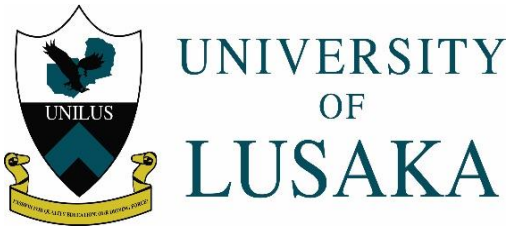

SCHOOL OF POSTGRADUATE STUDIES

ASSESSMENT OF FACTORS ASSOCIATED WITH CLIMATE CHANGE ADAPTATION BY FARMERS IN KAWAMBWA DISTRICT

A Dissertation Submitted to the School of Postgraduate Studies, University of Lusaka in Partial Fulfilment of the Award of the Master of Science in Environmental Management

By

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DECLARATION

I, **Micheal Mumba Mushinge,** student number (mscem23119196) hereby declare that this dissertation submitted for the award of the degree of Master of Science in Environmental Management at the University of Lusaka represents my own work. It conforms to copyright and academic writing rules and the university research ethics. All materials used have been fully acknowledged and referenced.

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Student	Signature	Date
Dr. Nellie Nyambe		14th January, 2025
Supervisor	Signature	Date

DEDICATION

This dissertation is dedicated to my wife Bilia Muyuya-Mushinge and my daughter Sarah Mumba Mushinge, for their love and support during my academic studies.

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LIST OF ACRONYMS

CSA	Climate-Smart Agriculture
FAO	Food and Agriculture Organization
FISP	Farmer Input Support Program
FRA	Food Reserve Agency
GCM	Global Climate Model
GDP	Gross Domestic Product
GHG	Green House Gases
IPCC	Inter-governmental Panel on Climate Change
MoA	Ministry of Agriculture
NGO	Non-Governmental Organization
NPCC	National Policy on Climate Change
SD	Standard Deviation
SE	Standard Error
SSA	Sub-Saharan Africa
UNFCCC	United Nations Framework Convention on Climate Change
UNILUS	University of Lusaka
USA	United States of America
ZMD	Zambia Meteorological Department

ABSTRACT

Climate change is a big challenge for farmers everywhere, especially in tropical regions like Africa. It is evident that climate change is adversely affecting agriculture and it has become the new norm and caused by human activities. Climate change is especially challenging in Africa, with aspects such as weak policies, limited technology, poverty, severe weather events, and economic hardship making the continent particularly susceptible. This study was conducted to assess climate change adaptation among small-holder farmers in Kawambwa District.

This study employed a mixed-methods approach. The study used multistage sampling technique. In the first stage, 3 agricultural camps were selected purposively from 29 camps. Then 301 farmers were randomly selected from 3 agricultural camps. The study targeted small-holder farmers within Kawambwa District. A structured questionnaire and semi-structured interview guide were used for data collection. The quantitative data were analyzed using SPSS to execute descriptive statistics and regression analysis on factors associated with adaptation strategies. Thematic analysis was used to analyse qualitative data to identify patterns and themes that emerged from the interviews.

The study established awareness of climate change and various adaptation strategies among farmers in Kawambwa District which included crop diversification (70%), use of improved seeds (18.39%), conservation agriculture (3.99%) and irrigation (9.9%). Finance ($p=0.01$), access to climate information ($p=0.04$), experience ($p=0.02$) and institutional support ($p=0.08$) were identified as vital enabling factors of adaptation. Financial, institutional, and infrastructural constraints limit farmers' ability to implement climate change adaptation strategies. Specific interventions, like extension services, infrastructure and financial resources need to be put in place to improve resilience of farmers against climate related shocks.

Keywords: *Climate Change, Adaptation, Climate Change Adaptation Practices, Smallholder Farmer, Vulnerability and Agricultural Extension*

CHAPTER ONE: INTRODUCTION

1.1 Introduction

The background of the study, statement of the problem, objectives of the study as well as research questions are presented in this chapter of the report. It also includes the significance of the study, the structure of the dissertation. Below is a section that gives a background to the study.

1.2 Background

Climate change is one of the main issues farmers worldwide are faced with, especially in sub-Saharan Africa (Niang et al., 2014). The impacts of climate change on agriculture are clear and this climate change is mostly driven by human activities (Anderson et al., 2019). Several studies have shown that Africa is particularly vulnerable to climate change due to factors such as economic challenges, poor and uncoordinated government policies, inadequate technology, high poverty levels and extreme weather (Niang et al., 2014; IPCC, 2014; and Ayanlade et al., 2022). Further, studies have identified low levels of education, inadequate institutional capacities, financial challenges, inadequate infrastructure and socio-cultural issues as barriers to reducing farmers' vulnerability to climate change and variability in Africa. Despite several studies on climate change adaptation measures, Africa lags in implementing effective strategies due to barriers hindering climate change adaptation efforts (Trenberth et al., 2015). Projections show that droughts and high temperatures will become more intense by the year 2040, further complicating agricultural practices thereby affecting agricultural productivity (Belay et al., 2017).

Implementing practical adaptation strategies is crucial to addressing climate change consequences such as floods, high temperatures, food insecurity and drought. Although climate change perceptions vary, they still can play a significant role in finding solutions. Zambia has experienced significant temperature increases and droughts in some parts of the country, affecting agricultural productivity in the region (Salvini et al., 2016 and Acquah et al., 2016). The use of fertilizer by farmers has not been effective in mitigating the impact of climate change.

Apart from affecting the environment, climate change also affects socio-economic, energy, food, water, and health systems. Hence, understanding factors influencing vulnerability to climate change is essential in developing adaptation strategies and so that they are effectively implemented (Deressa et al., 2018). When it comes to implementation of climate change adaptation strategies, farmers often adopt a mix of strategies, and this emphasizes the need for comprehensive approaches in adaptation planning and implementation, and the need for localized adaptation efforts. (Niang et al., 2014). Studies show that access to financial resources, climate information, and agricultural extension services are key in the successful implementation of climate change adaptation strategies. However, many farmers especially in Africa lack adequate access to these essential supports (Anim-Kwapong and Frimpong, 2021; and Moyo et al., 2020). For instance, the study in Ethiopia by Deressa et al. (2019) found that adoption of climate change adaptive measures such as soil conservation and irrigation techniques was being affected by inadequate infrastructure and support programmes in place by the government (Deressa et al., 2019). Similarly, a study in Ghana attributed low levels of adoption of climate-smart agricultural practices by farmers to poor infrastructure and limited market access. This exacerbates farmers' vulnerability to climate variability (Anim-Kwapong and Frimpong, 2021). This study therefore, assessed the factors influencing the adoption of climate change adaptation strategies in Kawambwa District of Luapula Province.

1.3 Statement of the Problem

Zambia is highly vulnerable to climate change and variability due to various factors, including financial constraints and inadequate infrastructure to cope with climatic shocks. Additionally, the majority of Zambia's rural population depends on agriculture and natural resources for their livelihoods. (Nyasimi et al., 2020). Agriculture is particularly vulnerable to the adverse effects of climate change, such as erratic rainfall patterns, rising temperatures, and the increasing frequency of extreme weather events. These challenges threaten food security, reduce agricultural productivity, and exacerbate poverty levels, especially in rural communities (Deressa et al., 2019 and Nyasimi et al., 2020). Given these risks, enhancing farmers' capacity to adapt to climate change is an urgent priority.

Although farmers are now more aware of climate change and its impacts, their capacity to implement adaptation strategies remains constrained by socio-economic, environmental, and institutional barriers (Anim-Kwapong and Frimpong, 2021; Moyo et al., 2020). These challenges underscore the necessity for climate-sensitive policies capable of addressing the distinct challenges encountered by smallholder farmers. In many African countries, local knowledge and traditional farming practices are considered as critical resources for adapting to climate variability, especially in environments where formal support structures are weak or absent (Moyo et al., 2020). However, as climate variability intensifies, these traditional systems alone are proving inadequate, necessitating a stronger integration between local knowledge and modern climate adaptation strategies (Chidiamassamba et al., 2021).

Furthermore, limited institutional capacity and weak governance frameworks hinder the coordination of climate adaptation policies, resulting in fragmented approaches at the local, regional, and national levels (Ziervogel et al., 2019). These challenges highlight the need for integrated adaptation strategies that address the specific socio-economic and environmental contexts of farmers (Ahmed et al., 2022 and Kalaba et al., 2023). Without coordinated efforts to equip farmers with essential resources and tools, the adverse effects of climate change on agricultural productivity will persist in undermining food security and rural livelihoods across the continent.

Despite the increasing focus on climate change adaptation, there has been limited research on the factors influencing adaptation strategies to specifically study Kawambwa District, leaving a critical knowledge gap. Kawambwa district presents a unique case for study due to its high dependence on rain-fed agriculture, and socio-economic constraints that limit adaptive capacity. Addressing this gap is essential for developing evidence-based interventions that will enhance the adaptive capacity of smallholder farmers, strengthen institutional support, and inform policies aimed at strengthening climate resilience in Zambia's agricultural sector. Further, the findings of this study will contribute to scaling up best practices as the lessons learned from kawambwa District can be applied to other districts facing similar challenges, thereby contributing to broader regional and national climate resilience efforts.

1.4 Aim of the Study

The primary objective of this study was:

To assess the factors associated with climate change adaptation by farmers in Kawambwa District.

1.5 Research Objectives

The following were the objectives study:

i. To assess farmers' awareness of climate change and its impacts in Kawambwa District.
ii. To identify the types of climate change adaptation practices currently being employed by famers in Kawambwa District.
iii. To identify and analyze key factors influencing farmers' decision to adopt climate change adaptation strategies in Kawambwa District.
iv. To evaluate the challenges that hinder farmers' ability to adopt climate change adaptation strategies in Kawambwa District.

1.6 Research Questions

i. What is the level of awareness of climate change and its impacts among farmers in Kawambwa District?
ii. What climate change adaptation strategies are currently being used by farmers in Kawambwa District?
iii. How do key factors influence farmers' decisions to adopt climate change adaptation strategies?
iv. What are the key challenges faced by farmers in implementing climate change adaptation strategies?

1.7 Significance of the Study

The study emphasizes the need to understand specific challenges farmers face in seeking to implement climate change adaptation across the district. Being aware of the main drivers behind their ability to take up adaptive options will empower farmers with information when designing their future cultivation system. Helping to identify and implement effective adaptation strategies would lead to increased farm productivity and resilience to climate shocks.

The study brings to light the implications for food security of climate change, and therefore it helps the society as a whole. Agriculture sector is key in Zambia, and it is vital that farmers be able to adapt to climate change in order to maintain and increase food production. This, in turn, directly helps to reduce hunger and improve nutrition and supports rural communities' livelihoods. On national level, the study is important as it calls for urgent and proactive implementation for climate-resilient policies. By identifying the obstacles or enabling factors of adaptation, this study can inform efforts by government to formulate better policies that promote sustainable agricultural development to enhance productivity.

The study also offers an examination of the barriers preventing farmers from adapting to climate change. The findings can help policymakers create targeted interventions that improve accessibility to extension services, credit facilities, and climate information systems. It adds to existing literature on farmer adaptation to climate change.

1.8 Scope of the Study

The study sought to assess the factors that influence climate change adaptation by farmers in Kawambwa District of Luapula Province where smallholder farming is a common practice. This research was aimed at small-holder farmers which are normally dependent on family labour. In this study factors associated with climate change adaptation were assessed: knowledge about climate change adaptation, age, gender, educational level, socioeconomic status, infrastructure, and community support.

1.9 Definition of Key Terms and Concepts

Climate Change

A long-term change in temperature, precipitation, wind patterns, and other elements of the Earth's climate system, mainly driven by human activities such as fossil fuel combustion, deforestation and industrial processes.

Adaptation

The process through which individuals, communities, and systems adjust to climatic changes and their effects. It often involves taking actions that reduce vulnerability to the current or expected impacts of climate change.

Climate Change Adaptation Strategies

Specific practices or measures that people employ to cope with the impacts of climate change. In agriculture, examples may include crop diversification, use of drought-resistant crop varieties, improved irrigation techniques, soil conservation practices and agroforestry.

Vulnerability

The extent to which a system, community, or individual is susceptible to or unable to cope with adverse climate change effects.

Agricultural Extension Services

Technical support provided to people engaged in agricultural activities by government or non-governmental organizations aimed at improving agricultural practices, disseminating information, and enhancing productivity.

1.10 Organization of the Report

This report is structured by six chapters. Chapter one is the introduction of the study which has presented the background to the study, research problem, aim, objectives, research questions and significance of the study. This is followed by chapter two which is the review of existing literature and theoretical and conceptual frameworks. Chapter three presents the methods used to execute the research. It describes the research approach, design, data collection, sampling procedure and sample size, analysis of data, data validation and ethical consideration. Chapter four is used to present an analysis of the research findings. Chapter five is a discussion of the findings. Finally, chapter six presents the conclusions and recommendations based on the findings of the research.

CHAPTER TWO: LITERATURE REVIEW

This chapter presents the literature review for the research. It discusses relevant existing literature on the impacts of climate change, adaptation practices and related determinants of adaptation practices from various regions of the globe to identify existing knowledge gaps. Additionally, this chapter has introduced theoretical and conceptual frameworks utilized in this research for data interpretation as well as conceptual development.

2.1 Empirical Review

2.1.1 Impacts of Climate Change

One of the biggest global environmental and development challenges today is climate change (Skogen et al., 2018). Climate change is affecting agriculture sector and natural resources more and more. Poor communities that rely on the natural resources for survival are left with few options for adaptive strategies, and this puts them in the climate change trap. Climate change has an adverse effect on the productivity of agriculture, and subsequently on food security (Gitz et al., 2016). Birthal et al. (2014) noted that food security is directly influenced by crop losses due to extreme environmental conditions and indirectly by changes in population dynamics and geographic distributions of agricultural pests. Climate change, which causes high temperatures and drought conditions, reduce agricultural productivity, leading to higher poverty levels (Aragón et al., 2021 and Gezie, 2019). While these studies highlight the global and general effects of climate change on agriculture and food security, there is lack of detailed regional-specific analyses. Further, the studies mention how climate change affects food security but do not sufficiently analyze how socio-economic and institutional factors such as education, gender and government support shape vulnerability or adaptive capacity of farmers. There is need for a study that looks at a specific agro-ecological zone and farming systems within Zambia, and to consider how socio-economic and institutional factors influence the implementation of adaptation measures.

Due to their dependence on natural resources, small-scale farmers are at even greater risk in Ghana and several other developing nations that are more vulnerable to the effects of climate change, which have impacted their environment, agriculture, and food security

(Acquah and Onumah, 2011). Research has indicated that the impact of climate change is more severely felt in African countries than in other territories of the globe, mainly due to inadequate feedback and adaptation strategies (Urama and Ozor, 2011). According to Chilunjika and Gumede (2021), the African continent runs the possibility of becoming the focus of a significant global food crisis if climate change challenges are not locally addressed. These studies highlight inadequate adaptation but do not delve deeply by exploring why farmers struggle to adapt. The study in Kawambwa District examines how various factors impact farmers' ability to adopt climate adaptation strategies.

Climate change impacts agriculture through increased frequencies of extreme climatic events such as droughts, floods and dry spells that directly affect agricultural productivity and production (Thurlow et al. 2012). Because climate change is uncertain, it is difficult for farmers to plan their production activities, especially in rain-fed farming systems (De Pinto et al. 2019, b). Climate change and variability lead to higher uncertainty in predicting weather events such as floods and dry spells and shifts in the onset and offset of rains. The impacts of climate change on crop yields differ by regions. For example, climate change has been found to reduce yields for staple crops such as maize and wheat in lower-altitude regions, while there are yield gains for sugar beets, maize, and wheat in higher altitude and elevation areas (Intergovernmental Panel on Climate Change (IPCC), 2019).

Like other countries in the region, Zambia has been affected by climate change. Climate change and variability have led to crop failure, livelihood losses, increased incidents of food insecurity, and a reduced contribution of agriculture to gross domestic product in the country (Alfani et al. 2019 and Mulenga et al. 2019). The southern parts of the country are projected to be more affected by climate change than are the northern parts and on average, rainfall is expected to be more variable, and rainy seasons are likely to shift (Hamududu and Ngoma, 2019; and Mulenga et al. 2019). This makes Zambian agriculture vulnerable to climate shocks, and this is exacerbated by the fact that more than 90% of smallholder production is rain-fed (GRZ, 2016b). For Zambia, climate change is expected to negatively affect food security and nutrition because of high poverty levels and low diversification in food production (Ngoma et al., 2020). Currently, about 63% of

energy requirements in Zambia are from cereals and yet cereals like maize, the staple food, are vulnerable to climate change. The study by Ngoma et al. (2020) provides valuable insights into the potential impacts of climate change on Zambia's agricultural sector. However, it relies heavily on quantitative models to assess impacts but does not integrate qualitative insights from farmers themselves regarding their perceptions of climate change impacts and their adaptive strategies. Smallholder farmers' local knowledge and experiences provide valuable insights into how they are affected, how they respond to climate change, and the strategies they find most effective. The study in Kawambwa uses mixed-methods to also gain in-depth insights on how smallholder farmers perceive climate risks and what kind of adaptation strategies they are already using or are willing to adopt.

Because of the adverse effects of climate change, it is important to carry out a study that looks at how smallholder farmers perceive climate change impacts and the various techniques for reducing their influence. Climate change adaptation is commonly regarded as a critical component of any policy response to climate change. It is a strategy for reducing vulnerability, increasing resilience and mitigating the risk of climatic-related consequences on people's livelihoods (GadedjissoTossou et al., 2018). Therefore, this study investigates some of the adaptive strategies used by smallholder farmers in Kawambwa District. While the literature suggests the importance of understanding farmers' perceptions, there is limited evidence on how farmers actually perceive climate change impacts and their willingness or ability to adopt new practices in Kawambwa District. Therefore, it is important to assess how farmers in Kawambwa understand climate change and its impacts, and what information or support they need for effective adaptation.

The studies above mostly focus on the agricultural and environmental aspects of climate change impacts, but do not address how socioeconomic factors, such as income levels, gender, education, and access to resources, influence farmers' vulnerability and their ability to adapt. Thus, this study in Kawambwa district explores how demographic, socio-economic status and institutional support of smallholder farmers influence their decision to adapt to climate change.

2.1.2 Climate Change Adaptation Strategies

De Pinto et al. (2012) identified several potential adaptation strategies for Ghana's agricultural sector including: measures dealing with risks and uncertainties (crop insurance, weather and climate information and raising awareness); farming practices and production technologies (resistant varieties, irrigation, extension services and training and crop diversification); and off-farm practices and strategies (improve access to credit, and better storage). Traditional practices among Ghanaian smallholder farmers include application of inorganic and organic fertilizers, adoption of improved crop varieties, legume crop rotations, agroforestry, no-till or reduced tillage practices, use of cover crops, mulching, integrated pest and water management, non-farm and crop diversification, among others (Adeboa and Anang, 2024).

The study conducted by Makondo et al. (2014) in Zambia found that very few smallholder farmers were practicing some of the recommended adaptation or sustainable farming approaches, which included conservation farming combined with crop mix selection based on early maturing varieties, drought resistant and intercropping. The study further found that 70% were not practicing any of the recommended adaptation farming techniques. The low levels of adoption of climate change adaptation practices among smallholder famers observed in the study by Makondo et al. (2014) highlights the need to investigate the factors influencing the adoption of adaptation practices. This study will investigate the factors influencing smallholder farmers' adoption of adaptation practices in Kawambwa District.

Kalaba et al. (2023) examined how farmers in the Southern Province of Zambia adapted to erratic rainfall and rising temperatures. The common adaptation practices that were observed among farmers by researchers were agroforestry, conservation agriculture, and crop diversification. The study by Kalaba et al. (2023) was conducted in the Southern region of Zambia, and so the adaptation practices observed are a response to the weather conditions in that area which are different from other regions of the country. Therefore, this study will be conducted in a different region, Northern part of Zambia, to learn of how farmers are adapting to environmental conditions specific to that region of the country.

Therefore, there is need to examine how farmers perceive climate change impacts and their unique adaptation practices, to help develop appropriate measures that are needed to address climate change at the local level.

The study makes a significant contribution to the literature by shedding light on the mix of local climate change adaptation strategies used by farmers in Kawambwa District of Luapula Province, in Zambia.

2.1.3 Factors Influencing the Adoption of Climate Change Adaptation Measures

In Denmark, a study was conducted by Lindegaard et al. (2019) on how socio-economic factors, including income, education, and farm size, had an influence on farmers' climate adaptation decisions. By means of a mixed-methods approach, the researchers found that wealthier farmers with bigger farms were more likely to implement climate-smart practices, such as improved irrigation techniques. In contrast, smallholder farmers with limited financial resources faced challenges to implement adaptation measures. This shows that economic capacity is an important factor in building farmers' resilience to climate change. The study further stressed that policies targeting financial support and resource access could improve adaptation outcomes for farmers with limited resources. In their investigation, Lindegaard et al. (2019) used mixed methods and longitudinal analysis, and this enhanced the reliability and depth of their findings.

In Austria, Mitter et al. (2021) conducted another significant study which focused on how government policies and institutional support are also important in helping farmers adapt to climate change. The researchers found that farmers were more likely to implement adaptation measures, such as water management systems and conservation practices, if they had access to government-funded programs and extension services. The study used longitudinal data to show that consistent support from governmental institutions was crucial in sustaining long-term adaptation behaviors. This research highlights the significance of strong institutional frameworks and policy incentives in promoting widespread adoption of climate adaptation strategies. The study by Mitter et al. (2021) was more focused on the role of institutional support in facilitating climate change adaptation. Therefore, this study integrates the role of socio-demographic characteristics

in the adoption of climate adaption measures in an area where the majority depend on agriculture and natural resources for their livelihoods.

Furthermore, Rodriguez et al. (2020) explored the factors influencing climate change adaptation among coffee farmers in Colombia. Through qualitative research approach, this study showed the implication of social networks and farmer collective action in the adaptation practices of farmers. Farmers who were members of cooperatives or local farmer organizations were more likely to exchange knowledge and best practices, access climate-resilient agricultural practices, and adopt practices like agroforestry and water conservation. The conclusion of the study was that enhancing adaptive capacity in rural farming areas demands community-level collaboration and collective action. The study by Rodriguez et al. (2020) was carried out among coffee farmers who, in the majority, are commercial producers. This study targeted smallholder farmers which included subsistence to small-scale commercial farmers producing various types of crops. This study did not focus only on a specific crop type in order to see how farmers with different crop types have been adapting to the impacts of climate change. Additionally, to improve its robustness, and the reliability of results, the study applied mixed methods approaches.

In Ethiopia, Deressa et al. (2019) carried out a survey to determine the factors influencing climate adaptation strategies of smallholder farmers. The study revealed that access to extension services, size of farm, as well as education and experience were significant factors determining the adoption of adaptation and sustainable practices like soil conservation, irrigation and crop diversification. This was done through a cross-sectional survey. The research also found that wealthier households were more inclined toward adaptive measures attributed to greater financial resources and access to information. They did show that lack of infrastructure and government technical assistance were barriers to adopting adaptation measures especially in remote places. While the study provides valuable insights into climate adaptation among Ethiopian farmers, it quantifies adaptation strategies but does not explore the qualitative aspects of how farmers perceive climate risks and decide on adaptation measures. Addressing this gap through mixed-method approaches of combining qualitative and quantitative methods to gain deeper

insights into farmer perceptions and decision-making processes could lead to more comprehensive and actionable policy recommendations.

In Kenya, Nyasimi et al. (2020) limited their focus in their study to the adoption of climate-smart agriculture (CSA) practices by smallholder farmers. Their research pointed out that farmers' knowledge about CSA practices was a critical factor for adoption, specifically for agroforestry, conservation tillage, and improved seed varieties. Farmers are also more likely to adopt CSA practices if they have increased access to climate information services and financial support, the study also observed. Nonetheless, lack of institutional support, few financing opportunities, and limited access to agricultural markets limited uptake of CSA practices. The investigators suggested stronger linkages between government agencies, NGOs and farmer cooperatives to help bridge the gap in access to resources and dissemination of knowledge. The study by Nyasimi et al. (2020) focuses on CSA practices (agroforestry, conservation tillage and improved seed varieties) as an adaptation measure. However, adaptation strategies include a wider range of practices, such as crop diversification, early planting, and irrigation techniques. The study conducted in Kawambwa expands the analysis by including a more diverse set of adaptation practices.

Ogunleye et al. (2021) investigated the role of social networks and collective action in climate adaptation decisions in rural farmers in Nigeria. The study found that farmers who participated in local farmer groups or cooperatives were also more likely to adopt adaptation strategies, including crop rotation; livestock diversification; and drought-resistant crops. These groups, in addition to assisting with climate information dissemination, also facilitated access to group style financing mechanisms and enhanced adaptive capacity at community and even individual levels. Finally, the study recommended that in an effort to enhance adaptation outcomes, enhancing the community-level sense of cooperation, and strengthening local institutions is important. This study by Komba and Muchapondwa (2021) looked at

A study of the local adaptation process investigating how institutional frameworks and governance structures influence local climate change adaptation was conducted in South Africa by Ziervogel et al. (2019). The researchers found that the success or failure of

adaptation strategies was heavily influenced by support from local governments and agricultural extension services. It noted that farmers were more likely to adopt adaptive practices, like better irrigation methods and drought-resistant crops, in areas where local institutions were strong and properly coordinated. Yet the study also noted a fragmented approach to policy implementation throughout the country, with certain areas receiving minimal or no support at all. Addressing this, the researchers suggested, could involve better integration of national policies with local level initiatives, helping create a more equitable means of accessing resources and technical support across all farmers. The study focuses heavily on institutional frameworks and governance structures, but does not deeply explore farmers' perceptions of institutional support, decision-making processes, or local adaptation practices. The study in Kawambwa integrates farmer's perception of the kind of support they receive and what they need to adopt adaptation measures.

In Mozambique, Chidiamassamba et al. (2021) investigated how access to climate-related financial services influences adaptation to climate change among smallholder farmers. Microfinance institutions played a key role in giving farmers essential funds to adopt climate-resilient practices such as better seed varieties, irrigation systems, and soil conservation techniques. Farmers who had access to this credit were significantly more likely to adopt adaptive measures to increase farm productivity and resilience to climate shocks. But it also expressed that many farmers did not have access to formal financial services, which led to low adoption levels of adaptive practices. This demonstrated the necessity for greater financial systems and policies to be inclusive of people who practice smallholder farming to cater to men, women and youth. This becomes critical, so we need more in practical ways to scale microfinance and technological tools as solutions to adapting to climate change.

The study by Nyasimi et al. (2020) highlights that adaptation to climate change is also shaped by socio-economic factors, including income levels, education, access to credit, land tenure, and availability of extension services. Research in other African regions suggests that smallholder farmers with greater financial stability and better institutional support are more likely to adopt climate adaptation measures such as drought-resistant

crops, conservation farming, and irrigation (Chidiamassamba et al., 2021 and Ziervogel et al., 2019). However, in Kawambwa District, the socio-economic landscape is distinct, and there is little empirical data on how factors such as access to credit, education, farmland size, and extension services influence the decision to adopt adaptation strategies.

Adeagbo et al. (2022) studied climate change adaptation and the role of climate risk perception on adaptation behaviour among rice farmers in Nigeria. Farmers who considered climate change a major danger to crop production and their livelihoods were more likely to adopt adaptive practices, including changing planting times, switching seed varieties and improved irrigation systems, the study found. Note that farmers with a low perception of climate change risk were also less willing to adopt adaptation strategies. To strengthen adaptation efforts, the study suggested promoting climate risk communication via targeted outreach and education programmes, and particularly for those who are still cynical about the effects of climate change. It should be noted though that while the study of Adeagbo et al. (2022), despite its heavy reliance on risk perception, made few references to broader socio-economic or institutional factors. It advocates for a holistic perspective that combines socio-economic and institutional elements when analyzing farmers' uptake of climate change adaptation practices, which are considered in the study in Kawambwa District.

The perception of farmers toward climate change and variability has been shown to significantly affect the successful implementation of climate change adaptation efforts (Guodaar et al., 2021; Kichamu et al., 2018; and Tesfaye and Seifu, 2016). A better understanding of individual perceptions and adaptation strategies can help policymakers and interventionists design programs that enhance farmers' resilience to climatic shocks. A good knowledge of smallholder farmers' perspective of climate change as well as existing local adaptation methods, and decision-making processes, is important in designing appropriate policies and programmes to encourage viable agricultural land-use systems in developing countries. The cited studies (Guodaar et al., 2021; Kichamu et al., 2018; and Tesfaye and Seifu, 2016) primarily focused on general perceptions of farmers toward climate change in different countries and across broad geographic regions.

However, these studies did not capture localized perspectives specific to farmers in Kawambwa District. It is unclear whether farmers in Kawambwa recognize climate change impacts, how they perceive risks, and what adaptation strategies they prioritize. Climate change impacts and adaptation strategies are not uniform, they vary significantly depending on geographical location, agro-ecological zones, and socioeconomic conditions (IPCC, 2019). Therefore, a context-specific study is necessary to uncover the unique barriers and opportunities for adaptation in Kawambwa.

2.2 Theoretical Review

Many theoretical frameworks to explain climate change adaptation in the agriculture sector have been developed. One commonly cited framework is the Sustainable Livelihoods Framework (SLF), which highlights the importance of human, natural, social, physical, and financial capital on the response of farmers to environmental crisis. According to Nyadzi et al. (2020), the access of farmers to livelihood assets determines the ability of farmers to adopt climate change adaptation strategies, especially during serious climatic impacts. In Vietnam, financial resources and social networks were crucial for farmers to adapt, enabling improvements like investments in better irrigation, crop diversification and others, the researchers found. The SLF was examined in the context of Vietnam using survey data from 350 smallholder households across two agro-ecological zone. While the model provides useful insights, it does not quantify livelihood assets as measuring social and human capital is often subjective and context-dependent. This makes it difficult to make comparisons across regions. Further, SLF does not fully consider structural inequalities that shape access to resources. For instance, smallholder farmers in Zambia may lack financial capital due to poor access to credit markets, a factor that SLF does not explicitly address.

The Theory of Planned Behavior (TPB) is another framework commonly used to explain that psychological factors influence farmers' decision to adopt adaptation strategies, suggesting that farmers' decisions are shaped by attitudes, perceived behavioral control, and subjective norms (Alam et al., 2019). In Bangladeshi, the TPB was applied to examine farmer's willingness to adopt conservation agriculture, using structured interviews with farmers across three regions. It was found that perceived control and social influences

were the strongest predictors of adaptive farming practices. The finding in Bangladeshi compares well with the study that was conducted in South Africa, utilizing the TPB to assess psychological factors influencing climate change adaptation among 400 smallholder farmers. The findings indicated that attitudes toward climate change, subjective norms, and trust significantly influenced farmers' adaptation behaviors (Masud et al., 2016). This theoretical model lends support for the notion that adaptation decisions depend not only on economic and environmental context, but that psychological factors like perceived control and social pressures also play roles in the decision process. While TPB provides useful insights into decision-making psychology, the model does not fully account for external barriers such as climate information services which are more influential than personal attitudes. Further, TPB assumes that stated intentions predict actual behavior, but intentions do not always translate into action. For example, a farmer may express a strong intention to adopt drought-resistant crops but fail to do so due to financial constraints.

The Adaptive Capacity Framework focuses on institutional support, knowledge, and innovation as key enablers of climate adaptation. Nyasimi et al. (2021) investigated this framework in Kenya, using focus groups and surveys with 280 farmers across three counties. The study found that farmers were more likely to adopt climate-smart agriculture when they had regular access to extension services, climate forecasts, and financial support. The framework assumes that extension services and climate information are readily available to farmers. However, access to agricultural extension services is highly uneven, making this framework less applicable without adjustments. Additionally, this framework often prioritizes formal institutional support over local knowledge, which plays a crucial role in smallholder adaptation strategies. While Nyasimi et al. (2021) provided valuable insights, the study lacked a control group for comparison, making it difficult to assess whether adaptation success was due to institutional support or other unmeasured factors.

These theoretical models offer a perspective of the complexity of adaptation to climate change as it relates to agriculture, suggesting that multiple influences can play a role in farmers deciding to adopt adaptive measures. Across various contexts around the globe,

several studies have illustrated that a mix of these factors ultimately determine farmers' adaptation behaviors (Hoa et al., 2019; Stringer et al., 2020; and Bahati et al., 2023).

Each of the theoretical frameworks discussed above offers valuable insights into climate adaptation, but none fully captures the complex and context-specific nature of adaptation decisions. Given these limitations, a more integrated approach, combining livelihood resources, behavioral insights, and institutional support, may be more effective in understanding how farmers in Kawambwa District adapt to climate change.

2.3 Conceptual Framework

The conceptual framework employed in this study is adapted from Megabia et al. (2022) and is designed to illustrate the causal relationships between various factors and farmer's decisions to adopt climate change adaptation strategies (Figure 2.3.1). The framework highlights how climate risks such as erratic rainfall, intra-seasonal dry spells, frequent drought, high temperature, land degradation, and soil erosion, pose significant threats to agricultural productivity (Ndiritu and Muricho, 2021). In response, farmers engage in adaptation strategies to mitigate these risks and sustain their livelihoods (Megabia et al. 2022).

The framework categorizes the factors influencing farmers' adaptation decisions into three broad domains: demographic factors, economic factors and institutional factors. characteristics of the farmers. Demographic factors include personal characteristics of farmers such as age, educational attainment and farming experience. The study by Franklin et al. (2021) indicates that education plays a crucial role in shaping a farmer's awareness and perception of climate change, which in turn affects their willingness and ability to adopt adaptive measures. Financial and resource-related aspects, such as farm size and access to credit, significantly influence adaptation decisions. Larger farm sizes may offer more opportunities for implementing diverse adaptation strategies, while access to credit provides farmers with the necessary resources to invest in adaptation measures (Megabia et al., 2022). Further, institutional factors such as access to climate information and extension services play a vital role in enhancing farmers' adaptive capacity. Well-informed farmers are more likely to implement effective adaptation measures, as they can make informed decisions based on accurate climate predictions and best farming

practices (Franklin et al., 2021). The study was conducted by Begum et al. (2023) in Bangladesh using survey data from 100 farmers by using a semi-structured questionnaire and a binary logistic model to identify the driving factors of the adoption of adaptation strategies. The study established that extension services such as access to training significantly influenced the adoption of adaptation strategies. It found that farmers who received training were more likely to implement practices such as intercropping and mulching (Begum et al., 2023).

Furthermore, the framework underscores the role of farmers' perceptions of climate change as a mediating variable. The framework suggests that farmers who perceive climate change as a serious threat are more likely to take proactive adaptation measures (Megabia et al., 2022). A study examining Kenyan farmers' found that their perception of climate change significantly influenced their engagement in climate-smart agricultural practices (Maumoh and Yindi, 2021). This underscores that farmers who recognize the seriousness of climate change are more proactive in adopting adaptive measures.

The framework posits that these factors do not operate in isolation but rather interact to influence farmers' adaptation decisions. For instance, Education (demographic factor) affects how farmers interpret and respond to climate information (institutional factor), which in turn shapes their adaptation choices. Access to climate information (institutional factor) enhances farmers' perception of climate change, reinforcing the importance of adaptation (Megabia et al., 2022).

Figure 2.3.1 provides a visual representation of these relationships, illustrating the interplay of demographic, economic, and institutional factors in shaping adaptation decisions. By structuring the conceptual framework in this way, the study provides a clear rationale for investigating these variables and offers a foundation for interpreting research findings. It has been used by the researcher to explain and interpret the observations and findings from the field. All in all, the conceptual framework has expounded the structure or framework within which the situation has been investigated, that is, provided a rationale for the perspective from which the investigator has examined the problem, and has provided a context for interpreting the findings.

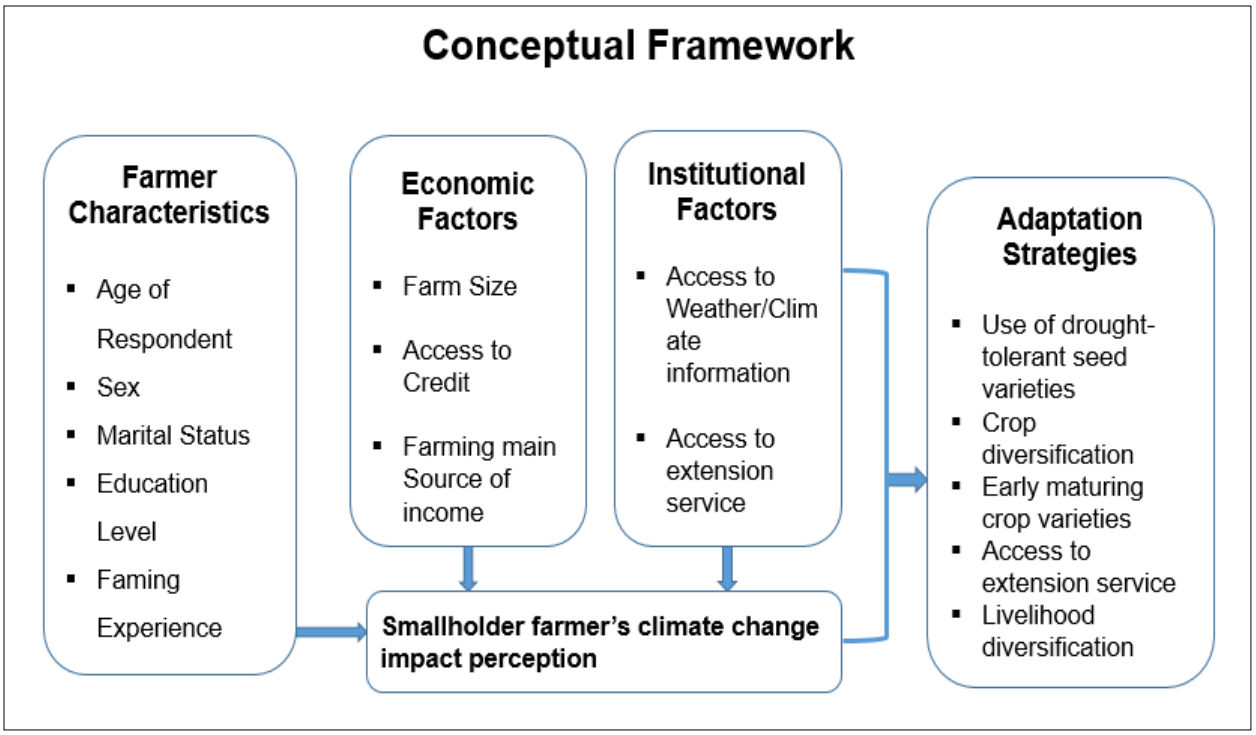

Figure 2.3.1: A Conceptual Framework for Factors Affecting the Decision to Adopt Climate Adaptation Strategies. (Source: Adapted from Megabia et al. (2022))

CHAPTER THREE: METHODOLOGY

This chapter outlines the research methods that were used in this study. It gives a brief description of the approach, design, target population, sample size, sampling technique, data collection, analysis methods and ethical considerations.

3.1 Research Approach

A mixed-methods approach was utilized in this study to ensure a comprehensive understanding of the research topic. The study used both qualitative and quantitative data collection techniques in order to gather diverse perspectives and also to ensure the reliability and validity of research findings. This approach enabled a holistic investigation of the adaptation strategies employed by smallholder farmers, allowing for statistical analysis of quantitative data alongside in-depth insights from qualitative interviews.

3.2 Research Design

The study employed a convergent parallel design, which facilitated the collection of quantitative and qualitative data simultaneously and analyzed them separately. Quantitative data was collected on factors associated with climate change adaptation alongside qualitative data to explore farmers' experiences, opinions and perceptions, to provide a comprehensive picture. The two data sets were merged into an overall interpretation. The findings from both data sets were compared to assess consistency and provide a comprehensive interpretation of the research problem. As noted by Creswell and Plano (2021), this approach facilitates a direct comparison of results from both methods, enhancing the robustness of the findings. The convergence of both data types revealed areas of agreement (Fetters and Freshwater, 2020). This strategy improved the overall validity and richness of the study, as it integrated the strengths of both approaches in understanding the climate change adaptation phenomena. By comparing the quantitative data on adaptation factors with qualitative insights into farmers' experiences, a more complete and nuanced understanding was formed (Guetterman and Fetters, 2019).

3.3 Study Population

The target population for the study consisted of smallholder farmers based in Kawambwa District of Luapula Province. These farmers are typically engaged in subsistence and commercial agriculture, representing a diverse range of socioeconomic backgrounds and farming practices.

3.4 Study Area

The study was conducted in Kawambwa District of Luapula Province, in Zambia, where small-scale farming is prevalent. The majority of people in the district depend on agriculture and natural resources for their livelihoods. This makes it a suitable case to explore climate change adaptation among farmers.

3.5 Sample Size

Sample size was determined using a formula which gave an estimation of the number of participants to be included in the study. The method allowed the determination of a sample size when nothing about the population is known.

$n = \frac{z^2 \times p(1-p)}{d^2}$, where

$n =$ Sample Size

$z =$ Z-score= 1.96 at 95% Confidence Level

$p =$ Prevalence Value, Expected Population Proportion = 0.50 (Prevalence = 50%)

$d =$ Margin of error = ± 5% =0.05.

No prior studies on the exact proportion of farmers adopting adaptation strategies were available at the time of study design. In such cases, using p=0.5 ensures an unbiased estimate. Previous research in agricultural adaptation has often employed p=0.5 when estimating sample sizes here prevalence data is scarce or unavailable (Sesay et al., 2021). For instance, a study by Trimmer et al. (2015) on agricultural technology adoption also follows this practice, as no clear prior estimate of adoption rates was available.

Given these uncertainties, the study used p=0.5 as the most conservative estimate to ensure a sufficient sample size for statistical reliability.

Therefore,

$$n = \frac{1.96^2 \times 0.5(1 - 0.5)}{0.05^2}$$

$$n = 384$$

Therefore, the estimated sample size was 380.

3.6 Sampling Technique

In order to select participants for the research, a multistage sampling technique was used. In the first stage, 3 agricultural camps were chosen purposively from a total of 29 agricultural camps based on their agricultural potential. This was done in consultation with the District Agricultural Coordinator in the district. In the second stage, farmers were randomly selected to participate in the survey using the Camp Farmer Registers with the help of Camp Extension Officers. The register was used to randomly select farmers in each camp.

Further, the study also employed purposive sampling because the researcher was targeting individuals exposed to the issue and expected to be reliable for some information. The researcher set out to identify and select the individuals that are proficient and well-informed with agriculture and climate agricultural practices. The officials from the Department of Agriculture were purposively selected as participants because they are responsible for implementing sustainable agricultural practices and support farmers in the district. Four officers were interviewed (one Senior Agriculture Officer (SAO) and three Camp Extension Officers).

3.7 Data Collection/Instruments:

Data was collected using a combination of structured questionnaires and semi-structured interview guides. The interview guide allowed for in-depth qualitative insights into farmers' experiences, perceptions and challenges regarding the adoption of climate change adaptation practices. A household survey and key informant interviews were utilized to collect data.

A questionnaire was administered on smallholder farmers to collect data on demographics, climate change adaptation strategies, perception of climate change and

access to resources and service. The researcher together with the research assistants made visits to the sampled households and conducted face-to-face interviews with farmers.

Key informants from the department of agriculture (SAO) and camp extension officers in each camp were interviewed to get more insights on adaptation practices being implemented in the district.

3.8 Variables

Dependent Variables

- The decision to adopt adaptive measures by farmers.

Independent Variables

- Gender
- Age
- Marital status
- Access to finance/credit
- Access to climate information
- Farmland size
- Farming experience
- Education level
- Farming as source of income
- Perception of Climate change
- Extension support service

3.9 Data Analysis

Quantitative data was analyzed using SPSS to perform descriptive and regression analysis to identify factors significantly associated with adaptation strategies. Descriptive statistics included frequency, percentages and graphs. The researcher used thematic analysis to analyze qualitative data, by identifying patterns and themes that emerged from the interviews. The researcher then integrated the findings. The integration of findings from both data types enriched the overall understanding of the factors influencing climate change adaptation among farmers in Kawambwa District.

3.10 Ethical Considerations

The proposal of this study was submitted to the University of Lusaka Review of Ethics Committee for ethical approval before it was actually carried out. Participants were fully informed about the study's purpose, their rights, and the nature of their involvement, and provided informed consent before participating. Dropping out of participation was possible at any stage of the study without consequences. The study respected local customs, traditions, and norms, ensuring that the research process was culturally appropriate. Personal information and data were anonymized to protect the privacy of participants. Data was securely stored in digital files and accessible only to the research team. After the completion of the study, all confidential data will be retained for a period of time and then securely destroyed. To ensure the neutrality of qualitative data interpretation, peer debriefing was conducted, where a peer examiner was given an opportunity to provide critical feedback and ensuring that interpretations were not biased. Additionally, intercoder reliability checks were performed, where assistants independently coded the qualitative data and then compared with the researchers coding to assess consistency and resolve discrepancies. These methods helped ensure the reliability and validity of the qualitative findings while minimizing potential researcher bias.

CHAPTER FOUR: PRESENTATION AND ANALYSIS OF RESULTS

This chapter presents the findings of the data analysis process. The aim of the study was to assess determinants of climate change adaptation among farmers of Kawambwa District. The data were analyzed using SPSS version 26 software. Results were presented as summaries in tables and graphs.

4.1 Socio-Demographic Characteristics of Participants

In total, 301 farmers were successfully included into the study as study participants. Most were (260, 86.38%) and female were (41, 13.62%). In terms of age, most participants were in age range of 36 to 50 years (151, 50.17%) and the lowest was above 50 years of age (40, 13.29%). In terms of education level, the most prevalent were no formal education (153, 50.83%), and the lowest was secondary education (23, 7.64%). Furthermore, in terms of marital status, most of the participants were married (159, 52.82%), and single individuals represented the smallest group (54, 17.29%). Additionally, the study also examined farm size of which the largest group had 1 to 5 hectares of farmland (209, 69.44%), while the smallest group had 6 to 10 hectares (41, 13.62%). Most participants had 6 to 10 years of experience (239, 79.4%), while the fewest less than 5 years of experience (23, 7.64%) in farming. Results also revealed most participants reported farming as their main source of income (283, 94.02%), while the fewest indicated other sources (18, 5.98%). Results are summarized in table 4.1.

Table 4.1: Socio-Demographic Characteristics of Participants

Variable and parameters	Frequency (n=301)	Percentage (%)
Gender		
Male	260	86.38
Female	41	13.62
Age		
18-35	110	36.54
36-50	151	50.17
>50	40	13.29
Marital Status		
Married	159	52.82

Never married	54	17.94
Divorced	88	29.24
Education		
No formal education	153	50.83
Primary	91	30.32
Secondary	23	7.64
Tertiary	34	11.30
Farm Size		
1-5 hectares	209	69.44
6-10 hectares	41	13.62
> 10 hectares	51	16.95
Years of Experience in Farming		
<5 years	23	7.64
6-10 years	239	79.40
>10 years	39	12.95
Whether Farming is Main Source of Income		
Yes	283	94.02
No	94	5.98

4.2 Knowledge and Perception of Climate Change

Table 4.2, results for knowledge and perception of climate change by participants. When asked if they know what climate change is, most participants answered with “Yes” (271, 90%). The 271 respondents were asked to define climate change in their local language and cite examples of its local impacts. Moreover, as participants were asked if they felt any changes in weather, the response of "Yes" verses "No" from the most to the least responses was "Yes" (241, 80.07%), versus "No" (60, 19.93%). The most commonly observed change was "increased temperature" (191, 63.46%), whereas "unpredictable rainfall patterns" (83, 27.57%) were the second most common. Floods (3, 1.0%) had least seen changes. Results also indicated that the highest number of respondents perceived climate change impacts as “very negative" (171, 56.81%), followed by “somewhat negative," (91, 30.23%) The least reported perceptions included "No impact" (32, 10.63%) and "positive impact" (7, 2.33%), as noted in table 4.2.

Table 4.2: Knowledge and Perception of Climate Change

Variable and Parameters	Frequency (n=301)	Percentage (%)
Knowledge of Climate Change		
Yes	271	90.0
No	30	10.0
Noticed Weather Changes		
Yes	241	80.07
No	60	19.93
Observed Changes		
Increased Temperature	191	63.46
Reduced Rainfall	21	6.98
Unpredictable rainfall patterns	83	27.57
Drought	83	27.57
Floods	3	1.0
Impact Perception		
Very negative	171	56.61
Somewhat negative	91	30.23
No impact	32	10.63
Positive impact	7	2.33

4.3 Adaptation Strategies Practiced by Farmers

The results indicated that most respondents use adaptation strategies (223, 74.09%), whereas fewer individuals reported that they were not utilizing any strategies (78, 25.91%), as seen in figure 4.4.1.

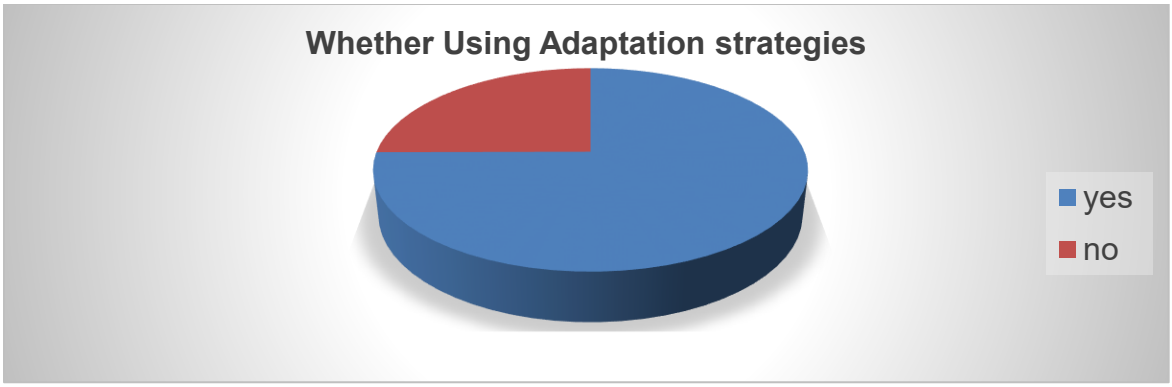

Figure 4.3.1: Farmers Using Adaptation Strategies

Among the 223 farmers that reported using adaptation strategies, the most commonly mentioned was “crop diversification” (157, 70%), followed by "use of drought resistant seed" (41, 18.39%), and 22 (9.9%) of those was “irrigation techniques”. The least adopted was "conservation agriculture (12, 3.99%) as shown in figure 4.4.1. The percentage mentioned does not add up to 100% because some farmers have adopted more than one strategy (They used a combination of adaptation strategies).

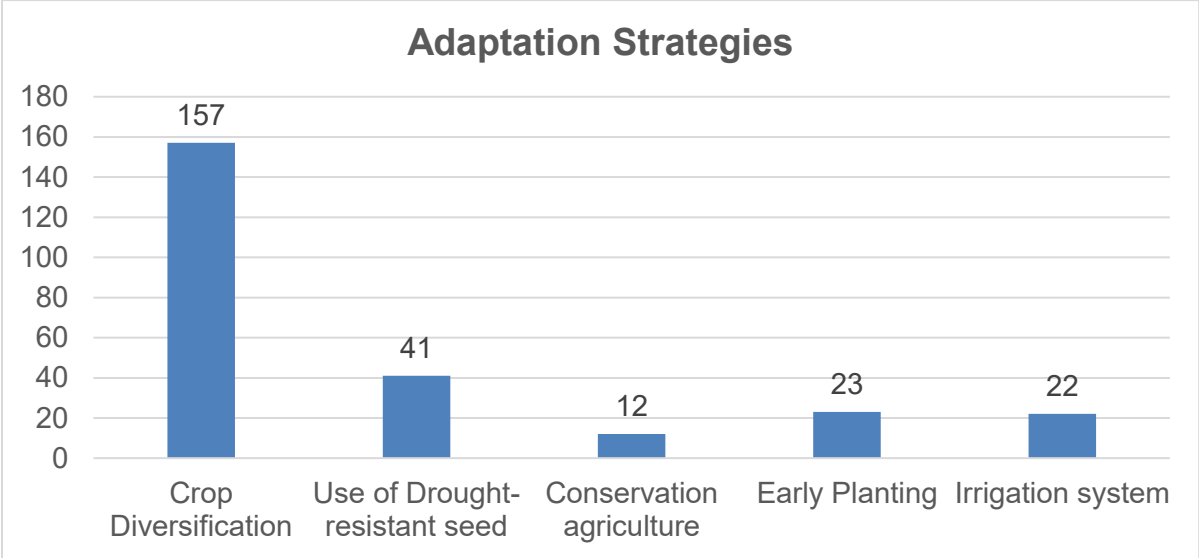

Figure 4.3.2: Adaptation Strategies

To assess the effectiveness of Strategies used by the participants, results showed that the majority of respondents found their adaptation strategies to be "Very effective" (123, 40.86%), while fewer reported them as "Effective" (29, 9.63%) or "Somewhat effective" (31, 10.3%). Results also showed that a significant proportion reported perception as "Not effective" (50, 16.61%) as shown in figure 4.4.3.

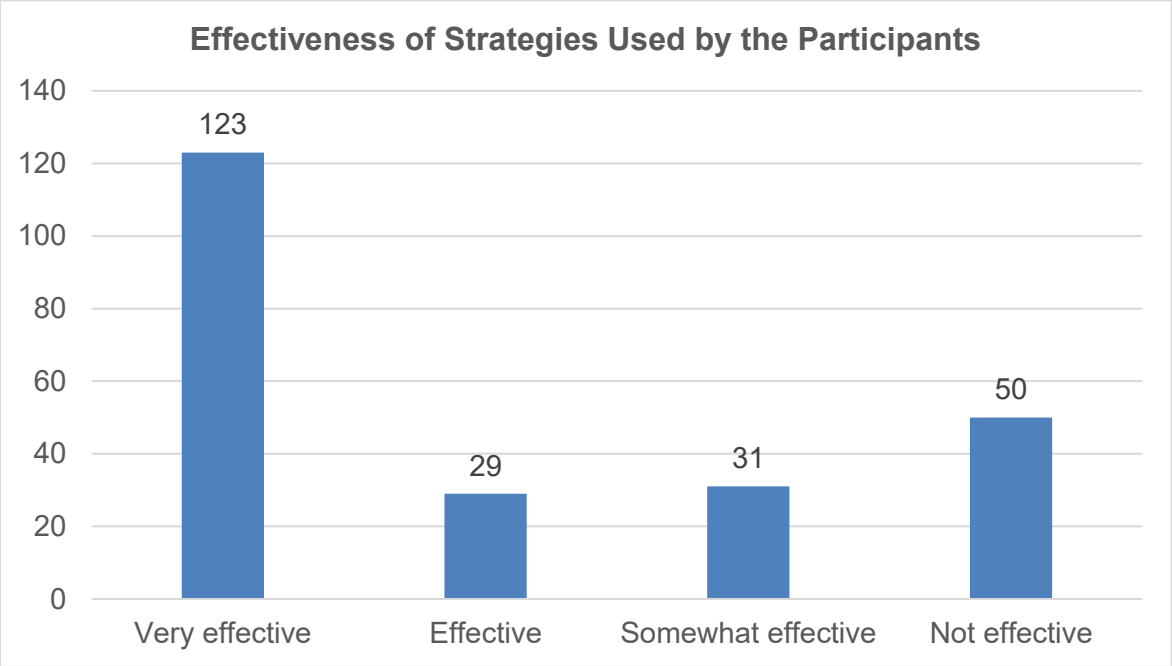

Figure 4.3.3: Effectiveness of Strategies Used by the Participants

4.4 Access to Resources and Services

A majority of respondents reported having access to climate information (197, 65.45%), while a smaller proportion indicated no access (104, 34.55%). Regarding the frequency of receiving climate-related information, "Never" was the most common response (99, 32.89%), followed by "Daily" (79, 26.25%) and "Monthly" (53, 17.61%). The least frequent responses were "Weekly" (43, 14.29%) and "Rarely" (27, 8.97%). When asked about the sources of climate information, the highest number of respondents identified "Radio/TV" (141, 46.84%) as their primary source, followed by "Community meetings" (91, 30.23%). Other sources included "Extension officers" (38, 12.62%). In terms of access to agricultural extension services, a majority of respondents reported having access (179, 59.47%), while 122 (40.53%) indicated no access. However, access to financial resources for farming showed an opposite trend, with the majority of respondents (174,

57.81%) reporting no access, compared to 127 (42.19%) who indicated having access. Among those with access to financial resources, "Never" accessing financial services was the most frequent response (144, 47.84%), followed by "Rarely" (83, 27.57%), "Occasionally" (41, 13.62%), and "Frequently" (33, 10.96%).

Table 4.4: Access to Resources and Services

Variable and Parameters	Frequency (n=301)	Percentage (%)
Access to Climate Information		
Yes	197	65.45
No	104	34.55
Frequency of Climate Information		
Daily	79	26.25
Weekly	43	14.29
Monthly	53	17.61
Rarely	27	8.97
Never	99	32.89
Source of Climate Information		
Radio/TV	141	46.84
Mobile Apps	31	10.30
Extension Officers	38	12.62
Community Meetings	91	30.23
Access to Agricultural Extension		
Yes	179	59.47
No	122	40.53
Access to Financial Resources		
Yes	127	42.19
No	174	57.81
Frequency of Financial Services		
Frequently	33	10.96
Occasionally	41	13.62
Rarely	83	27.57
Never	144	47.84

4.5 Multi-Logistic Regression Analysis

Table 4.5 shows odds ratios, coefficients, standard errors, z-values and p-values. By employing the multi-logistic regression analysis, several critical factors affecting farmers' adoption of climate change adaptation strategies were identified. The results indicated that access to finance or credit had the most substantial positive influence (coefficient =1.35; odds ratio = 3.86). In this regard, it indicates that farmers with access to finance or credit are nearly four times more likely to adopt climate change adaptation strategies compared to those who are not. This effect is statistically significant (p = 0.001).

The output reveals a broader and statistically significant positive effect of government support through extension services, with a coefficient of 0.075 and an odds ratio of 1.08, meaning that farmers who receive technical support from extension services are more likely to adopt the adaptation strategies (p=0.008). Similarly, the perceived impact of climate change was included among the most important factors, with an odds ratio of 2.86 (p=0.001), highlighting the role of farmers' perceptions of climate-related risks in shaping adaptation choices.

The access to climate information was shown to have a coefficient of 0.85 and an odds ratio of 2.34 (p=0.004), suggesting that farmers who receive frequent updates on weather conditions are over twice as likely to implement strategies than those who do not. Agricultural experience was also an important determinant of outcome (p=0.002). More experienced farmers are 1.91 times more likely to adopt adaptation measures than those with less experience.

Some other variables, that were positively impacting adoption were farm size (coefficient = 0.45, odds ratio = 1.57, p=0.007), and education level (coefficient = 0.20, odds ratio = 1.22, p=0.045). But they had a very moderate impact compared to other factors. Their statistical significance does, however, underscore the importance of resources and knowledge in the success of climate adaptation.

Table 4.5: Multi-Logistic Regression Analysis

Factor	Coefficient	Standard error	Z-value	P-value	Odds Ratio
Gender	0.35	0.34	1.50	0.501	0.88
Age	0.85	0.45	1.28	0.201	0.59
Marital Status	0.47	0.25	0.30	0.090	0.17
Access to Finance/Credit	1.35	0.30	4.50	0.001	3.86
Access to Climate Information	0.85	0.25	3.40	0.004	2.34
Farm Size	0.45	0.15	3.00	0.007	1.57
Education Level	0.20	0.12	2.01	0.045	1.22
Farming Experience	0.65	0.20	3.25	0.002	1.91
Farming is Main Income Source	0.85	0.45	0.38	0.701	0.59
Extension services	0.075	0.25	2.65	0.008	1.08
Perceived impact of climate change	1.05	0.28	3.75	0.001	2.86
Using Adaptation Strategy	0.85	0.46	1.04	0.301	0.38

4.6 Adoption of Climate Change Adaptation Strategies: Facilitators and Obstacles

This section presents the results from the field on the challenges and perspectives faced by farmers in Kawambwa District when adopting and implementing adaptation strategies to cope with climate change and variability.

Respondents identified unpredictable weather events as directly affecting their planning when they were asked about the challenges they face in implementing adaptation measures in relation to their farming activities. They reported that this results in frequent crop failures, which they attributed to inadequate access to reliable weather forecast information. Some farmers in certain communities lack access to climate or weather information, according to respondents, so they base their decisions on what they see or experience, which they said is unreliable.

Lack of access to modern farming equipment and drought resistant seeds was mentioned some respondents. Regarding access to improved seed varieties, some participants stated the following:

> *"In order to grow our crops during the months of low rainfall or during the late onset of the rainy season, we need improved seeds, such as drought resistant seeds and modern tools that our fellow farmers are using in other regions. However, even if we were to find them in shops, they would still be costly to purchase, meaning we would not have access to them."*

Further, majority of the participants said the biggest obstacle to embracing or implementing climate change adaptation strategies is the lack of financial resources to obtain inputs and equipment so as to be able to cope with climate change and variability and reduce their vulnerability. They said they do not have resources to invest in adaptive technologies such as irrigation and also to diversify their livelihood options.

Additionally, limited knowledge and awareness of adaptation practices emerged as a challenge. Some farmers indicated that they were unfamiliar with practices such as agroforestry and conservation agriculture. They reported relying on traditional farming methods passed down from previous generations due to a lack of training and technical support:

> *"We just rely on traditional methods of farming that we learned from our parents when we were young because we have limited knowledge on other better agricultural practices to deal with climate change or variability. We just hear of them from others but we do not know how to implement them. We need to be trained as well by officers from agriculture like Camp Extension officers."*

Although a majority of respondents said they were aware of government programs promoting climate-smart agriculture, not all were able to participate. Some farmers who had engaged in climate change training programs reported that there was a lack of follow-up and monitoring to support implementation. As one farmer noted:

"I participated in a government-led training on agroforestry, but there was no follow-up support or monitoring to ensure we were able to successfully implement what we learned."

Respondents did indicate that trainings provided them with valuable knowledge but without continued guidance, monitoring, or assistance from extension officers, they struggle to implement the practice effectively. This was attributed to limited extension officers to provide that support. The limited number of extension officers in the district indicates that one officer has to cover a huge area thereby reducing the time spent with farmers and the frequency of visits to farmers. Where training programs occur, there is lack of long-term engagement with farmers or beneficiaries.

Further, respondents mentioned inadequate infrastructure to enable them implement adaptation measures to help them cope with climate change impacts. The respondents said:

“We do not have irrigation canals in the district that can help farmers to engage in farming activities all year round. If I can count, we only have maybe one or two earthen canals that were done by government a long time ago, and they only serve a small population. It is now that we have seen the construction of some canals that will be lined though they have not yet been completed to serve communities, and are only in two communities. In other words, they are not enough. If we had a number of irrigation canals constructed in a number of communities to serve more communities, we would be producing certain crops throughout the year even when there is a delay in the onset of rainy season or have little rains in that particular season.”

Participants were further asked about what kind of support they would need for improved adaptation. Respondents said they would like the government to introduce subsidies on improved seed varieties tailored for changing environmental conditions and new organic fertilizers that are on the market. They also mentioned that they need more trainings on adaptation practices such as conservation agriculture and soil management techniques, and frequent visits after trainings by extension officers. The participants also mentioned that they need increased access to financial resources such as loans or grants to invest

in technologies such as irrigation equipment. More reliable and frequent dissemination of climate information was also one thing the participants said they would like to have. They said information can be disseminated though SMS alerts and community radio stations for broader so that they also prepare themselves.

When asked about the most effective strategies for adapting to climate change and variability in their district in order to cope with climate impacts and reduce vulnerability, the participants mentioned:

> *"encouraging crop diversification to reduce dependency on single crops, investing in small-scale irrigation systems to manage water scarcity, adopting conservation agriculture practices like mulching and minimal tillage, and using climate-resilient seeds that withstand droughts and floods".*

Further, when asked about what could be done to increase adoption of climate change adaption measures among smallholder farmers, respondents mentioned the following:

Increasing awareness of climate change impacts through community sensitizations; enhancing farmers' access to financial services such as low-interest loans and grants to be able to invest in improved agricultural technologies; strengthen partnerships with NGOs to support farmers with financial resources, improved farming inputs and trainings; investing in rural infrastructure like roads to improve market linkages, irrigation facilities to promote all-year round faming, and storage facilities to reduce post-harvest losses; and establishing early warning systems for extreme weather events to improve preparedness.

CHAPTER FIVE: DISCUSSION OF FINDINGS

This chapter discusses the results from the field as presented in chapter four. This chapter is divided into a number of sections. The first section discusses the level of awareness of climate change among farmers in Kawambwa. The second section looks at the climate change adaptation strategies being adopted by farmers in Kawambwa district. Further, the chapter discusses factors influencing the adoption of climate change adaptation measures. Finally, the last section presents a discussion of some of the challenges faced by farmers in Kawambwa District in implementing climate change adaptation strategies.

5.1 Level of Awareness of Climate Change

The findings from Kawambwa showed a high level of knowledge and awareness of climate change among farmers in the district. Most respondents (80%) reported having noticed changes in weather patterns over the past years, reflecting a significant level of engagement with environmental changes. Among those who reported observed changes, the majority of respondents mentioned unpredictable rainfall patterns, followed by increased temperatures and reduced rainfall. Other notable observations made by some respondents included droughts. This highlighted the diversity of climate change experiences among farmers in the district. These findings suggest that farmers are highly observant of their environment, likely due to their reliance on weather-sensitive agricultural activities and natural resources for their livelihoods, and that climate change is bringing about noticeable impacts in the area. This level of awareness is critical for informing adaptation strategies to manage climate change impacts and reduce vulnerability among farmers (Ado et al., 2019), as it reflects a readiness to acknowledge climate-related challenges and explore potential solutions.

Additionally, when asked about the perceived impact of these changes on their farming activities, 56.61% of the respondents reported that the changes had a very negative impact, while about 30% felt the impact was somewhat negative. Only a small proportion of the respondents perceived no impact, and an even smaller number reported a positive impact. These responses further demonstrate that farmers are not only aware of climate change but also understand its implications for their livelihoods, particularly regarding agricultural productivity and sustainability. The findings in this study support the

arguments of other research studies that awareness requires understanding climate change and its associated risks and the impacts that must be addressed (Lieske et al., 2014).

The results from Kawambwa District compare well with previous studies on farmers' knowledge and awareness of climate change. One such example is the study conducted by Nhemachena et al. (2018), where most farmers (over 85%) were aware of changing weather patterns, which most attributed to climate change in Southern Africa. Similarly, according to a study in Ethiopia by Dotes et al. (2019), 88% of farmers had seen changes in rainfall patterns and temperature, and this matched with high awareness level in Kawambwa District (89%). These studies have shown that farmers in most African regions are very aware of environmental changes as they depend on livelihoods that are climate-sensitive. Once farmers are aware of climate change and variability, the next priority is encouraging farmers to adopt adaptation strategies to be resilient to climatic shocks. Awareness of climate risks and potential impacts is therefore critical in the early stages of the adaptation process (Ado et al., 2019), in order to mitigate impacts of climate change and protect the overall vulnerability.

Although awareness levels are high across several studies, specific changes do vary somewhat by region. The most reported phenomena in the Kawambwa study were unpredictable patterns of rainfall and higher temperatures. These findings are consistent with those of Ayanlade et al. (2020) in Nigeria, where farmers were mostly worried about erratic rainfall patterns. However, in some regions, like the Sahel, research by Ouédraogo et al. (2021) reported prolonged droughts as the most commonly observed, contrary to the comparatively lower reporting of droughts (43%) in Kawambwa. These regional variations reflect localized climate impacts that shape farmers' perception and adaptation responses. Thus, adaptation measures promoted in each region must be informed by localized climate change impacts. farmers may become more vulnerable to climate change and find it more difficult to cope with climatic shocks if specific adaptation measures are not implemented (Le Dang et al., 2014).

Higher awareness levels among farmers may be seen in areas extension services, the media, or community networks provide better access to climate-related information. In

Kawambwa, a significant number of farmers reported receiving climate-related information, which likely contributed to their ability to identify and describe specific weather pattern changes. On the other hand, farmers in isolated or underserved areas might lack access to reliable information, which could lead to lack of awareness or a limited comprehension of climate change impacts. Further, the high level of awareness of climate change in Kawambwa has also been linked to a number of sensitization programmes and risk assessments that have been conducted by extension agents and cooperating partners implementing climate change initiatives in the district, like the Transforming Landscapes for Resilience and Development Project (TRALARD), a World Bank-supported climate change project.

5.2 Main Climate Change Adaptation Techniques in Kawambwa District

The study found that various climate change adaptation techniques were used by farmers in Kawambwa District to mitigate the effects of climate change on their farming activities, which reflected their proactive responses to changing weather patterns.

The majority of respondents stated crop diversification as their main strategy to mitigate the impacts of climate change. This consistent with findings from earlier research studies indicating that diversifying crops is a widely adopted measure to reduce risk and ensure food security under variable climatic conditions. This confirms a study conducted by FAO in developing countries which showed that planting different crop varieties enhances achievement of food security amidst climate change (McCarthy et al., 2018). Farmers are able to reduce the risk of total loss as a result of extreme weather events such as drought by planting a variety of crops. Hence, most smallholder farmers find it easy to incorporate crop diversification into their shift to conservation agriculture because it yields short term benefits, unlike agroforestry (Umar, 2021).

The practice of diversifying crops, being implemented by smallholder farmers in Kawambwa, is consistently identified as one of the most common adaptation strategies practiced by farmers in Africa in other studies. For instance, Nhemachena and Hassan (2018) found that more than 70% of farmers in Southern Africa employed crop diversification as a climate risk mitigation measure. Similarly, 78% of farmers in Ethiopia employed crop diversification as reported by Asfaw et al. (2019), mainly to address food

insecurity as a result of variable rainfall patterns. These results give emphasis to the universal recognition of crop diversification as an effective risk management measure.

This study found farmers in Kawambwa using improved seed varieties. Studies in other areas have reported on the use of this strategy as a mitigation measure. A study by Deressa et al. (2019) in Ethiopia established that 67% of farmers used improved seed varieties to deal with water scarcity, while Ayanlade et al. (2020) in Nigeria noted the increase in the use of drought-tolerant seeds among smallholder farmers. These studies show how the use of improved agricultural inputs is becoming an increasingly important component of climate adaptation. With regard to improved see varieties, farmers in Kawambwa District reported using drought-resistant seeds. This practice demonstrates how the majority of farmers are depending on improved seed varieties to increase productivity and sustain livelihoods in the face of changing climatic conditions. This is comparable to a study by Amondo et al. (2019), which showed the advantages of using drought tolerant maize varieties in Zambia with respect to productivity, yield stability and downside risk in the face of climate change. The use of these seeds shows an understanding of the need for resilient farming inputs that can sustain productivity and sustain livelihoods despite harsh weather conditions (Atube et al., 2021). Therefore, in order to increase agricultural productivity and reduce the risks of weather shocks, there is need for more concerted efforts to scale-out the use of improved seed varieties.

The study found farmers using conservation agricultural techniques such as mulching, minimum tillage and crop rotation in Kawambwa to cope with the changing climatic conditions. Farmers employed soil and water conservation techniques, highlighting the significance of preserving critical natural resources for long-term agricultural productivity. According to the study in Eastern Zambia by Umar (2021), smallholder farmers embraced conservation agriculture in order to cope with changing climatic conditions. Further, the use of mulching, crop rotation and reduced tillage were effective in improving soil health and water retention response to unpredictable rainfall patterns, according to studies by Bryan et al. (2019) in East Africa and Maponya and Mpandeli (2021) in Zimbabwe. These methods are known to improve soil fertility, retain moisture, and enhance crop yields, making them very effective for climate adaptation and sustainable food production. By

using these techniques, farmers demonstrate their commitment to sustainable farming practices in order to address the challenges presented by climate change and variability.

Another strategy that was found being implemented by smallholder farmers in Kawambwa is early planting. Early planting allows crops to benefit from early rains, reducing the risk of crop failure caused by unpredictable rainfall patterns. According to Charlotte et al. (2022), one of the meaningful strategies to respond to climate change at farm level is reallocating plating times to coincide with the onset of the rainy season. The practice of early planting is possible in Kawambwa as the district is known for having an early onset of rains, though this appears to be changing (Kawambwa Town Council, 2023). This means that timely and accurate climate information should be provided to support farmers' decision to reallocate planting time (Mpundu and Shichilima, 2020). This emphasizes how important it is to provide farmers with access to climate information, especially in rural areas whose agriculture is mainly rain fed.

This study has revealed that some smallholder farmers in Kawambwa are using, though the majority are still using traditional methods and at a small-scale, irrigation as an adaptation strategy to mitigate the effects of climate change. Those with resources have been able to drill boreholes and install drip irrigation networks while others rely on shallow wells and surface water by channeling water into their fields using furrows or earthen canals. This allows them to engage in farming activities when the district experiences dry spells, and they are able to cultivate crops all year round, though on a small plot of land. This study has found that few people are using irrigation techniques in the district. These results of low irrigation adoption in Kawambwa are similar to those of Binswanger-Mkhize and Savastano (2017) for Malawi, Tanzania, Niger, Nigeria, Ethiopia, and Uganda, and Ngoma et al. (2019) for Zambia. Despite the fact that irrigation plays a vital role in agricultural intensification, the low adoption levels found in this study highlights the high cost of irrigation infrastructure investments. This should bolster investments in irrigation development rather than decrease them.

5.3 Key Factors Influencing Adoption of Climate Change Adaptation Strategies

The results of the logistic regression analysis provide valuable insights into the main factors influencing the adoption of climate change adaptation strategies by farmers in

Kawambwa District. Farmers' decisions are greatly influenced by various factors, including access to climate information, access to finance or credit, extension services, perceived impact of climate change and farming experience. Additionally, although moderately, level of education and farm size also have a positive influence on farmers' adoption decisions.

As revealed by the study, having access to financial resources is one of the critical factors in adopting or implementing climate change adaptation strategies. Access to credit or financial resources reduces the economic barriers associated with implementing new adaptation technologies or practices such as drought resistant seeds and irrigation systems. This is in line with research by Asfaw et al. (2019) and Ouédraogo et al. (2021), which highlighted the importance of financial capital in overcoming the costs associated with acquiring improved inputs or installing infrastructure. With financial support, farmers are able to take calculated risks and invest in long-term resilience measures. In order to remain resilient to climate change, the study found that farmers who had access to financial resources or loans were more likely to implement strategies like irrigation, the use of drought-resistant seeds and diversifying their livelihoods to include livestock-related activities. This is similar to the findings of the study conducted in Ghana by Hirons et al. (2018), which showed that financial measures provide a safety net that allows farmers to invest in adaptive measures and be able to quickly recover from climatic shocks. This demonstrates how crucial financial mechanisms are in the adoption of climate change adaptation strategies and the reduction of risks related to climate change. It helps make sustainable agricultural practices possible.

With a p-value of 0.004 and an odds ratio of 2.34, the study shows that access to climate information is another significant factor influencing farmers' willingness to adopt climate change adaptation behaviors. The findings of this study support other studies that have suggested that lack of access to climate information services is one of the major obstacles to the adoption of climate adaptation technologies, and that availability of climate-related information provides a promising avenue for scaling up and out climate adaptation technologies (Autio et al., 2021; World Meteorological Organization (WMO), 2021). Farmers are better able to anticipate weather changes and make informed decisions

when they have access to timely and accurate climate data. The finding of this study is in line with literature that highlights the value of information dissemination systems in rural communities to enhance the resilience of livelihoods and food systems (Hansen et al., 2011). To support climate change adaptation, strengthen climate resilience and improve sustainable livelihoods, climate information is essential (WMO, 2021). In order to improve the adaptive capacity of farmers, timely and accurate climate information must be made available so that farmers can effectively plan their farming activities and make decisions regarding planting dates, crop types and seed variety selection.

Farmers who regularly received extension support services were much more likely to implement a variety of adaptation strategies, such as conservation farming and agroforestry. Extension officers play a crucial role as facilitators by offering technical knowledge, demonstrating new techniques, and connecting farmers with available resources. Bryan et al. (2019) similarly reported that having access to extension services significantly improves the ability of a farmer to adapt to climate change by increasing their knowledge of effective practices and available support systems. Extension contact provides an opportunity for farmers to obtain timely information about seasonal climate forecasts and best sustainable farming practices so that they can make better informed farming decisions and adjust to changing environmental conditions (Enujeke and Ofuoku, 2012). Improving farmers' access to extension services could greatly increase their knowledge of risks associated with changing climatic condition, as well as adaptation strategies they can employ to respond to climate variability and change. This emphasizes how important extension services are in increasing adoption rates of adaptation strategies. Therefore, the focus should be on improving the effectiveness of extension services especially to smallholder farmers.

This study has also found that farmers' adoption of adaptation measures is significantly influenced by their perceptions of climate change and climate risks. This supports the findings of a study by Talanow et al. (2021), which indicated that farmers' beliefs and perceptions about climate change affect their willingness to implement adaptive measures. Further, Nzeadibe and Ajaero (2010) analyzed how perception is arguably connected to one's level of awareness and availability of information on a phenomenon.

Farmers are more likely to respond to observed changes if they are aware of changes in climatic conditions and how they look at the impact of the changes. This shows promoting adaptive behaviour may depend on raising farmer's awareness, understanding and perception of climate change and the risks it poses. This demonstrates how important awareness campaigns and localized evidence of climate change impacts are to enhancing farmers' understanding of the threats posed by climate change and in encouraging adaptation behavioral change.

This study shows that farming experience is another element that influences farmers' adoption of climate change adaptation practices. Farmers with more experience are likely more knowledgeable about climate variability and are better able to implement effective strategies. Farmers become more knowledgeable and have a better understanding of the changes in the environment as they gain experience. The findings of the study by Adger et al. (2005), which stated that practical knowledge and familiarity with farming challenges improve adaptive capacity, are supported by this result. Therefore, adaptation strategies should make use of the knowledge and insights of seasoned farmers. Among farmers, peer to peer learning should be encouraged.

Other studies, however, have found a negative relationship between farmer experience and adoption of adaptation strategy. The study by Hassan et al. (2023) observed that experienced farmers are more inclined towards traditional methods than modern agricultural practices, so they are not interested to take improved technologies regarding climate change. The level of awareness about certain adaptation strategies can explain the variations. For instance, the relatively lower adoption of agroforestry in Kawambwa may be due to lack of knowledge or understanding of its long-term benefits. Studies such as Ajayi et al. (2018), emphasize the importance of targeted awareness campaigns and community trainings focused on promoting adaptation practices and the benefits of implementing these practices.

The level of education also emerged as one of the predictors of adaptation strategy adoption, though moderately. Educated farmers were more likely to implement improved agricultural technologies such as irrigation, conservation farming and agroforestry. This result is consistent with studies by Deressa et al. (2019) and Bryan et al. (2019), which

showed that farmers with higher levels of education are better able to understand and correctly implement technological adaptation strategies. Additionally, it is consistent with the study by Doherty et al. (2021) which found that more educated farmers are more likely to use innovative techniques. This association may be explained by the ability to process information, access technical training and comprehend policy incentives. Since education has been shown to positively play a role in the adoption adaptation measures, there must be continued promotion and support of it in farming communities.

Adaptation decisions were also moderately influenced by the size of farmland. The study showed that who owned larger farms (at least 10 hectares) were more likely to implement diverse adaptation strategies as compared to those with smaller farms. Larger landholdings allow for the experimentation of strategies such as crop diversification, agroforestry, and diversification into other livelihood activities like fish farming and livestock production, which may not be practical on smaller plots. Similar results were reported by Nhemachena and Hassan (2018), who found a positive correlation between farm size and adaptation implementation because of availability of resources on land and economies of scale. Ochieng et al. (2017) also argued that farm size presents the diversity in adaptive capabilities, as larger farms usually have more resources for adaptive strategies into practice.

This study has shown how various factors influencing the adaptive practices among smallholder farmers in Kawambwa District in responding to climate change and variability. This emphasizes the necessity of a comprehensive approach that takes into account various factors, ranging from socio-demographic characteristics to institutional and financial resources.

5.4 Challenges Faced by Farmers in Implementing Climate Change Adaptation Strategies

The study identified a number of significant challenges that hinder farmers in Kawambwa District from implementing climate change adaptation measures. These challenges include financial constraints, limited access to resources and services, inadequate climate information, poor infrastructure, and institutional barriers.

Lack of financial resources was noted as one of the main issues, with many farmers pointing to the high cost of inputs such as improved seed varieties, irrigation equipment, and fertilizers as obstacles. Many farmers in this study reported that financial barriers remain a significant hurdle, suggesting that existing institutional programs are either insufficient or not effectively reaching those who need them most. The practice of small-scale farming and limited access to affordable credit facilities makes the problem worse. This aligns with the findings from Manda et al. (2019), who highlighted that smallholder farmers often struggle with high borrowing costs, limited collateral, and bureaucratic hurdles when accessing financial support. Further, Asfaw et al. (2019) reported similar findings, highlighting that the capacity of farmers to invest in adaptive practices is hampered by financial limitations. Targeted subsidies or affordable financing options designed for small-scale farmers are needed to address this issue. Farmers' adaptation decisions are significantly influenced by economic factors. Implementation of adaptation technologies may be hampered by financial constraints in Kawambwa, where the majority of farmers practice small-scale farming.

Farmers also reported issues related to limited access to agricultural extension services and inputs required for the implementation of strategies such as conservation agriculture and agroforestry. The slow adoption of effective adaptation practices was because extension visits conducted are not frequent and training programs are not adequately covered due to limited time spent with farmers by extension agents. This supports the findings of Bryan et al. (2019), who pointed out that farmers' awareness and technical ability to adapt to climate change are limited by weak extension networks. Further, according to Lobogurrero et al. (2021), this lack of sustained engagement and technical assistance, called institutional gap, hinders the actual implementation of adaptation practices. According to Loboguerrero et al. (2021), ongoing farmer engagement and post-training support are critical for long-term adoption of climate adaptation measures. Without proper follow-up, farmers may struggle to apply new techniques, leading to low adoption rates and ineffective implementation of adaptation strategies. In some parts of Kawambwa, limited access to extension support services and programs may have contributed to the lower adoption rates of practices like agroforestry. This is attributed to the vastness and number of communities that each extension officer or agent has to

serve, which leads to less contact periods with farmers, thereby compromising the quality of technical assistance provided to them.

Lack of timely and accurate climate information was noted as a significant challenge by respondents, with many citing irregular or unreliable forecasts as a major hindrance. Farmers find it difficult to plan and carry out adaptation measures like early planting or which type of seed variety selection when they lack accurate information on weather patterns. Similar to this finding, a study by Ayanlade et al. (2020) highlighted how important reliable climate information is to making adaptation choices. There is need to enhance the dissemination of climate information to smallholder farmers through a variety of channels. For the sake of making appropriate decisions and at the right time, the information must be accurate and disseminated in timely manner.

Infrastructure issues, such as inadequate irrigation systems and road networks, were noted as barriers to the implementation of climate change adaptation practices. The absence of irrigation infrastructure limits water access during dry prolonged periods, thereby reducing the effectiveness of strategies like the use of drought-resistant seed varieties. Poor road networks make it more difficult for farmers to transport inputs and farm produce, which further complicates adaptation efforts. This challenge is consistent with findings from Ouédraogo et al. (2021), which showed that farmers' ability to put into practice resilience measures is hampered by a lack of or inadequate infrastructure.

The study has identified institutional challenges such as bureaucratic inefficiencies and a lack of supportive government policies as a hindrance to adaptation efforts. Gaps in program outreach and implementation were highlighted by the fact that many farmers were either unaware of or unable to take part in government-led adaptation programs. This finding is supported by Deressa et al. (2019), who pointed out that weak institutional frameworks often limit the effectiveness of adaptation initiatives. Research suggests that strong institutional frameworks are essential in facilitating climate adaptation by providing farmers with the necessary information with respect to available adaptation programs that are intended to benefit farmers (Agrawal and Perrin, 2020). Effective government policies, combined with NGO and private sector partnerships, can ensure that adaptation information and programs reach vulnerable farming communities.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

The findings of this study have been thoroughly discussed in the previous chapter with reference to farmers' awareness of climate change, some of the main adaptation strategies being implemented in Kawambwa, the factors influencing their adoption, and the challenges encountered in the adoption of adaptation practices. This chapter presents the conclusions and recommendations of the study. The section on conclusions gives a summary of the findings as discussed in chapter five, recommendations are made based on the findings.

6.1 Conclusions

The study aimed to assess the level of awareness of climate change, identify key adaptation strategies, analyze the factors influencing the adoption of these strategies, and investigate the challenges faced by farmers in implementing them in Kawambwa District. According to the findings, farmers in Kawambwa District demonstrated a high level of awareness of climate change, with the majority reporting noticeable changes in weather patterns such as increased temperatures, reduced rainfall and unpredictable rainfall patterns. This increased awareness suggests that farmers are aware of how the changing climate, likely due to direct experiences of how it affects their agricultural activities.

The study identified a number of adaptation strategies being implemented by farmers, which included crop diversification, the use of drought-resistant seeds, conservation agriculture and irrigation techniques. While these strategies demonstrate proactive attempts by farmers to cope with climate variability, their adoption rates varied based on resource availability and institutional support, among other factors. Early planting and agroforestry were also cited by farmers as effective measures, indicating a preference for strategies that are less resource-intensive and align with traditional practices.

Education level, farmland size, financial resources, climate information and extension services all were found to have a significant influence on adoption of climate change adaptation strategies. Access to credit and extension services facilitated the adoption of successful practices, and farmers with higher levels of education and larger farms were

more likely to implement improved agricultural technologies. Demographic characteristics like marital status and farming experience showed less significance, highlighting the crucial role that structural and institutional factors play in motivating adaptation. While being married may provide social support, it does not necessarily translate into increased adoption of climate adaptation strategies. Decision-making on adaptation is often influenced more by economic, educational, and institutional factors. Further, more experienced farmers may rely on traditional knowledge rather than adopting new climate-smart practices. This can lead to resistance to change, making farming experience less significant in influencing adaptation.

Nonetheless, farmers faced several challenges in implementing adaptation strategies, including financial constraints, inadequate access to agricultural inputs and extension services, lack of climate information, and inadequate infrastructure such as irrigation systems. Further, adaptation efforts were hindered by institutional barriers, such as low awareness levels of government adaptation programs and thus less participation of farmers in such programs. The challenges mentioned here, highlight how complex it is to achieve widespread adaptation in the agriculture sector.

6.2 Recommendations

In light of the key findings, the following recommendations are made in order to effectively improve the adoption of climate change adaptation strategies among farmers:

i. Although farmers in Kawambwa are conscious of climate change, more comprehensive climate education initiative are needed. Increasing knowledge of climate change impacts, the science behind it, and the long-term benefits of implementing adaptive strategies. Should be the main focus of awareness campaigns, extension services and community-based trainings. There must be sustained follow-up efforts in agricultural training programs, such as periodic visits from extension officers, peer learning opportunities, or refresher workshops to ensure that farmers can successfully adopt new practices.

ii. Farmers should have easier access to affordable credit, as well as grants, to support their implementation of adaptation measures like irrigation, soil conservation, and the buying of improved seed varieties. In partnership with government, financial institution

should tailor their products and services to meet the specific needs of smallholder farmers in particular. Further, there must be improved coordination between government and NGOs. Multi-stakeholder partnerships must be strengthened to integrate private-sector funding, technological innovations, and capacity-building initiatives.

iii. The study emphasized the role extension services play in promoting climate change adaptation. It is essential to increase the reach and coverage of agricultural extension officers, especially in remote areas. Providing trainings to extension officers in climate-resilient practices and equipping them with up-to-date climate information will enable them to be more effectiveness in providing technical assistance to farmers. Further, to improve institutional support, government should increase the number of extension officers to ensure regular farm visits to provide technical support. Increased contact between extension staff and farmers will address the issue of low awareness levels of government programs as information regarding government programs will be disseminated by extension officers to farmers.

iv. In order for farmers to make better informed decisions, they require timely and accurate climate information. Farmers can plan better if climate information systems are strengthened and weather forecasts are disseminated via easily accessible channels. There is need to leverage digital platforms like mobile applications, radio, and SMS alerts to disseminate real-time weather updates.

v. Farmers' ability to implement adaptation strategies would be greatly increased by providing adequate infrastructure such as roads, irrigation systems and storage facilities. Investing in rural infrastructure by the public and private sectors is essential to reducing farmers' vulnerability to the impacts of climate change.

vi. Government policies should be designed to give farmers more direct support in adapting to climate change. This includes implementing and expanding current efforts for adapting to climate change, offering technical assistance and making sure that policies are inclusive and farmer-friendly. To make sure these policies are meeting farmers' needs, it will be helpful to monitor and assess their effectiveness.

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APPENDICES

Appendix I: Questionnaire

Section A: Data on Demographics

1. Age Range:

[ ] 18 to 25 [ ] 26 to 35 [ ] 36 to 45 [ ] 46 to 55 [ ] 56 and above

2. Gender:

[ ] Male [ ] Female

3. Level of Education:

[ ] Absence of formal education [ ] Primary Level [ ] Secondary [ ] The Tertiary

4. Marital Status:

[ ] Unmarried [ ] Married [ ] Widowed [ ] Divorced or Separated

5. Farmland Size (in hectares):

[ ] Less than 1 [ ] 1 to 5 [ ] 6 to 10 [ ] Over 10

6. Years of Experience in Farming:

[ ] Less than 5 years [ ] 5 to 10 years [ ] 11 to 20 years [ ] Over 20 years

7. Main Source of Income:

[ ] Agriculture [ ] Other (Specify) _____

Section B: Perception of Climate Change

8. In the last 5 years, have you noticed any changes in weather patterns?

[ ] Yes [ ] No

9. If yes, what kind of changes have you observed? (Select all that apply)

[ ] A rise in temperature [ ] Decreased rainfall [ ] Unpredictable rainfall patterns

[ ] Droughts [ ] Floods [ ] Other (specify) _____

10. How do you think these changes will affect your farming activities?

[ ] Very negative [ ] Somewhat negative [ ] No impact [ ] Positive impact

Section C: Strategies for Adaptation

11. Do you use any strategies to adapt to changes in weather patterns?

[ ] Yes [ ] No

12. If yes, which of the adaptation strategies from the list below are you using? (Select all that apply)

[ ] Crop diversification [ ] Use of drought-resistant seed [ ] Irrigation

[ ] Conservation agriculture (e.g., mulching, no-till) [ ] Agroforestry

[ ] Soil and water conservation techniques [ ] Early planting

Other (specify) _____

13. How effective do you find these coping strategies for dealing climate change?

[ ] Very effective [ ] Effective [ ] Somewhat effective [ ] Not effective

Section D: Access to Resources and Services

14. Do you have access to weather forecasts and other climate information?

[ ] Yes [ ] No

15. How often do you receive information about climate?

[ ] Daily [ ] Weekly [ ] Monthly [ ] Rarely [ ] Never

16. Where do you get most of your climate information? (Check all that apply)

[ ] Radio [ ] TV [ ] Mobile apps/SMS[ ] Extension officers/Agents

[ ] Community meetings [ ] Other (specify) _____

17. Are agricultural extension services available to you?

[ ] Yes [ ] No

18. Do you have access to loans of other financial resources for farming?

[ ] Yes [ ] No

19. If yes, how often do you access financial services for farming?

[ ] Frequently [ ] Occasionally [ ] Rarely [ ] Never

Section E: Barriers to Climate Change Adaptation

1. What challenges do you face in adapting to climate change? (explain)
2. What kind of support would help you better adapt to climate change? (Explain)
3. Do you know of any government policies or programs that support farmers in adapting to climate change? If yes, have you participated in any government-led climate change adaptation programs?
4. How do you rate the support provided by the government in helping farmers with climate change adaptation?
5. In your opinion, what are the most effective strategies for assisting farmers adapt to climate change?
6. What changes would you suggest to help farmers become more resilient to climate change?

THANK YOU FOR YOUR PARTICIPATION!

Appendix II: Informed Consent Form

Title of Research: Assessment of Factors Associated with Climate Change Adaptation by Farmers in Kawambwa District

Introduction

You are being invited to participate in a research study that aims to assess the factors associated with climate change adaptation by farmers. Before you decide whether or not to participate, it is important that you understand why the research is being conducted and what it will involve.

Purpose of the Study

The purpose of this study is to investigate the various factors influencing farmers' ability to adapt to the changing climate. The study seeks to identify strategies currently employed by farmers and the barriers they face, as well as to evaluate how access to resources and government policies affect their adaptation efforts.

Objectives

The specific objective of the study is to assess the factors associated climate change adaptation among farmers of Kawambwa district.

Procedure

If you agree to participate in this study, you will be asked to answer questions related to your experiences with farming and your adaptation strategies to cope with changing climate conditions. The data collection will take place through face-to-face interviews using a questionnaire. The interview will take approximately 30 minutes. Your participation is voluntary, and you can choose to stop the interview at any time without any consequences.

Risks

There are no major risks associated with participating in this study. However, some of the questions might make you reflect on personal issues regarding your farming practices. Should you feel uncomfortable answering any question, you are free to skip that question or withdraw from the study entirely without any penalties.

Benefits

By participating in this study, you will contribute valuable information that may help improve farming practices in the face of climate change. Your responses will provide insights that could inform policy decisions and the design of support programs aimed at helping farmers like you to adapt better to climate change. While you may not receive any immediate personal benefits, your input will potentially contribute to improving agricultural resilience for the wider community.

Confidentiality

All the information you provide will be kept strictly confidential. Your identity will not be revealed at any point during or after the study. Data will be anonymized and used only for research purposes. Only the research team will have access to the data, and it will be securely stored. Any reports or publications resulting from this study will not include any information that could identify you.

Voluntariness

Participation in this study is entirely voluntary. You are under no obligation to participate, and you are free to withdraw from the study at any time without giving any reason. Your decision whether or not to participate will not affect your relationship with any organization or institution associated with the study.

If you have any questions or concerns regarding the study, please feel free to ask.

I voluntarily agree to participate in this research program

[ ] Yes [ ] No

I understand that I will be given a copy of this signed Consent Form

Name of Participant: …… Signature: …….

Date: ……..

Person Obtaining Consent: ……. Signature: ……

Date: ……

Thank you for considering participating in this research. Your contribution is highly appreciated!