: Farmers' knowledge and adoption of drip irrigation

Farmers' knowledge and awareness about drip irrigation technology emerges as a critical factor influencing its adoption. Studies done in the past point to the fact that inadequate knowledge and awareness constitutes a significant barrier to the widespread uptake of the technology among smallholder farmers (United Nations Environmental Programme, 2018). Insufficient knowledge about the benefits and proper management of drip irrigation systems can hinder farmers from considering it as a viable option. Educational campaigns, extension services, and targeted information dissemination initiatives have been proposed as effective strategies to enhance farmers' awareness about drip irrigation (Muthui, 2015). Jabbariet al.,(2024) emphasize the need for tailored awareness programs that not only introduce farmers to drip irrigation but also emphasize its potential advantages, including water savings, increased crop yields, and resource efficiency.

Farmers' technical knowledge about the operation, maintenance, and troubleshooting aspects of drip irrigation systems is fundamental for successful adoption. Dace (2020) points out that farmers often grapple with the complexities of system operation, leading to suboptimal utilization of the technology. Technical knowledge gaps contribute to challenges in system setup, component maintenance, and efficient water and nutrient management. Research underscores the importance of farmer training programs and capacity-building initiatives to bridge technical knowledge gaps (World Bank, 2021). Hands-on training, demonstrations, and farmer-to-farmer knowledge sharing have proven effective in enhancing technical know-how, empowering farmers to overcome challenges associated with adopting and maintaining drip irrigation systems.

2.6.4: Water availability and adoption of drip irrigation

In regions facing water scarcity, water source limitations pose substantial challenges to adopting water-efficient technologies like drip irrigation. Inadequate water supply, whether due to erratic rainfall patterns or the unavailability of reliable water sources, can hinder the feasibility of implementing drip irrigation practices. Studies emphasize that the success of drip irrigation adoption is contingent on addressing water source limitations, particularly in arid and semi-arid regions (Yang, *et al.*, 2023). The exploration of substitute source of water, including underground water and harvesting rainwater, is often necessary to overcome limitations posed by unreliable or insufficient natural water sources (United Nations Environmental Programme, 2018).

Studies done in Kitui County have revealed that lack of water is a major factor that affects agricultural activities in the region. For instance, Mutunga, Ndungu and Muendo (2018) revealed that lack of access to irrigation water was one of the significant constraints to farmers' adaptation to climate variability in Kaveta and Mikuyuni Villages of Kitui County. A study done in the same County by Ogecha, Wakhungu and Obiri (2016) revealed that, although there were efforts to address water shortage challenges through establishment of water conservation projects, majority of the farmers still largely rely on rainfed agriculture. Another study in Kitui County by Koreeny (2022) found that type of soil affected farmers' willingness to engage in water harvesting practices. The researcher found that the farmers in the County preferred sand as opposed to clay soil for construction of rain water harvesting technologies since it easily ruptures

The reliability of water harvesting systems directly impacts the adoption and success of drip irrigation. Inconsistencies in rainfall patterns and the dependability of water harvesting mechanisms, such as rainwater harvesting systems, can significantly affect farmers' decisions to adopt drip irrigation Kenya Institute for Public Policy Research and Analysis (KIPPRA) report (2020). The literature underscores that while rainwater harvesting presents an opportunity for water-efficient irrigation, the reliability of these systems is subject to climatic variations (Freni & Liuzzo, 2019). Farmers often face challenges in managing and maintaining water harvesting infrastructure, affecting the reliability of these systems for sustained agricultural production. Addressing issues related to the reliability of water harvesting systems requires a holistic approach,

including the incorporation of climate-resilient technologies and practices that enhance the consistency and efficiency of water collection (Mati *et al.*, 2017).

Integrated water management strategies that combine multiple sources, such as rainwater harvesting, surface water, and groundwater, are proposed as effective solutions to address water source limitations (Meran *et al.*, 2021). These strategies aim to optimize water availability for agriculture while minimizing environmental impacts. Research suggests that adopting a portfolio approach to water management enhances resilience, allowing farmers to navigate uncertainties associated with water availability and climatic variability (Paydar & Qureshi, 2012). Government policies that promote integrated water resource management, coupled with community-driven initiatives, can contribute to creating a more reliable and sustainable water supply for drip irrigation adoption (Food and Agricultural Organization (FAO), 2018). By addressing both natural water source limitations and the reliability of water harvesting systems, interventions can enhance the overall water resilience of small-scale farming systems.

2.7 Research Gaps

While existing literature has provided important insights into the factors influencing the uptake of drip irrigation amongst smallholder farmers, a number of gaps in literature have been established, and the study in Kitui County aimed to address these gaps. The majority of existing studies focus on broad factors influencing drip irrigation adoption, often derived from diverse geographical contexts. There is limited local research that specifically addresses the unique challenges experienced by smallholder farmers in Kitui County, Kenya. The study aimed to bridge this gap by providing context-specific insights into the hindrances to drip irrigation adoption within the region.

While water availability is recognized as a critical factor, existing literature often provides generalized insights without focusing on the various water-related challenges specific to Kitui County. The research aimed at filling this gap by exploring how water source limitations, and reliability of water harvesting systems impact on the uptake of drip irrigation within the local context. The reviewed studies discuss the importance of farmers' knowledge in adopting drip irrigation, but there is a lack of in-depth exploration into the dynamics of knowledge acquisition and dissemination. The

study intended to establish the specific knowledge gaps, awareness levels, and technical knowledge constraints among small-scale farmers in Kitui County, providing a comprehensive understanding of how knowledge influences adoption.

While financial constraints are acknowledged as hindrances to adoption, the existing literature often provides a broad overview without focusing on the specific financial burdens experienced by smallholder farmers in Kitui County. The study aimed to identify and analyze the specific financial barriers, including initial costs, operational expenses, and access to credit, offering a deeper understanding of the financial dynamics influencing adoption

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter provides a summary of the study location, the research design, population, sampling techniques and the sample size, data collection methods, procedures, and research instruments. The data analysis techniques are also discussed.

3.2 Study Area

Kitui County is located at Kenya in the Cities place category with the GPS coordinates of 1° 22' 30.2916" S and 37° 59' 42.7668" E. Topographically, the characteristics of these zones are as follows: *Very Arid zone VI*: The area covers Mutitu, Mutomo and Ikutha Sub County which is nearly 75% of the County area. The rainfall here is between 150 and 250mm per annum. *Agro ecological zone IV*: This area covers Kitui West, Lower Yatta, and Mwingi. The rainfall here is between 250 and 350mm per annum. *Semi-arid zone IV*: This zone covers areas the larger areas of Matinyani and Kitui Central. This zone approximately receives total annual rainfall range of 250 and 650mm per year.

This study was conducted in Kitui County (Fig. 3.1), that is under semi-arid zone IV. The area is classified under hot and dry climate characterized with high temperatures and low rainfall. Kitui County is divided into eight administrative Sub-Counties, that is, Mwingi North, Mwingi Central, Mwingi West, Kitui West, Kitui Central, Kitui East, Kitui Rural and Kitui south. The County has a total population of approximately 1.2 million people (Kenya National Bureau of statistics (KNBS), 2019).

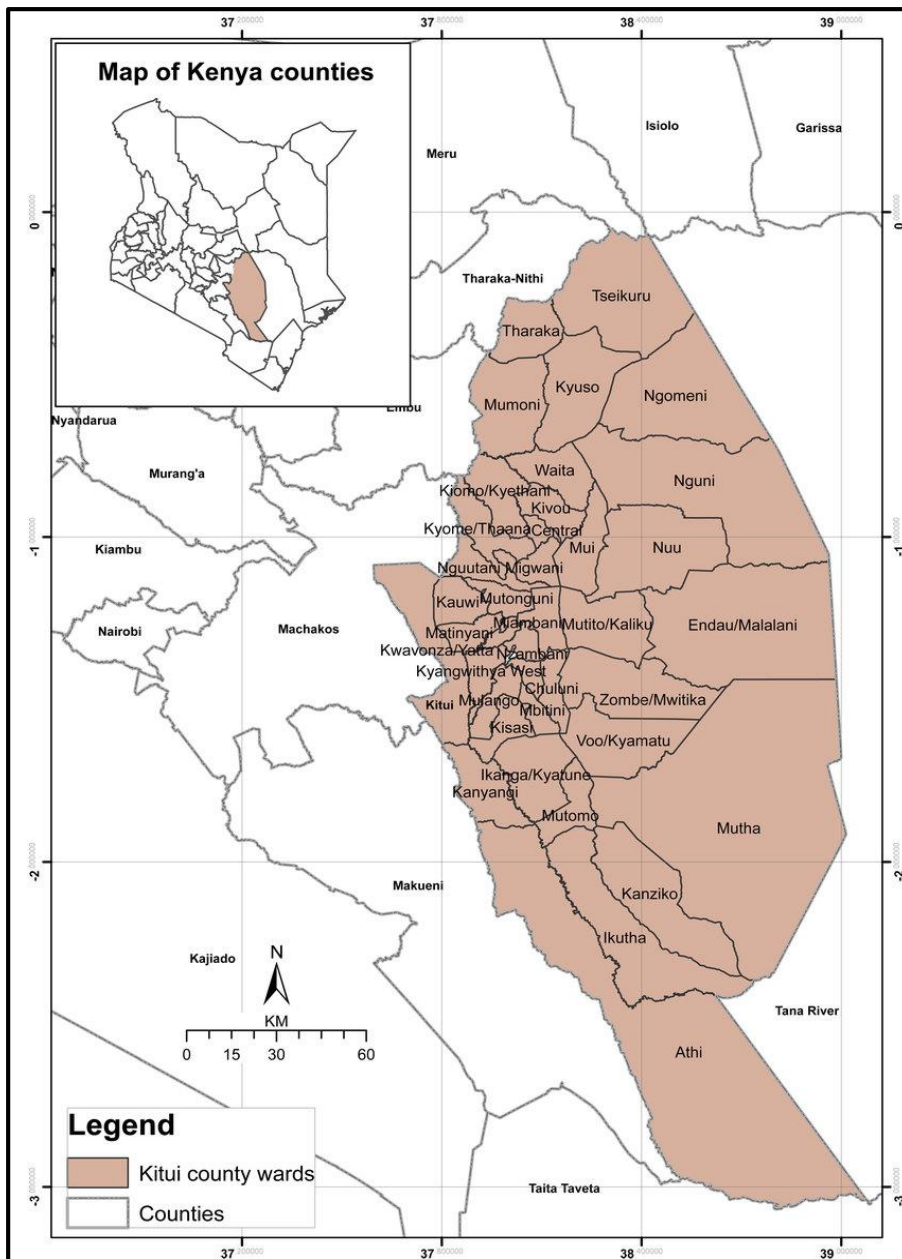


Figure 3.1: A Map of Kitui County. Source: Kitui County PCRA Report (2023).

3.2.1: Climate

In Kitui, the dry season are short lasting from January to march which ushers in the long rains which lasts from March to May, warm, and overcast; while cold period lasts from June to August, they are short, comfortable, and partly cloudy; and it is dry year-round and the short rains starts in November to December. Over the course of the year, the average annual temperature is 23.1 °C. The warmest month of the year is March, with an average temperature of 24.8 °C. In contrast, July is the coldest month, with temperatures averaging 21.1 °C. County is characterized by different agro

climatic zones, each receiving varying levels of rainfall, which influences the types of livelihoods, potential hazards, and other factors. Rainfall in the region varies from less than 250mm in the drier areas to over 400mm, though it does not surpass 500mm (Kitui County Meteorological Office, 2021). High temperatures and increased risk of floods are experienced during the long rains season, (March-May) while in the short rains season (October-December) the climate is more stable and can potentially be exploited with adaptations such as early maturing crop varieties (Kenya County Climate Risk Profile, 2021).

3.2.2: Economic activity

Agriculture is the main economic activity in Kitui County contributing to food security and generating 87 percent of rural household income (Naeku & Irungu, 2024).

3.2.3: Soils

Soil types are majorly sandy red and black clay cotton soils (Kenya County Climate Risk Profile, 2021) which are predominantly vulnerable to erosion, poorly drained and are restricted in their ability to reserve moisture and nutrients.

3.3 Research Design

This study on drip irrigation in Kitui County employed a descriptive survey research design. The design was chosen because it facilitates specific predictions and allows for the narration of facts and characteristics related to the performance of the technique (Kothari, 2004). Descriptive survey studies aim to gather relevant and accurate data about a phenomenon's current status, and where possible, derive valid conclusions from the findings.

3.4 Target Population

The study targeted all the farmers who use drip irrigation method in their farms in Kitui County. From the County's Ministry of Agriculture and Kitui County Development office, a list of farmers was acquired to help the researcher in reaching the farms. According to Kitui County Intergrated Plan 2014, Kitui County had estimated 200 farmers, out of the total 1000 farmers, using drip irrigation during the period this research was done. In addition, the study targeted farmers who are not using drip irrigation, in order to compare views and establish hinderances to adoption of the technology.

3.5 Sample Size and Sampling Procedure

The study targeted farmers in Kitui County, where a total of 2,022 farmers were identified as engaging in irrigation activities, including both furrow and drip irrigation. To determine an appropriate sample size, the study adopted Nassiuma's (2000) formula for sample size determination:

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

Where:

n = sample size,

N = population size,

C = coefficient of variation (taken to be 21 to 30%),

e = margin of error (commonly set at 0.05).

Using the population of 2,022 farmers, a coefficient of variation of 21%, and a margin of error of 0.05, the computation gave a sample size of approximately 155 farmers. This was considered sufficiently representative while remaining manageable for field data collection. From the computed sample, stratified sampling was applied to ensure that both adopters and non-adopters of drip irrigation were represented. Among the farmers using drip irrigation kits in organized groups across the five administrative wards, 30% of the 200 identified adopters were randomly sampled, yielding 60 farmers. To allow for comparative analysis, an equal number of 60 farmers not using irrigation were also randomly sampled. This gave a total effective sample size of 120 farmers. Although the initial Nassiuma computation yielded 155 as the statistically appropriate sample, practical considerations of cost, time, and accessibility led the researcher to work with 120 respondents while retaining a balanced comparison between adopters and non-adopters. This ensured both representativeness and feasibility of the study.

3.6 Research Instruments

The researcher made use of a primary data collection tool. Structured questionnaires were used to get information from farmers. Questionnaires are a convenient and cost-effective method for reaching respondents across a wide geographic area, allowing them to feel comfortable providing honest responses to sensitive inquiries. The questionnaire had rating questions in the form of Likert scale since it was presumed to

be an appropriate method of getting evaluation responses. In order to address any complexities or anxieties that could arise from filling out questionnaires, the researcher supplemented the process with verbal clarifications during administration. Informal interactions with farmers allowed for explanation of terms and questions whenever needed. This ensured that the respondents clearly understood the items. This approach helped to mitigate possible limitations and strengthened the quality of responses. Field observations were also done and some photographs taken regarding some of the activities carried out by the farmers.

3.6.1 Validity of the Instruments

Validity is defined to refer to the degree to which measures produce same results. A measure is said to be valid if it does what it is intended to do (Orodho, 2006). In order to determine the instrument's validity, the researcher consulted the specialists in the area of the research and the comments and suggestions were incorporated to better the instrument before data collection was done.

3.6.2 Reliability of the Instruments

WAC Clearinghouse (2024) noted that reliability pertains to the ability to yield consistent results across different yet comparable instances. Reliability of the instrument of this study was established using split-half method of reliability testing. To do this, a pilot study was done among 30 farmers who were not comprised in the real study. During the pilot study, the selected farmers were administered the instrument to assess its effectiveness and identify any potential issues related to clarity, coherence, or ambiguity in the questionnaire. The aim was to refine and enhance the instrument based on the feedback and responses obtained from the pilot group. The split-half method involved splitting the filled-in questionnaires into two equal parts and comparing the responses obtained from each half. The obtained correlation coefficient between the two halves was 0.64. To adjust for the fact that the reliability of a full test is usually higher than that of a half test, the Spearman-Brown prophecy formula was applied:

$$r_{SB} = \frac{2r}{1+r}$$

Where:

r = correlation between the two halves.

Substituting the values:

$$r_{SB} = \frac{2(0.64)}{1 + 0.64} = \frac{1.28}{1.64} = 0.784$$

The resulting reliability coefficient was 0.784, which indicates satisfactory internal consistency and provides evidence of reliability for the questionnaire.

3.7 Data Analysis

Following the completion of fieldwork, the gathered data were systematically organized, reviewed, examined, and coded for analysis. Initially, the raw data were input into an Excel spreadsheet before being analyzed using SPSS Version 27. The data underwent descriptive statistical analysis, followed by summary statistics, and ultimately, the data were interpreted. Data from the questionnaires were analyzed by summing up the multiple items to get frequencies. Data were then tabulated and analyzed, to give a summary for each of the four specific objectives. Questions in the farmers' questionnaire were combined systematically according to objectives and computations of frequencies, means and standard deviations were done. To evaluate the study's hypotheses, the data were analysed by use of a t-test with a significance level of 0.05. The results were summarized and displayed using tables and bar charts in relation to research objectives and questions.

3.8 Ethical Issues

Authorization letter was given by Kenyatta University Graduate School and the ethics office of Kenyatta University, while permit to collect data given by National Commission for Science Technology and Innovation (NACOSTI). To conduct data collection, clearance was required from the Ministry of Agriculture in Kitui County. An introductory letter was provided to different offices to support the permissions requested from each group. Farmers were visited in their farms by the researcher. An elaborate explanation to the farmers was then done. Assurance was given to study participants regarding confidentiality, and they were informed of their right to decide whether to be participants in the research or not. Only consenting farmers were involved in the study.

CHAPTER FOUR: RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter provides the results of the study whose aim was to determine the factors hindering the adoption of drip irrigation in Kitui County, Kenya. The chapter starts with a presentation of the demographic data of the study participants, after which the descriptive data for each research variable is provided. Thereafter, the data analysis procedures and results are presented for each of the four research objectives.

4.2 Questionnaire Return Rate

The study targeted a sample of 120 farmers, among them 60 farmers who were using drip irrigation system and 60 who were not using drip irrigation. Table 4.1 shows the response rate on farmers' questionnaire.

Table 4.1: Response rate on farmer's questionnaire

Respondents	Targeted sample	Actual Sample	Return rate (%)
Using drip irrigation	60	56	93.3
Not using drip irrigation	60	59	98.3
Total respondents	120	115	95.8

Table 4.1 shows that out of the targeted sample, those who returned fully-filled questionnaires were 56 farmers using drip irrigation, representing 93.3% of this subset, and 59 farmers not using drip irrigation, which translates to 98.3% of the subset. As shown in Table 4.1, overall, 115 farmers out of the targeted 120 farmers were included in the study, which is a questionnaire return rate of 95.8%. According to Mugenda and Mugenda (2003), a response rate of 70% and over is appropriate for statistical analysis.

4.3 Demographic Data of Respondents

This part presents the demographic data of the farmers who participated in the study. The data presented includes gender, age, and education level attained by farmers.

4.3.1 Gender distribution of the respondents

Table 4.2 shows the distribution of the farmers by gender. There was 76 representing (66.1%) male farmers and 39 (33.9%) female farmers who participated in the study. Among the farmers who were using drip irrigation, 60.7% were male while 39.3% were female.

Table 4.2: Distribution of farmers by gender

Gender	No. of farmers	Percent
Male	76	66.1
Female	39	33.9
Total	115	100.0

Source: Farmers' questionnaire

The higher percentage of male farmers using drip irrigation suggests that there may be gender-specific barriers affecting female farmers' ability to adopt this technology. These barriers could include limited access to financial resources, technical knowledge, or extension services, which are often more accessible to male farmers. Previous studies have highlighted that women in agriculture frequently face challenges such as lower access to land, credit, and training opportunities compared to their male counterparts (Akpa, Amegnaglo&Chabossou, 2024). Gender imbalance in the adoption of drip irrigation may have broader implications for agricultural productivity and sustainability. Since women play a crucial role in agricultural activities, particularly in subsistence farming and smallholder systems, their lower adoption rates of improved irrigation technologies could impact overall farm efficiency and productivity. Empowering female farmers by improving their access to resources and knowledge could enhance the effectiveness of irrigation practices and contribute to better agricultural outcomes.

4.3.2 Age distribution of the respondents

Table 4.3 provides the distribution of farmers by age in a given sample. Out of 115 farmers surveyed, the largest group in the sample (42.6%) falls within a range of 31 to 40 years of age, signifying a noteworthy presence of middle-aged farmers. Additionally, 35.7% of farmers are aged between 41 and 50 years, suggesting stability and experience. Meanwhile, the 13.0% of the farmers aged 30 years or below represent the younger generation, and their engagement is crucial for the future of agriculture. Finally, the 8.7% of farmers aged 51 to 60 years face unique challenges as they approach retirement. Understanding these age dynamics can inform targeted interventions to promote sustainable farming practices, including drip irrigation adoption.

Table 4.3: Age distribution of farmers

Age in years	No. of farmers	Percent
30 years or below	15	13.0
31 - 40 years	49	42.6
41 - 50 years	41	35.7
51 - 60 years	10	8.7
Total	115	100.0

Source: Farmers' questionnaire

4.3.3 Respondents' levels of education

Table 4.4 presents the distribution of farmers based on their highest level of education. Out of 115 farmers surveyed, the largest group (40.9%) had completed secondary school, which indicates a solid foundation of basic education. Farmers with a college diploma make up 27.8% of the sample, suggesting a higher level of knowledge. Another 18.3% of the farmers had only completed primary school. Those with a university degree constitute 13.0% of the sample, representing a smaller but potentially influential group. This indicates that most farmers in the sample had at least a secondary school education, with 40.8% of them having pursued further education at the college diploma or university level.

Table 4.4: highest education level attained by farmers

Educationlevel		Using drip irrigation	Not using drip irrigation	Total
Primary school	n	7	14	21
	%	12.5	23.7	18.3
Secondary school	n	26	21	47
	%	46.4	35.6	40.9
College diploma	n	14	18	32
	%	25.0	30.5	27.8
University degree	n	9	6	15
	%	16.1	10.2	13.0
Total	n	56	59	115
	%	100.0	100.0	100.0

Source: Farmers' questionnaire

4.4 Correlation Analysis of Independent Variables

In this study there were four independent variables: costs associated with drip irrigation, access to credit, knowledge about drip irrigation, and water availability. Each variable was assessed using a 5-point Likert-type scale that ranged from Disagree Strongly to Agree Strongly. In order to establish the degree of association among the study's independent variables, a Pearson Product-Moment Correlation analysis was conducted. The variables tested included initial cost, access to credit, knowledge, and water availability. The results are presented in Table 4.5.

Table 4.5: Correlation matrix of independent variables

Variable	Initial Cost	Access to Credit	Knowledge	Water Availability
Initial Cost	1	.131	.208*	-.134
Access to Credit	.131	1	-.298*	0.039
Knowledge	.208*	-.298*	1	0.131
Water Availability	-.134	0.039	0.131	1

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

The correlation results in Table 4.5 indicate that, there was a positive and significant correlation between initial cost and knowledge ($r = .208$, $p < 0.05$). This suggests that farmers who perceived higher initial costs also tended to report higher levels of

knowledge regarding drip irrigation. The results also show that there was a negative and significant correlation between access to credit and knowledge ($r = -.298, p < 0.05$). This implies that farmers with better access to credit were likely to have lower knowledge scores, or conversely, those with higher knowledge levels reported poorer access to credit facilities. The correlations between initial cost and water availability ($r = -.134, p > 0.05$), as well as between access to credit and water availability ($r = .039, p > 0.05$), were not statistically significant. Similarly, the association between knowledge and water availability ($r = .131, p > 0.05$) was weak and non-significant. These results imply that, while some independent variables are interrelated, the majority show weak associations. This suggests that each factor contributes relatively independently to the adoption or non-adoption of drip irrigation, thus justifying their separate testing under the study's hypotheses.

4.5 Costs Associated with Adoption of Drip Irrigation

The first goal of the research was determining the financial challenges associated with adopting drip irrigation among smallholder farmers in Kitui County, focusing on the initial investment and operational costs. The descriptive data associated with this objective is presented first, after which inferential data analysis is done to establish the influence of associated costs on adoption of drip irrigation. The farmer's choice on what crops to grow, where, and when, the farm technologies to adopt and other long- and short-term management decisions determines how profitable a farm can be. Most economists believe that farmers make decisions to boost their farm income, reduce their physical and financial risk and labor requirements. In most cases, farmers biophysical, geophysical and available production technologies, input, labor, knowledge and skill gaps, market, access to credits and social norms are great constraints to farmer's adaptations adapt (United Nation Framework Convention for Climate Change, 2023).

4.5.1 Descriptive data on associated costs

The costs associated with adoption of drip irrigation were defined to encompass both initial investment costs, including expenses related to equipment purchase and installation, and operational costs related to the ongoing use and maintenance of drip irrigation systems. Data for this research variable was collected using a 9-item Likert scale that assessed farmers' levels of agreeing or disagreeing with items regarding their perceptions of the costs of procuring and maintaining a drip irrigation system.

The questions were weighed using a 5-point Likert-type scale that ranged from Disagree Strongly to Agree Strongly. The frequencies, percentages and the mean scores for each of the nine items are presented in Table 4.6.

Table 4.6: Descriptive data for costs associated with drip irrigation

Costs Associated with Drip Irrigation	SD	D	N	A	SA	Mean score
	F	F	F	F	F	
	(%)	(%)	(%)	(%)	(%)	
The initial investment cost of installing a drip irrigation system is too high for me.	0 (0.0)	15 (13.0)	9 (7.8)	54 (47.0)	37 (32.2)	2.02
The operational costs of maintaining a drip irrigation system are manageable.	4 (3.5)	15 (13.0)	8 (7.0)	17 (14.8)	71 (61.7)	4.18
I can easily afford the initial setup costs of a drip irrigation system.	10 (8.7)	15 (13.0)	19 (16.5)	50 (43.5)	21 (18.3)	3.50
The cost of purchasing the necessary equipment for drip irrigation is a major barrier for me.	9 (7.8)	36 (31.3)	7 (6.1)	39 (33.9)	24 (20.9)	2.71
The financial benefits of drip irrigation outweigh the initial investment costs.	6 (5.2)	10 (8.7)	3 (2.6)	68 (59.1)	28 (24.3)	3.89
I find it difficult to cover the ongoing operational costs of drip irrigation.	0 (0.0)	26 (22.6)	22 (19.1)	59 (51.3)	8 (7.0)	2.57
The availability of subsidies or financial assistance makes adoption of drip irrigation more feasible for me.	30 (26.1)	66 (57.1)	11 (9.6)	8 (7.0)	0 (0.0)	1.97
The costs associated with repairing and maintaining a drip irrigation system are too high.	34 (29.6)	55 (47.8)	18 (15.7)	8 (7.0)	0 (0.0)	2.00
I believe that the long-term savings from using drip irrigation justify the initial costs.	11 (9.6)	22 (19.1)	33 (28.7)	34 (29.6)	15 (13.0)	3.17

Source: Farmers' questionnaire

Key: SD- Strongly disagree, D- Disagree, N- Neutral, A- Agree, SA- Strongly agree

The table shows that, regarding the initial investment cost, a significant portion of farmers (79.2%) agreed or strongly agreed that it is too high, which is reflected in a mean score of 2.02. Conversely, most farmers (76.5%) agreed or strongly agreed that the operational costs of maintaining a drip irrigation system are manageable, resulting in a high mean score of 4.18. When considering the affordability of setup costs, 61.8% of farmers agreed or strongly agreed that they can easily afford these costs, with a mean score of 3.50.

The perception of the cost of purchasing the necessary equipment for drip irrigation was divided, as about half (54.8%) of farmers agreed or strongly agreed that this cost is a major barrier, leading to a mean score of 2.71. However, a majority of farmers (83.4%) agreed or strongly agreed that the financial benefits of drip irrigation outweigh the initial investment costs, which is reflected in a mean score of 3.89.

In terms of ongoing operational costs, over half of the farmers (58.3%) agreed or strongly agreed that covering these costs is difficult, resulting in a mean score of 2.57. When it comes to the availability of subsidies or financial assistance, most farmers (83.2%) disagreed or strongly disagreed that these factors make the adoption of drip irrigation more feasible, indicated by a low mean score of 1.97.

Table 4.5 also shows that a large majority of farmers (77.4%) disagreed or strongly disagreed that the costs associated with repairing and maintaining a drip irrigation system are too high, reflected in a mean score of 2.00. Lastly, farmers had mixed views on whether long-term savings justify the initial costs, with 42.6% agreeing or strongly agreeing with this statement, resulting in a mean score of 3.17. Overall, the data suggests that while operational costs were generally seen as manageable, initial investment and equipment costs were perceived as significant barriers. The role of subsidies and financial assistance is viewed negatively, indicating a need for better financial support mechanisms.

To better understand the perceptions of farmers regarding the costs associated with adoption of drip irrigation, an aggregate score was calculated based on responses to nine items related to costs associated with drip irrigation. Each farmer's responses to

these items were summed up to come up with an overall score, with a low score demonstrating greater perceived financial burdens. The items included statements about the initial investment costs, operational costs, and affordability of the system, among others. The mid-point of this scale was a score of 27, with scores above 27 indicating greater perceived financial burdens, while scores below 27 indicate low perceptions of financial burdens associated with adoption of drip irrigation. The aggregate scores are summarized in Figure 4.1.

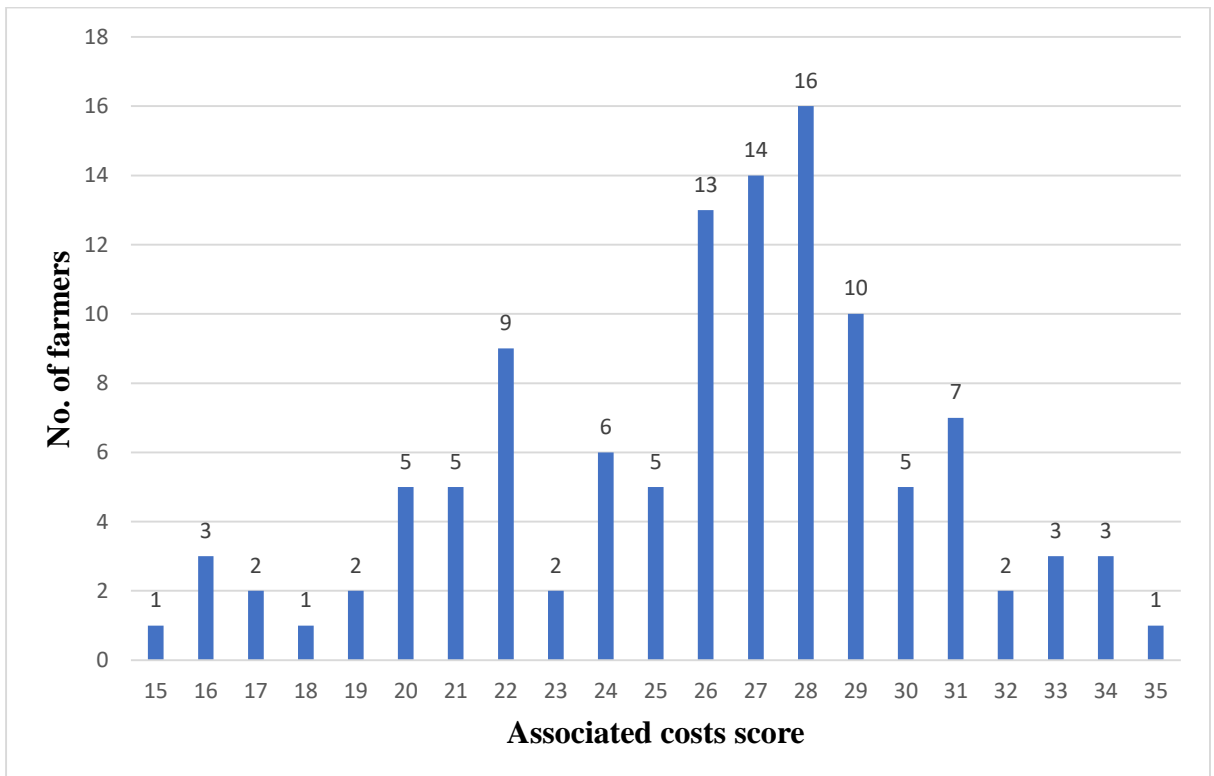


Figure 4.1: Costs associated with drip irrigation.

Source: Farmers’ questionnaire

Figure 4.1 shows that the aggregate scores ranged from 15 to 35. There were 54 (47%) farmers who scored below the midpoint of 27, which means that they perceived costs associated with drip irrigation to be high. Another 47 (40.9%) obtained scores above the midpoint of 27, indicating that they perceived the costs associated with drip irrigation to be manageable, while 14 farmers had a score of 27, which denotes that they were neutral. The fact that nearly half of the respondents perceive the costs as high suggests that financial barriers are a substantial impediment to adoption of drip irrigation. This perception might discourage farmers from investing in drip irrigation systems despite their potential long-term benefits. On the other hand, the 40.9% of the

farmers who found the costs manageable indicates that there is a segment of the farming population in Kitui County that is willing and able to invest in this technology. Despite the evident benefits of drip irrigation systems, many farmers in Kitui County find the initial investment costs, including infrastructure like water storage towers, to be prohibitively high.



Plate 1: Drip Irrigation Setup with Water Storage Tower.*Source: Researcher (2024)*

4.5.2 Influence of associated costs on adoption of drip irrigation

The first null hypothesis of the study stated:

H₀₁: The costs associated with drip irrigation have no significant effect on adoption of the technology by small-scale farmers in Kitui County.

This hypothesis was tested by use of a t-test analysis. The primary aim of this analysis was to determine whether there is a statistically significant difference in the adoption rates of drip irrigation between farmers who perceive the associated costs to be high

and those who perceive them to be manageable. The farmers were grouped into two categories – those who had adopted drip irrigation (n = 56) and those who had not adopted drip irrigation (n = 59). The aggregate associated cost scores, derived from responses to nine items related to the financial aspects of drip irrigation, were then compared between these two groups. The results of this analysis are as shown in Table 4.7.

Table 4.7: T-test for costs and adoption of drip irrigation

Use of drip irrigation	N	Associated cost mean score	Std. Dev.	Std. error mean	
Using drip irrigation	56	28.5000	3.19659	.42716	
Not using drip irrigation	59	23.6610	3.98536	.51885	
t-test statistics					
			t	df	Sig. (2-tailed)
Associated cost	Equal variances assumed		7.159	113	.001
	Equal variances not assumed		7.200	109.986	.001

The t-test analysis results shown in Table 4.7 indicate that, farmers using drip irrigation (N = 56) obtained significantly higher perceived cost scores (M = 28.50, SD = 3.20) compared to those not using drip irrigation (N = 59; M = 23.66, SD = 3.99), $t(113) = 7.159$, $p < .001$. This indicates that farmers who had adopted drip irrigation obtained significantly higher mean scores on the associated cost of drip irrigation than those who had not adopted. Therefore, the first null hypothesis was rejected, and its alternate form confirmed, that:

H_{a1} The costs associated with drip irrigation have a significant effect on adoption of the technology by small-scale farmers in Kitui County.

These findings suggest that farmers who have adopted drip irrigation perceive the associated costs to be more manageable compared to those who have not adopted the technology. The significant difference in mean cost scores underscores the importance of perceived financial barriers in influencing the adoption of drip irrigation. This highlights the need for financial support and interventions to reduce the perceived costs and encourage more farmers to adopt drip irrigation systems.

The findings above suggest that, while initial and operational/maintenance costs are often cited as significant barriers to the adoption of drip irrigation, those who overcome this barrier and adopt the technology perceive the costs as manageable and worthwhile investments. For instance, Yanget *al.*, (2023) found that farmers who adopt drip irrigation systems often experience substantial cost savings in the long term due to increased water use efficiency and higher crop yields, which help to offset the initial investment costs. Similarly, research by Lavakumar, Reddy, Radhika and Supriya (2023) indicates that the financial benefits of drip irrigation, including reduced labour costs and improved crop quality, can make the technology economically viable for those who are able to invest in it. However, other researchers, such as Sinha (2020), have found that the high upfront costs associated with drip irrigation may result in a delayed return on investment, impacting farmers' willingness to embrace the technology. This suggests that access to financial resources and credit facilities can play a crucial role in the adoption process. This is addressed in the section that follows.

4.6 Access to Credit and Adoption of Drip Irrigation

The second objective of the study was to explore how the accessibility of credit and financial resources influences the decision-making process of small-scale farmers regarding the adoption of drip irrigation in Kitui County. The descriptive data associated with this objective is presented below, after which inferential data analysis is provided to show the influence of access to credit on adoption of drip irrigation.

4.6.1 Descriptive data on access to credit

Access to credit was defined as the ability of small-scale farmers to obtain financial resources for investing in drip irrigation. The variable encompassed two components: Credit availability which relates to the existence and accessibility of credit options, loans, or financial support mechanisms available to farmers; and cost of credit, which

refers to the economic implications associated with accessing credit, including interest rates, repayment terms, and overall affordability. The variable was measured using a 10-item Likert scale that assessed farmers' levels of agreement or disagreement with statements related to their perceptions of ease of access to credit. The items were assessed using a 5-point scale that ranged from Disagree Strongly to Agree Strongly. The frequencies, percentages and the mean scores for each of the ten items are presented in Table 4.8.

Table 4.8: Descriptive data for access to credit

Access to credit	SD	D	N	A	SA	Mean score
	F (%)	F (%)	F (%)	F (%)	F (%)	
I find it easy to access credit from financial institutions for agricultural purposes.	52 (45.2)	55 (47.8)	5 (4.3)	3 (2.6)	0 (0.0)	1.64
The application process for obtaining a loan is straightforward and simple.	41 (35.7)	21 (18.3)	21 (18.3)	16 (13.9)	16 (13.9)	2.52
The interest rates on loans available for drip irrigation are affordable.	31 (27.0)	37 (32.2)	26 (22.6)	8 (7.0)	13 (11.3)	2.43
I am confident that I can meet the collateral requirements for obtaining a loan for drip irrigation.	14 (12.2)	20 (17.4)	20 (17.4)	43 (37.4)	18 (15.7)	3.27
I have received sufficient information about available credit options for adopting drip irrigation.	21 (18.3)	36 (31.3)	6 (5.2)	31 (27.0)	21 (18.3)	2.96
The repayment terms of loans for drip irrigation are flexible and manageable.	11 (9.6)	32 (27.8)	37 (32.2)	27 (23.5)	8 (7.0)	2.90
I have access to informal financial resources (e.g., community savings groups) that support agricultural investments.	20 (17.4)	56 (48.7)	16 (13.9)	23 (20.0)	0 (0.0)	2.37
The availability of grants and subsidies influences my decision to adopt drip irrigation.	25 (21.7)	66 (57.4)	20 (17.4)	4 (3.5)	0 (0.0)	2.03
The cost of credit is a significant barrier to adopting drip irrigation on my farm.	8 (7.0)	34 (29.6)	16 (13.9)	24 (20.9)	33 (28.7)	2.65
I have faced challenges in securing enough financial resources to invest in drip irrigation.	0 (0.0)	23 (20.0)	14 (12.2)	45 (39.1)	33 (28.7)	2.23

Source: Farmers' questionnaire

Key: SD- Strongly disagree, D- Disagree, N- Neutral, A- Agree, SA- Strongly agree

Table 4.8 shows that majority of the farmers (93.0%) found it difficult to access credit from financial institutions for agricultural purposes, as indicated by a low mean score of 1.64. The application process for obtaining a loan was also seen as complex, with 54.0% of farmers disagreeing or strongly disagreeing with the statement, resulting in a mean score of 2.52. Interest rates on loans for drip irrigation were perceived as unaffordable by 59.2% of farmers, with a mean score of 2.43.

When it comes to meeting collateral requirements, 53.1% of farmers agreed or strongly agreed that they can meet these requirements, with a mean score of 3.27. However, 49.6% of farmers felt they had not received sufficient information about available credit options, resulting in a mean score of 2.96. The repayment terms of loans were considered flexible and manageable by 30.5% of farmers, with a mean score of 2.90.

Access to informal financial resources, such as community savings groups, was limited, with 66.1% of farmers disagreeing or strongly disagreeing that they have access to these resources, leading to a mean score of 2.37. The availability of grants and subsidies was not seen as significantly influencing the decision to adopt drip irrigation, as 79.1% of farmers disagreed or strongly disagreed with the statement, resulting in a mean score of 2.03.

The cost of credit was viewed as a significant barrier to adopting drip irrigation by 49.6% of farmers, with a mean score of 2.65. Additionally, 67.8% of farmers agreed or strongly agreed that they have faced challenges in securing enough financial resources to invest in drip irrigation, indicated by a mean score of 2.23. The data in Table 4.7 suggests that farmers face significant barriers in accessing credit for drip irrigation, with complex application processes, unaffordable interest rates, and insufficient information about credit options. Meeting collateral requirements and repayment terms were relatively more manageable, but the cost of credit and challenges in securing financial resources were considered significant obstacles.

Access to informal financial resources and the influence of grants and subsidies were also cited as areas of concern.

To gain insights into farmers' perceptions of credit accessibility and financial resources for adopting drip irrigation, we computed an aggregate score. This score was derived from the sum of each farmer's responses to ten items related to credit access. Lower scores reflect more significant challenges in accessing credit. The midpoint of the scale was set at 30, with scores above 30 indicating perceived ease of credit access, while scores below 30 suggest perceived difficulties in obtaining credit for acquiring drip irrigation kits. The aggregate scores are summarized in Figure 4.2.

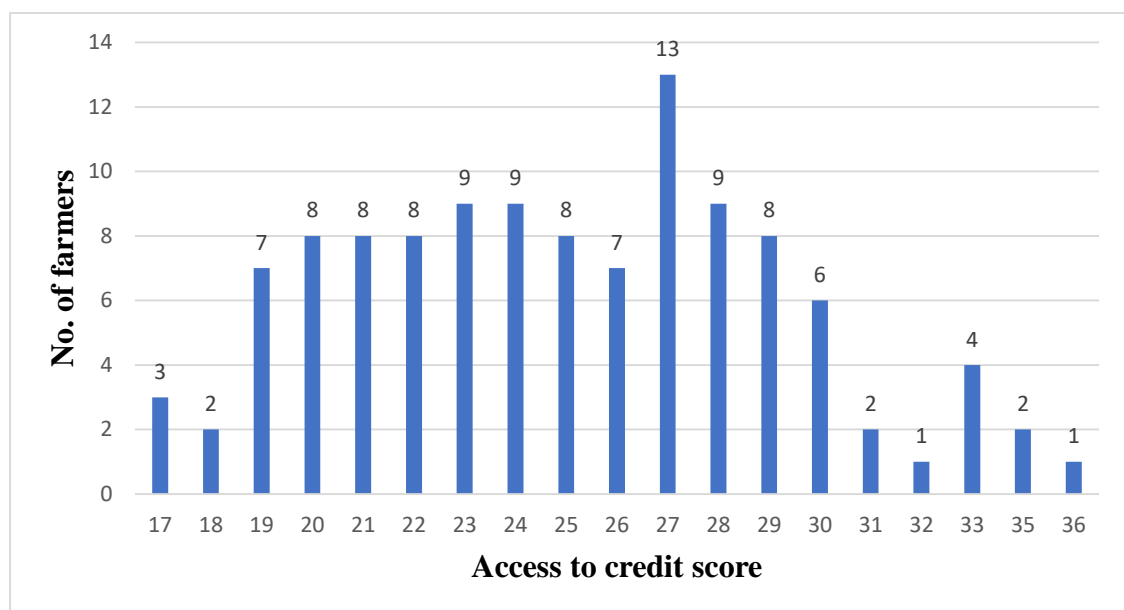


Figure 4.3: Access to credit for drip irrigation.Source: Farmers' questionnaire

The results in Figure 4.4 indicate that the aggregate scores for access to credit ranged from 17 to 36. There were 99 (86.1%) farmers who scored below the midpoint of 30, which is an indication that they perceived it challenging to access credit for procurement of drip irrigation technology. These farmers likely face barriers related to credit availability, terms, or eligibility criteria. Another 10 (8.7%) of the farmers obtained scores above the midpoint of 30, indicating that they were of the opinion that credit is easily accessible for acquisition of drip irrigation technology. This group of farmers may have better access to financial resources or are aware of credit options specifically for irrigation equipment. There were also six farmers (5.2%) with a score of 30, which denotes that they were neutral. Neutrality could be as a result of lack of information about access to credit. The high percentage of farmers perceiving

difficulties in accessing credit highlights a major barrier to adopting drip irrigation technology, which could impede efforts to improve agricultural efficiency and productivity. Access to credit can encourage more farmers to adopt drip irrigation technology, thereby improving livelihoods in Kitui.



Plate 2: Thriving Farm Under Drip Irrigation in Kitui County.*Source: Researcher (2024).*

4.6.2 Influence of access to credit on adoption of drip irrigation

The second null hypothesis of the study stated:

H₀₂: The accessibility of credit and financial resources has no significant effect on the adoption of drip irrigation in Kitui County.

To test this hypothesis, a t-test analysis was performed. The goal of this analysis was to assess if there is a statistically significant difference in drip irrigation adoption rates between farmers who perceived credit as accessible and those who did not. Farmers were categorized into two groups: those who had adopted drip irrigation (n = 56) and

those who had not (n = 59). The aggregate scores related to access to credit, based on responses to ten specific items, were compared between these two groups. The outcomes of this analysis are as reported in Table 4.9

Table 4.9: T-test for access to credit and adoption of drip irrigation

Use of drip irrigation	N	Access to credit mean score	Std. Dev.	Std. error mean	
Using drip irrigation	56	25.3929	4.39702	.58758	
Not using drip irrigation	59	24.6441	4.20083	.54690	
t-test statistics					
			t	df	Sig. (2-tailed)
Associated cost	Equal variances assumed	.934		113	.352
	Equal variances not assumed	.933		111.921	.353

The results of t-test analysis as shown in Table 4.9 indicate that farmers using drip irrigation and those who were not using the technology did not differ significantly in perceptions of access to credit. As such, the second null hypothesis was retained, that, “accessibility of credit and financial resources has no significant effect on the adoption of drip irrigation in Kitui County”. This finding suggests that the perceived access to credit is not a determining factor in the decision to adopt drip irrigation among small-scale farmers in Kitui County. Studies done in the past have often highlighted the role of financial constraints in the adoption of agricultural technologies. For instance, studies by Ullah *et al.* (2020) and Tinsley and Agapitova (2018) have identified access to affordable credit as a crucial factor influencing the adoption of innovative farming practices. However, the current study’s findings indicate that while access to credit might generally influence the adoption of new technologies, the perceived access to credit alone does not significantly impact farmers’ decisions to implement drip irrigation.

This could be attributed to various reasons. First, it is possible that other factors, such as the initial investment cost and operational expenses, play a more critical role in the adoption decision than access to credit itself. Second, farmers may have alternative financial strategies or informal credit sources that mitigate the impact of formal credit costs. Lastly, the perceived benefits and long-term savings associated with drip irrigation might outweigh concerns about access to credit, leading to a neutral impact on adoption decisions.

Another factor could be the lack of adequate knowledge about the accessibility of credit. Many farmers might not be aware that there are credit facilities specifically targeting agricultural investments. This lack of awareness can prevent farmers from exploring and utilizing available financial resources, thereby diminishing the perceived importance of credit cost in their decision-making process. Information dissemination and education about available credit options could play a vital role in overcoming this barrier.

4.7 Level of Knowledge about Drip Irrigation

The third objective of the study was to determine the level of knowledge among small-scale farmers in Kitui County regarding drip irrigation technology and its impact on adoption. The descriptive and inferential data analysis process for addressing this objective are provided below.

4.7.1 Descriptive data on knowledge about drip irrigation

Farmers knowledge encompasses the awareness and technical understanding of drip irrigation technology among small-scale farmers. This variable was measured using two components: awareness of drip irrigation, which entails the extent to which farmers are cognizant of the existence, benefits, and potential drawbacks of drip irrigation; and technical knowledge, which refers to farmers' understanding of the technical aspects, operation, and maintenance requirements associated with drip irrigation systems. Data for this variable was collected using a 10-item Likert scale that ranged from Strongly Disagree to Strongly Agree. The frequencies, percentages and the mean scores for each of the ten items are presented in Table 4.10.

Table 4.10: Farmers' levels of knowledge about drip irrigation

Knowledge levels	SD	D	N	A	SA	Mean score
	F (%)	F (%)	F (%)	F (%)	F (%)	
I am well aware of the benefits of using drip irrigation for crop production.	0 (0.0)	4 (3.5)	9 (7.8)	63 (54.8)	39 (33.9)	4.19
I have received training on how to install and operate a drip irrigation system.	16 (13.9)	52 (45.2)	5 (4.3)	29 (25.2)	13 (11.3)	2.75
I understand the technical aspects of maintaining a drip irrigation system.	12 (10.4)	29 (25.2)	8 (7.0)	49 (42.6)	17 (14.8)	3.26
I know how to troubleshoot common issues that arise with drip irrigation systems.	13 (11.3)	33 (28.7)	9 (7.8)	44 (38.3)	16 (13.9)	3.15
I am familiar with the types of crops that are most suitable for drip irrigation.	0 (0.0)	4 (3.5)	12 (10.4)	42 (36.5)	57 (49.6)	4.32
I have access to resources (e.g., guides, manuals) that help me understand drip irrigation technology.	17 (14.8)	33 (28.7)	11 (9.6)	23 (20.0)	31 (27.0)	3.16
I can calculate the amount of water required for my crops using drip irrigation.	4 (3.5)	30 (26.1)	15 (13.0)	47 (40.9)	19 (16.5)	3.41
I am knowledgeable about the cost savings associated with drip irrigation compared to traditional irrigation methods.	8 (7.0)	5 (4.3)	10 (8.7)	29 (25.2)	63 (54.8)	4.17
I am aware of the environmental benefits of using drip irrigation.	8 (7.0)	17 (14.8)	3 (2.6)	32 (27.8)	55 (47.8)	3.95
I feel confident in my ability to independently manage a drip irrigation system on my farm.	5 (4.3)	24 (20.9)	17 (14.8)	43 (37.4)	26 (22.6)	3.53

Source: Farmers' questionnaire

Key: SD- Strongly disagree, D- Disagree, N- Neutral, A- Agree, SA- Strongly agree

The results in Table 4.10 show that farmers generally exhibited high awareness of the benefits of using drip irrigation for crop production, with 88.7% agreeing or strongly agreeing, and a mean score of 4.19. However, only 36.5% of farmers agreed or strongly agreed that they had received training on how to install and operate a drip irrigation system, indicated by a mean score of 2.75. The farmers exhibited moderate understanding of the technical aspects of maintaining a drip irrigation system, with 57.4% of farmers agreeing or strongly agreeing, and a mean score of 3.26. Similarly,

52.2% of farmers agreed or strongly agreed that they know how to troubleshoot common issues with drip irrigation systems, resulting in a mean score of 3.15.

Awareness of the types of crops most suitable for drip irrigation was high, with 86.1% of farmers agreeing or strongly agreeing, leading to the highest mean score of 4.32. Access to resources such as guides and manuals that help understand drip irrigation technology was perceived as moderate, with 47.0% of farmers agreeing or strongly agreeing, and a mean score of 3.16. The table further shows that, knowledge about calculating the amount of water required for crops using drip irrigation was relatively high, with 57.4% of farmers agreeing or strongly agreeing, and a mean score of 3.41. Further, understanding of the cost savings associated with drip irrigation compared to traditional irrigation methods was also high, with 80.0% of farmers agreeing or strongly agreeing, reflected in a mean score of 4.17.

The farmers had a high level of awareness of the environmental benefits of using drip irrigation, with 75.6% of farmers agreeing or strongly agreeing, and a mean score of 3.95. lastly, the farmers had moderate confidence in the ability to independently manage a drip irrigation system on their farm, with 60.0% of farmers agreeing or strongly agreeing, resulting in a mean score of 3.53. The data in the table suggests that farmers were well aware of the benefits, suitable crops, and cost savings associated with drip irrigation. However, there emerged a need for more training on installation, operation, and technical maintenance, as well as better access to resources that can support farmers in effectively managing drip irrigation systems.

To gain a comprehensive understanding of the farmers' knowledge levels regarding drip irrigation, an aggregate score was calculated based on their responses to ten specific items related to this subject. Each farmer's answers were summed to produce a total score. Lower scores indicated a lack of or inadequate knowledge about drip irrigation, whereas higher scores reflected a better understanding. The midpoint of the scale was set at 30; scores above 30 denoted higher knowledge levels, while scores below 30 indicated lower knowledge levels about drip irrigation. The aggregate scores are summarized in Figure 4.3.

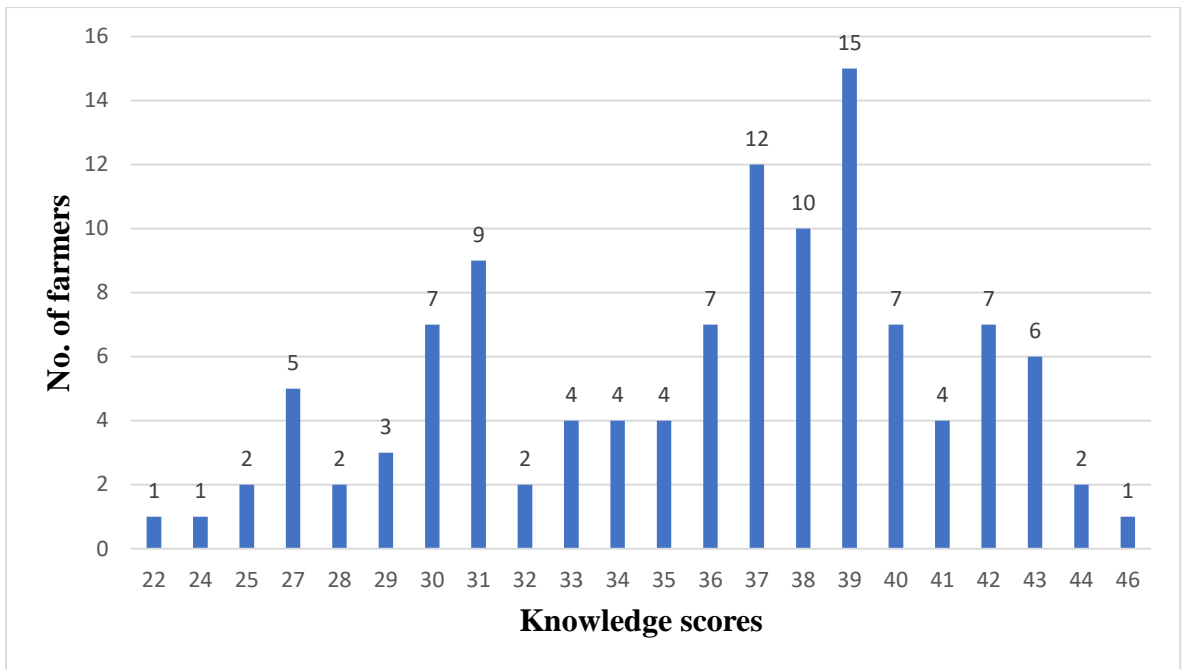


Figure 4.5: Knowledge about drip irrigation:Source: Framers’ questionnaire

The findings in Figure 4.5 reveal that the aggregate scores for farmers’ knowledge about drip irrigation ranged from 22 to 46. Fourteen farmers (12.2%) scored below the midpoint of 30, indicating low levels of knowledge about drip irrigation technology. In contrast, 94 farmers (81.7%) scored above the midpoint, suggesting that they were well-informed about various aspects of drip irrigation. Additionally, seven farmers (6.1%) scored exactly 30, which indicates an average level of knowledge. The findings imply that a majority of farmers in the study possessed a good understanding of drip irrigation technology, which is a positive indicator for the potential adoption and effective implementation of this method. However, the 12.2% of farmers with low knowledge levels represent a critical area for targeted educational interventions. Increasing the knowledge base among these farmers could help in overcoming barriers to adoption and ensure more widespread and effective use of drip irrigation, ultimately contributing to improved agricultural productivity and sustainability in Kitui County.

The results could be attributed to fact that many farmers in the area have access to newspapers, publications, radio, TV sets and mobile phones which acts as a source of information. Indigenous knowledge (expert knowledge) could also be another source of Knowledge of adoption or non-adoption of drip irrigation. This knowledge could be passed on to the young generation from their parents on issues of the effect climate

and the young have continued to practice them. Indigenous knowledge can operate at a much finer spatial and temporal scale than science. This includes people's understandings on how to adapt and cope with environmental variability and trends. Indigenous knowledge therefore makes a significant contribution to Sustainable Development Goal (SDG13) (Sustainable Development Goal, 2019) which urges people to take matters climate seriously and its related impacts. This can be done by enacting climate variability policies, finding local adaptation methods, climate financing, adapting to impacts, locally observing changing climates, and contributing to local and global mitigation efforts. Comparison of Crop Outcomes in the Same Locality On the left, a thriving farm under drip irrigation; on the right, a farm with failing crops under rain-fed agriculture. Raising awareness among farmers can promote the uptake of drip irrigation, leading to more successful and sustainable farming practices.



Plate 3: Knowledge about drip irrigation:*Source: Researcher (2024)*

4.7.2 Influence of knowledge on adoption of drip irrigation

The third null hypothesis of the study stated:

H0₃: The level of knowledge among small-scale farmers in Kitui County regarding drip irrigation has no significant influence on their decision to adopt the technology.

In order to test this hypothesis, a t-test analysis was carried out. The aim of this analysis was to assess if there is a statistically significant difference in drip irrigation adoption rates between farmers who were knowledgeable about drip irrigation and those who were not. Farmers were categorized into two groups: those who had adopted drip irrigation (n = 56) and those who had not (n = 59). The aggregate scores related to knowledge levels, based on responses to ten specific items, were compared between these two groups. The outcomes of this analysis are as reported in Table 4.11.

Table 4.11: T-test for knowledge and adoption of drip irrigation

Use of drip irrigation	N	Knowledge score	mean	Std. Dev.	Std. error mean
Using drip irrigation	56	37.05		4.514	.603
Not using drip irrigation	59	34.76		5.456	.710
t-test statistics					
			t	df	Sig. (2-tailed)
Associated cost	Equal variances assumed		2.446	113	.016
	Equal variances not assumed		2.458	110.963	.016

The t-test analysis results shown in Table 4.11 show that, farmers using drip irrigation (N = 56) had significantly higher levels of knowledge about the technology (M = 37.05, SD = 4.514) compared to those not using drip irrigation (N = 59; M = 34.76,

SD = 5.456), $t(113) = 2.446$, $p < .016$. This finding suggests that a higher level of knowledge is associated with the adoption of drip irrigation among small-scale farmers in Kitui County. Therefore, the third null hypothesis of the study was rejected, and its alternate form confirmed, that:

H0₃: The level of knowledge among small-scale farmers in Kitui County regarding drip irrigation has a significant influence on their decision to adopt the technology.

This result is in line with previous studies that emphasize the critical role of knowledge and information in the adoption of agricultural innovations. Rogers' (2003) Diffusion of Innovations theory posits that knowledge is one of the key stages in the adoption process. Farmers who are more informed about the benefits, operation, and maintenance of drip irrigation are more likely to adopt the technology, as they perceive it as advantageous and are confident in managing it effectively.

Furthermore, research work by Muthui (2015) indicate that lack of knowledge and awareness constitutes a significant barrier to the widespread adoption of drip irrigation among small-scale farmers. Other studies such as Jabbari *et al.* (2024) and Dace (2020) highlight that access to information and training significantly influences the adoption of agricultural practices. The current finding supports these studies by demonstrating that higher knowledge levels correlate with the likelihood of adopting drip irrigation. The significant difference in knowledge levels between adopters and non-adopters underscores the importance of educational programs and extension services. Enhancing farmers' knowledge through training and information dissemination could bridge the gap, leading to increased adoption rates (World Bank, 2021). This, in turn, can improve water use efficiency, crop yields, and overall agricultural sustainability in the region.

4.8 Availability of Water for Drip Irrigation

The fourth objective of the study was to examine how water availability influences the adoption of drip irrigation among small-scale farmers in Kitui County. The descriptive and inferential data analysis procedures used for this objective are presented and discussed below.

4.8.1 Descriptive data for availability of water

Water availability was defined as the assessment of water-related factors influencing the adoption of drip irrigation among small-scale farmers. This variable was assessed using a 10-item Likert scale that ranged from Strongly Disagree to Strongly Agree. The frequencies, percentages and the mean scores for each of the ten items are presented in Table 4.12.

From Table 4.12, it emerges that a significant portion of farmers (67.0%) disagreed or strongly disagreed with having a reliable water source that can support drip irrigation throughout the year, with mean score of 2.11. Similarly, 50.4% of farmers disagreed or strongly disagreed that their current water supply is sufficient for implementing drip irrigation, reflected in a mean score of 2.88. Challenges with water scarcity affecting the ability to use drip irrigation were reported by 38.3% of farmers who strongly disagreed, while 35.6% agreed or strongly agreed, leading to a higher mean score of 3.51. Reliability and adequacy of water harvesting systems (e.g., tanks, dams, water pans) for drip irrigation was doubted by 47.8% of farmers, with a mean score of 2.88.

Table 4.12: Water availability for drip irrigation

Availability of water	SD	D	N	A	SA	Mean score
	F (%)	F (%)	F (%)	F (%)	F (%)	
I have a reliable water source that can support drip irrigation throughout the year.	60 (52.2)	17 (14.8)	3 (2.6)	35 (30.4)	0 (0.0)	2.11
My current water supply is sufficient for implementing drip irrigation.	20 (17.4)	38 (33.0)	5 (4.3)	40 (34.8)	12 (10.4)	2.88
I have faced challenges with water scarcity that affect my ability to use drip irrigation.	44 (38.3)	18 (15.7)	12 (10.4)	35 (30.4)	6 (5.2)	3.51
My water harvesting systems (e.g., tanks, dams, water pans) are reliable and adequately store water for drip irrigation.	17	38	12	38	10	2.88

	(14.8)	(33.0)	(10.4)	(33.0)	(8.7)	
I have access to alternative water sources during dry seasons to support drip irrigation.	33	15	15	38	14	2.87
	(28.7)	(13.0)	(13.0)	(33.0)	(12.3)	
The quality of water available to me is not suitable for drip irrigation systems.	54	37	2	22	0	4.07
	(47.0)	(32.2)	(1.7)	(19.1)	(0.0)	
I have the necessary infrastructure (e.g., pumps, pipes) to ensure a consistent water supply for drip irrigation.	12	25	27	44	7	3.08
	(10.4)	(21.7)	(23.5)	(38.3)	(6.1)	
Seasonal variations in water availability do not significantly impact my ability to use drip irrigation.	5	27	30	24	29	3.39
	(4.3)	(23.5)	(26.1)	(20.9)	(25.2)	
I can efficiently manage and distribute the available water using my current irrigation setup.	26	34	13	31	11	2.71
	(22.6)	(29.6)	(11.3)	(27.0)	(9.6)	
Government or local programs provide adequate support to ensure water availability for drip irrigation.	28	48	21	18	0	2.25
	(24.3)	(41.7)	(18.3)	(15.7)	(0.0)	

Source: Farmers' questionnaire

Key: SD- Strongly disagree, D- Disagree, N- Neutral, A- Agree, SA- Strongly agree

The farmers reported having limited access to alternative water sources during dry seasons, with 41.7% of farmers disagreeing or strongly disagreeing, yielding a mean score of 2.87. The quality of available water was deemed unsuitable for drip irrigation by 79.2% of farmers, reflected in a high mean score of 4.07. Infrastructure necessary for a consistent water supply (e.g., pumps, pipes) is reportedly insufficient, with 32.1% of farmers disagreeing or strongly disagreeing, leading to a mean score of 3.08. Seasonal variations in water availability was reported to significantly impact drip irrigation for 44.4% of farmers, reflected in a mean score of 3.39.

Over half of the farmers expressed doubts about their ability to efficiently manage and distribute available water using current irrigation setups, resulting in a mean score of 2.71. Government or local programs were perceived as inadequate in providing support for ensuring water availability for drip irrigation, as indicated by 66.0% of

farmers disagreeing or strongly disagreeing, leading to a mean score of 2.25. The results indicate that farmers in Kitui County face significant challenges related to water availability, including unreliable water sources, insufficient water supply, poor water quality, and inadequate support from government or local programs, all of which hinder the effective adoption of drip irrigation systems.

In order to gain a thorough understanding of farmers' perceptions of water availability, an aggregate score was derived from their responses to the ten specific items related to this issue. Each farmer's answers were summed to produce a total score. Lower scores indicated a perception of inadequate water for drip irrigation, while higher scores suggested sufficient water availability. The midpoint of the scale was set at 30; scores above 30 denoted perceived water adequacies, whereas scores below 30 indicated perceived water inadequacy for supporting drip irrigation. The aggregate scores are summarized in Figure 4.4.

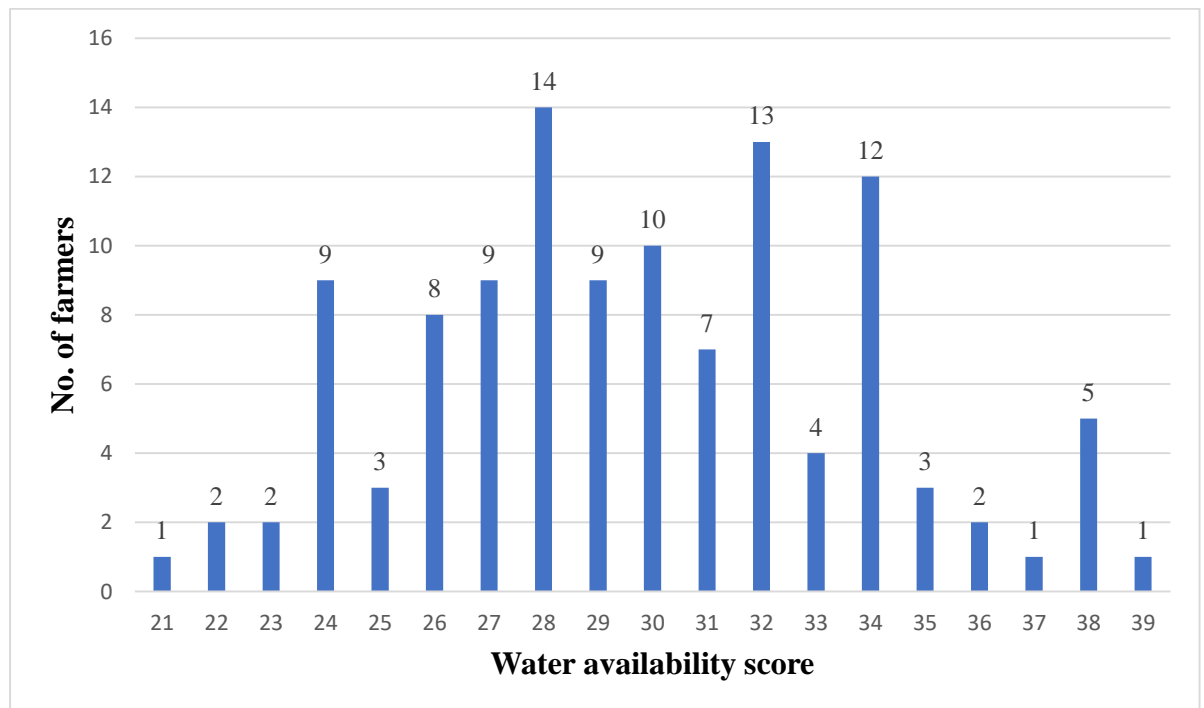


Figure 4.7: Water availability for drip irrigation

Source: Farmers' questionnaire

The results displayed in Figure 4.4 show that the aggregate scores for availability of water ranged from 21 to 39. There were 57 farmers (49.6%) who scored below the midpoint of 30, indicating that they perceived the water available to them as

inadequate for supporting drip irrigation. Another 48 farmers (41.7%) obtained scores above 30, which is an indication that they consider the water available to them as adequate for purposes of drip irrigation. Ten of the farmers (8.7%) obtained a score of 30, which indicates that they were neutral. These findings highlight a significant divide among farmers regarding water availability for drip irrigation. Nearly half of the respondents feel that their water supply is insufficient, which could hinder the adoption and effectiveness of drip irrigation systems. On the other hand, a substantial portion of farmers believes their water supply is adequate, suggesting that water availability issues might be localized or dependent on individual circumstances. Farmer practicing drip irrigation using rainwater harvested in a water pan – Effective rainwater harvesting, as shown here, can provide a reliable source of water to sustain drip irrigation systems, mitigating concerns about water scarcity.



Plate 4: Knowledge about drip irrigation.*Source: Researcher (2024)*

4.8.2 Influence of water availability on adoption of drip irrigation

The fourth null hypothesis of the study stated:

H0₄: Water availability, including potential limitations in water sources, has no significant effect on the adoption of drip irrigation among small-scale farmers in Kitui County.

To test this hypothesis, a t-test analysis was carried out with the goal of establishing whether there is a statistically significant difference in drip irrigation adoption rates between farmers who perceived to have adequate water for drip irrigation and those who did not. The farmers were categorized into two groups: those who had adopted drip irrigation (n = 56) and those who had not (n = 59). The aggregate scores related to perceived water availability, based on responses to ten specific items, were compared between these two groups. The results of this analysis are as reported in Table 4.13.

Table 4.13: T-test for water availability and adoption of drip irrigation

Use of drip irrigation	N	Water availability mean score	Std. Dev.	Std. error mean	
Using drip irrigation	56	29.39	3.902	.521	
Not using drip irrigation	59	30.10	4.163	.542	
t-test statistics					
			t	df	Sig. (2-tailed)
Associated cost	Equal variances assumed		-.941	113	.349
	Equal variances not assumed		-.942	112.983	.348

The results of t-test analysis as shown in Table 4.13 show that farmers using drip irrigation and those who were not using the technology did not differ significantly in perceptions of availability of water for use with drip irrigation. Consequently, the fourth null hypothesis of the study was retained, that: “Water availability, including potential limitations in water sources, has no significant effect on the adoption of drip

irrigation among small-scale farmers in Kitui County”. These findings are particularly interesting given that all respondents are from the same region, Kitui County, which is known for its arid and semi-arid conditions. The significant portion of farmers perceiving water as inadequate aligns with the general understanding of the area's climatic challenges. However, the fact that 41.7% of farmers view their water availability as adequate indicates that some farmers have developed effective strategies for water management, such as rainwater harvesting, constructing water pans, or digging boreholes. The results of t-test analysis suggest that the decision to adopt drip irrigation is not solely influenced by the perceived availability of water. It might be that those who have adopted drip irrigation have managed to overcome water scarcity challenges through innovative water management practices. This finding echoes previous studies by He, Cao and Li (2007), Yang, *et al.* (2023) and Meranet *al.* (2021), who have emphasized the role of water harvesting and storage techniques in enhancing irrigation practices in arid regions.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1: Introduction

This chapter provides the summary of the research with a focus on the main findings of the study. The chapter also provides a conclusion of the study based on the findings. Further, the chapter presents recommendations as well as suggestions of areas of related research that can be carried out in the future.

5.2: Summary of the Research Findings

The main objective of the study was to evaluate the influence of selected factors on the adoption of drip irrigation in Kitui County. The study did not aim to exhaustively identify all possible hindrances but rather focused on four key factors that the literature consistently highlights as affecting irrigation adoption in smallholder contexts: financial challenges (initial investment and operational costs), access to credit and financial resources, farmers' knowledge regarding drip irrigation technology, and water availability. Based on this scope, the study collected data from 115 small-scale farmers, among whom 56 were using drip irrigation and 59 were not. The findings related to each research objective are summarized below.

5.2.1: Cost Associated with drip irrigation

The findings indicated that initial investment and equipment costs were significant barriers to drip irrigation adoption for farmers in Kitui County, with many viewing them as prohibitively high. While operational costs were generally seen as manageable, farmers expressed mixed views on the affordability of setup costs and the role of financial assistance. Overall, nearly half of the farmers perceived drip irrigation costs as high, while a smaller portion found them manageable. T-test analysis showed that farmers using drip irrigation ($N = 56$) obtained significantly higher perceived cost scores ($M = 28.50$, $SD = 3.20$) compared to those not using drip irrigation ($N = 59$; $M = 23.66$, $SD = 3.99$), $t(113) = 7.159$, $p < .001$. This was an indication that the farmers who had adopted drip irrigation viewed these costs as more manageable compared to those who had not.

5.2.2: Access to credit for adoption of drip irrigation

The findings for the second objective showed that farmers faced significant challenges in accessing credit for drip irrigation. Most found credit difficult to obtain, citing complex loan application processes, high interest rates, and limited information

on credit options. Access to informal financial resources and the influence of grants and subsidies were also limited. Despite these barriers, t-test results showed that there were no significant differences in access to credit mean scores of farmers using drip irrigation ($M = 25.39$, $SD = 4.40$) and to those not using drip irrigation ($M = 24.64$, $SD = 4.20$), $t(113) = 0.934$, $p = .352$. As such, it was concluded that there was no significant difference in credit access perceptions between farmers who had adopted drip irrigation and those who had not, indicating that perceived credit accessibility may not strongly impact the adoption of drip irrigation in Kitui County.

5.2.3: Knowledge about drip irrigation

Findings for the third objective revealed that while farmers in Kitui County had high awareness of drip irrigation benefits, crop suitability, and cost savings, only a minority had received training on installation and operation. Knowledge of technical maintenance was moderate, and access to instructional materials was limited. Farmers generally understood the water requirements and environmental benefits of drip irrigation, yet confidence in managing the system independently was only moderate. The t-test analysis results revealed farmers using drip irrigation had significantly higher levels of knowledge about the technology ($M = 37.05$, $SD = 4.514$) compared to those not using drip irrigation ($N = 59$; $M = 34.76$, $SD = 5.456$), $t(113) = 2.446$, $p < .016$. The study therefore established that farmers already using drip irrigation had significantly higher knowledge levels than those who hadn't adopted it, indicating that knowledge may positively influence adoption.

5.2.4: Water availability for drip irrigation

For the fourth objective, findings indicated major challenges with water availability for drip irrigation among Kitui County farmers. Most farmers lacked a reliable year-round water source, found current supplies insufficient, and viewed water quality as unsuitable. Issues with seasonal water scarcity, limited alternative sources, and inadequate infrastructure further impacted water reliability. Additionally, government support for improving water access was perceived as lacking. Despite these obstacles, results of t-test analysis indicated that there were no significant differences in water availability mean scores of farmers using drip irrigation ($M = 29.39$, $SD = 3.902$) and to those not using drip irrigation ($M = 30.10$, $SD = 4.16$), $t(113) = -0.9341$, $p = .348$. As such, it was concluded that there was no significant difference in water availability perceptions between farmers who adopted drip irrigation and those who had not.

5.3: Conclusion of the Study

The goal of this study was to establish the factors hindering the adoption of drip irrigation in Kitui County, Kenya. The study identified several key factors influencing the adoption of drip irrigation among small-scale farmers in Kitui County, as outlined below.

In relation to objective number one, which was “to investigate how the costs associated with drip irrigation influence adoption and non-adoption of drip irrigation technology among small-scale farmers in Kitui County”, the study established that, farmers who had adopted drip irrigation perceived the associated costs to be more manageable compared to those who had not adopted the technology. This suggests that the perception of high costs is a significant barrier to adoption. The high initial investment and equipment costs were particularly seen as prohibitive, despite operational costs being viewed as more manageable. This finding aligns with previous studies that have highlighted the financial burden of initial setup costs as a major deterrent for small-scale farmers considering the adoption of new agricultural technologies. Interventions should focus on reducing the initial costs of drip irrigation systems through subsidies, grants, or low-interest loans. This could make the technology more accessible to small-scale farmers who are deterred by the high upfront costs.

The second objective of the study was “to find out how accessibility to credit influences the adoption or non- adoption of drip irrigation”. In relation to this objective, the findings indicated that complex application processes, high interest rates, and insufficient information on credit options were noted as significant obstacles for farmers in accessing credit for drip irrigation. The study however found no significant difference between farmers using and not using drip irrigation in terms of their perceptions of access to credit. This suggests that credit accessibility is not a primary determinant in the decision to adopt drip irrigation. While access to credit is challenging, it does not appear to be the decisive factor preventing adoption. This finding contrasts with some studies that emphasize financial constraints as a major barrier; however, it may indicate that other factors, such as perceived costs and knowledge, play a more critical role in this specific context. Efforts should still be made to streamline the credit application process and promote the use of efficient

water management practices. Providing information about available credit options and simplifying the loan application process could further support farmers.

The third research objective was “to establish how the level of knowledge among small-scale farmers influences the adoption and non - adoption of drip irrigation technology”. Regarding this objective, it was established that farmers using drip irrigation had significantly higher levels of knowledge about the technology compared to those not using it. This finding highlights the importance of knowledge in the adoption process. A lack of training and understanding of the technical aspects and benefits of drip irrigation appears to be a major obstacle among small-scale farmers in Kitui County. This is consistent with research indicating that farmer education and awareness are critical to the adoption of innovative farming practices. Providing targeted training programs and extension services could enhance farmers’ knowledge and facilitate the adoption of drip irrigation. There is a clear need for comprehensive training programs to improve farmers’ knowledge and skills related to drip irrigation. Extension services should be strengthened to provide continuous support and information to farmers, ensuring they can effectively install, operate, and maintain drip irrigation systems.

The fourth research objective was “to find out how the availability and challenges of water influence the adoption of drip irrigation among small-scale farmers in Kitui County”. The findings regarding this objective highlight significant challenges related to water availability, including unreliable sources, insufficient supply, poor quality, and lack of government support, which hinder the effective adoption of drip irrigation systems in Kitui County. There was no significant difference in perceptions of water availability between farmers using and not using drip irrigation. Despite Kitui County being a dry area, water accessibility did not emerge as a major issue. Those who perceived water to be available likely engaged in rainwater harvesting or had boreholes. Therefore, water availability is not seen as a critical barrier to the adoption of drip irrigation. This suggests that innovations in water management practices might already be mitigating some of the challenges posed by the region's arid climate.

5.4: Recommendations

The recommendations provided below are made to address the identified barriers and enhance the adoption of drip irrigation among small-scale farmers:

1. To address the barrier of high initial investment and equipment costs, the government and relevant agricultural agencies should introduce subsidies, grants, or low-interest loan programs aimed at reducing the initial financial burden on farmers. Additionally, promoting cost-sharing schemes and cooperative purchasing arrangements among farmers could help lower individual expenses related to acquiring and installing drip irrigation systems.
2. Given the significant role of knowledge in the adoption of drip irrigation, training programs and extension services should be developed and implemented by the Ministry of Agriculture working together with businesses offering drip irrigation products. These programs should focus on educating farmers about the benefits, installation, operation, and maintenance of drip irrigation systems. Training sessions, demonstrations, and field visits can be used to improve farmers' technical skills and awareness. Collaboration with agricultural extension officers and local farmer groups can facilitate the dissemination of knowledge and best practices.
3. There is need to simplify the credit application process and provide better information about available credit options to small-scale farmers. Financial institutions should streamline their loan application procedures and offer tailored financial products that cater to the specific needs of small-scale farmers. Additionally, raising awareness about these financial products through workshops and informational campaigns can help farmers make informed decisions about funding their irrigation projects.
4. Initiatives promoting water harvesting techniques, such as rainwater collection and storage, and the construction of water pans or small dams, should be expanded in Kitui County. Farmers should be encouraged to adopt sustainable water management practices, and support should be provided for the maintenance and improvement of existing water infrastructure. Government and local programs should focus on enhancing water accessibility and reliability to support year-round agricultural activities.

5. More research is needed to explore the socio-cultural factors that influence the adoption of drip irrigation among small-scale farmers. Such research could investigate the roles of gender, community dynamics, and local knowledge systems in shaping farmers' decisions to adopt new agricultural technologies.

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APPENDICES

Appendix I: Farmers' Questionnaire

LETTER OF INTRODUCTION TO THE RESPONDENT

Charles M. Muema

Reg.No: N50/CE/26793/2011

Dear respondent,

I am a Kenyatta University postgraduate student undertaking a **Master of Environmental Studies (Environmental Education)**. To meet the requirements for the award of this degree, I must choose a topic within my field, gather data about it, and write a project report about it. My research focuses on **Hindrance to Adoption of Drip Irrigation by Small-Scale Farmers in Kitui County, Kenya**. As a result, I have included you in the list of responders for this study. Your assistance with this report will be greatly appreciated. The key objective of this research was to determine the factors hindering the adoption of drip irrigation in Kitui County, Kenya. This questionnaire is aimed at collecting information for a study titled "**hindrance to adoption of drip irrigation by small-scale farmers in Kitui County, Kenya**". You are kindly requested to assist in filling in the questionnaire. This information will only be used for academic purposes. Do not write your name anywhere in the questionnaire. The information provided will be kept as confidential.

Part A: Demographic Information

3. Gender of the Household Head if not respondent?

Male Female

4. What is the age of the Household Head?

30 years or below 31 – 40 years 41 – 50 years

51 – 60 years 60 years and above

6. What is the highest level of education attained by the Household Head?

Primary Secondary Certificate Diploma

Degree Other (specify).....

7. For how many years has the family stayed in this area?

Below 5 years 5 – 10 years 11 – 15 years

16 – 20 years Over 20 years

10. What is the Household size (Number of children)?

1 – 3 4 – 6 7 or more

Part B: Factors Associated with Adoption of Drip Irrigation

In the table below, indicate your level of agreement with the following statements about the factors associated with adopting drip irrigation on your farm. Use the following scale to respond:

SD = Strongly Disagree; D = Disagree; N = Neutral; A = Agree; SA = Strongly Agree

A. Costs Associated with Drip Irrigation	SD	D	N	A	SA
1. The initial investment cost of installing a drip irrigation system is too high for me.					
2. The operational costs of maintaining a drip irrigation system are manageable.					
3. I can easily afford the initial setup costs of a drip irrigation system.					
4. The cost of purchasing the necessary equipment for drip irrigation is a major barrier for me.					
5. The financial benefits of drip irrigation outweigh the initial investment costs.					
6. I find it difficult to purchase and cover the ongoing operational costs of drip irrigation.					
7. The availability of subsidies or financial assistance makes the adoption of drip irrigation more feasible for me.					
8. The costs associated with repairing and maintaining a drip irrigation system are too high.					
9. I believe that the long-term savings from using drip irrigation justify the initial costs.					
B. Access to credit	SD	D	N	A	SA
1. I find it easy to access credit from financial institutions for agricultural purposes.					
2. The application process for obtaining a loan is straightforward and simple.					
3. The interest rates on loans available for drip irrigation are affordable.					
4. I am confident that I can meet the collateral requirements for obtaining a loan for drip irrigation.					
5. I have received sufficient information about available credit options for adopting drip irrigation.					
6. The repayment terms of loans for drip irrigation are flexible and manageable.					
7. I have access to informal financial resources (e.g., community savings groups) that support agricultural investments.					
8. The availability of grants and subsidies influences my decision to adopt drip irrigation.					

9. The cost of credit is a significant barrier to adopting drip irrigation on my farm.					
10. I have faced challenges in securing enough financial resources to invest in drip irrigation.					
C. Knowledge about drip irrigation	SD	D	N	A	SA
1. I am well aware of the benefits of using drip irrigation for crop production.					
2. I have received training on how to install and operate a drip irrigation system.					
3. I understand the technical aspects of maintaining a drip irrigation system.					
4. I know how to troubleshoot common issues that arise with drip irrigation systems.					
5. I am familiar with the types of crops that are most suitable for drip irrigation.					
6. I have access to resources (e.g., guides, manuals) that help me understand drip irrigation technology.					
7. I can calculate the amount of water required for my crops using drip irrigation.					
8. I am knowledgeable about the cost savings associated with drip irrigation compared to traditional irrigation methods.					
9. I am aware of the environmental benefits of using drip irrigation.					
10. I feel confident in my ability to independently manage a drip irrigation system on my farm.					
D. Availability of water	SD	D	N	A	SA
1. I have a reliable water source that can support drip irrigation throughout the year.					
2. My current water supply is sufficient for implementing drip irrigation.					
3. I have faced challenges with water scarcity that affect my ability to use drip irrigation.					
4. My water harvesting systems (e.g., tanks, dams, water pans) are reliable and adequately store water for drip irrigation.					
5. I have access to alternative water sources during dry seasons to support drip irrigation.					
6. The quality of water available to me is not suitable for drip irrigation systems.					
7. I have the necessary infrastructure (e.g., pumps, pipes) to ensure a consistent water supply for drip irrigation.					
8. Seasonal variations in water availability do not significantly impact my ability to use drip irrigation.					

9. I can efficiently manage and distribute the available water using my current irrigation setup.					
10. Government or local programs provide adequate support to ensure water availability for drip irrigation.					

**APPENDIX II: RESEARCH AUTHORIZATION LETTER FROM
KENYATTA UNIVERSITY**



**KENYATTA UNIVERSITY
GRADUATE SCHOOL**

E-mail: dean-graduate@ku.ac.ke

Website: www.ku.ac.ke

OUR REF: N50/CE/26793/11

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 8710901 Ext. 57530

Date: 3rd September, 2015

The Director General,
National Commission for Science, Technology & Innovation
P.O. Box 30623-0100,
NAIROBI

Dear Sir/Madam,

RE: RESEARCH AUTHORIZATION FOR MR. CHARLES MUEMA REG. NO. N50/CE/26793/11

I write to introduce Mr. **Muema** who is a Postgraduate Student of this University. He is registered for M.Env. Science Degree programme in the Department of Environmental Education in the School of Environmental Studies.

Mr. Muama intends to conduct research for a M.Sc. Degree Thesis entitled, "Utilization and Adaption to Drought using Drip Irrigation System from Waste Plastic Bottles among Farmers in Kitui Central Sub-County, Kenya."

Any assistance given will be highly appreciated.

Yours faithfully,






A handwritten signature in black ink, appearing to be 'Lucy N. Mbaabu', written over a horizontal line.

**MRS. LUCY N. MBAABU
FOR: DEAN, GRADUATE SCHOOL**

ST/cao

Committed to Creativity, Excellence & Self-Reliance

APPENDIX III: NACOSTI LICENCE

 REPUBLIC OF KENYA	 NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION
Ref No: 251865	Date of Issue: 18/October/2024
RESEARCH LICENSE	
	
This is to Certify that Mr.. CHARLES MUTINDA MUEMA of Kenyatta University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Kitui on the topic: HINDRANCE TO ADOPTION OF DRIP IRRIGATION BY SMALL-SCALE FARMERS IN KITUI COUNTY, KENYA for the period ending : 18/October/2025.	
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