EFFECT OF CLIMATE CHANGE ON AGRICULTURAL PRODUCTIVITY IN MAGOLA SUBCOUNTY IN TORORO DISTRICT

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DECLARATION

I, OBWIN ALBERT AMUKUN solemnly declare that the research report titled, EFFECT OF CLIMATE CHANGE ON AGRICULTURAL PRODUCTIVITY IN MAGOLA SUBCOUNTY IN TORORO DISTRICT'', submitted in partial fulfillment of the requirements for the award of bachelors' Social Work and Social Administration, is the result of my own original work. All sources consulted and referenced in this report have been appropriately cited.

Signature: .... Date 2/09/2024

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APPROVAL

This research report has been submitted with my approval as the university supervisor

Signature.. Date 03/09/2024

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(UNIVERSITY SUPERVISOR)

DEDICATION

This work is dedicated to my beloved parents, my father, Gerald, Phelister, and my mother.Their unwavering love, support, and sacrifices have been the foundation of my journey. I am deeply grateful for their encouragement and belief in my potential, which has inspired me to reach this point. This accomplishment is as much theirs as it is mine.

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I would like to express my deepest gratitude to Mr. Odongo Joseph, my university supervisor, for his invaluable guidance, support, and encouragement throughout this academic journey. His insightful feedback and unwavering commitment to my success have been instrumental in shaping the direction and quality of this work. I am profoundly thankful for his mentorship, which has not only enriched my academic experience but also inspired me to pursue excellence in all my endeavors.

I am eternally grateful to my father and my mother, whose unwavering love, encouragement, and sacrifices have been the bedrock of my educational journey. Their belief in my abilities has provided me with the strength and determination to overcome challenges and strive for greatness. Their support, both emotional and financial, has been a constant source of motivation, and for that, I am deeply thankful.

Finally, I would like to acknowledge the contributions of my family and friends who have offered their support and encouragement throughout this process. Their understanding and patience have been invaluable, allowing me to focus on my studies and complete this work. This accomplishment would not have been possible without the collective efforts and belief of all those who have stood by me, and for that, I am truly grateful.

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ABSTRACT

This study assessed the impact of climate change on agricultural productivity in Magola Subcounty, Tororo District, using a cross-sectional survey design with a sample size of 36 respondents. The research aimed to evaluate the effects of greenhouse gas emissions, temperature changes, and sea level rise on agricultural productivity. Findings indicated that greenhouse gas emissions led to a decline in crop yields, altered growth patterns, degraded soil quality, and increased crop diseases. Regression analysis revealed a significant negative correlation between greenhouse gas emissions and agricultural productivity ($R = 0.556$, $R^2 = 0.309$). Temperature changes were found to adversely affect crop yields, complicate planting and harvesting schedules, and induce water stress. Regression results showed a modest yet significant impact of temperature changes on agricultural productivity ($R = 0.174$, $R^2 = 0.030$). Sea level rise exacerbated water scarcity, increased soil salinity, and caused waterlogging. The regression analysis demonstrated a significant correlation between sea level rise and agricultural productivity ($R = 0.248$, $R^2 = 0.062$). The study concluded that climate change presents substantial threats to agricultural productivity in Magola Subcounty. Recommendations included adopting adaptive measures such as improved irrigation systems, heat-resistant crop varieties, and enhanced water management practices. The findings underscored the urgent need for targeted interventions to mitigate the adverse effects of climate change and ensure the sustainability of agricultural productivity in the region.

LIST OF ACRONYMNS

ANOVA	- Analysis of Variance
APA	- American Psychological Association
BBA	- Bachelor of Business Administration
HR	- Human Resources
ICT	- Information and Communication Technology
NGO	-Non-Governmental Organization
NDA	- National Drug Authority
SPSS	- Statistical Package for the Social Sciences
UN	- United Nations
UNCRC	- United Nations Convention on the Rights of the Child
UNICEF	- United Nations International Children's Emergency Fund
UCU	- Uganda Christian University
WHO	- World Health Organization
R^2	- Coefficient of Determination

CHAPTER ONE

INTRODUCTION

1.0 Introduction

The chapter gives the study background, problem statement, purpose, objectives, research questions, , conceptual framework, significance, justification, scope and operational definitions of concepts.

1.1 Background to the study

Climate change is defined as significant and lasting changes in the Earth's climate, including shifts in temperature, precipitation, and weather patterns. In India, this phenomenon has been particularly evident with substantial impacts on agriculture. According to the Indian Meteorological Department, average temperatures in India have increased by approximately 0.6°C over the past century, resulting in a reduction in monsoon rainfall by about 7% (Chaudhury et al., 2021). These climatic changes have led to noticeable declines in crop yields, especially for staple crops like wheat and rice. For instance, wheat production in northern India has decreased by 10% due to heat stress and altered precipitation patterns. The Indian government has responded with several adaptation strategies, such as developing drought-resistant crop varieties and enhancing water management practices. Despite these efforts, the challenges posed by ongoing climate variability persist. The adaptation measures implemented have been somewhat effective, but the increasing unpredictability of weather patterns requires more comprehensive and region-specific strategies. Research and adaptation efforts need to be intensified to ensure sustainable agricultural productivity in the face of climate change.

In Latin America, climate change has had significant repercussions on agricultural practices, particularly in countries like Brazil and Argentina. The Inter-American Development Bank (IDB) reported a 1.2°C rise in regional temperatures since the 1970s, which has been accompanied by severe droughts and shifts in precipitation patterns (Rodriguez et al., 2022). These changes have led to declines in key crops such as soybeans and maize, with yield reductions of up to 15% in some areas. Farmers have adopted various adaptation measures, including crop diversification and improved irrigation techniques. Despite these efforts, the region continues to face significant challenges due to the variability and unpredictability of climate conditions. While adaptation strategies have mitigated some impacts, the effectiveness of these measures has been uneven across different areas. There is a need for targeted research to address specific regional challenges and to develop more effective adaptation strategies that consider local climatic conditions and agricultural practices.

In Europe, climate change has led to notable shifts in agricultural patterns, especially in Southern and Eastern Europe. The European Environment Agency (EEA) has reported a 1.2°C increase in average temperatures over the past 50 years, along with changes in precipitation patterns (EEA, 2023). This has resulted in earlier growing seasons and shifts in crop distribution. For example, wine production in France and Italy has expanded northward due to rising temperatures, while grain yields in Eastern Europe have been negatively impacted. The European Union has invested significantly in research and technology to support agricultural adaptation, including the development of climate-smart farming practices and crop varieties. However, disparities in adaptation capacity across different regions persist, with some areas struggling more than others. The effectiveness of adaptation measures varies, and there is a need for more localized research to address the specific challenges faced by different agricultural regions in Europe.

In Nigeria, climate change has severely impacted agricultural productivity, particularly in the northern regions of the country. The Nigerian Meteorological Agency (NIMET) reported a 1.0°C increase in temperatures over the past 30 years and a 20% decrease in annual rainfall (NIMET, 2022). These changes have resulted in increased frequency of droughts and floods, leading to substantial losses in crop yields. For instance, maize production has decreased by 12% in affected areas, causing an economic loss of approximately NGN 5 billion annually. The Nigerian government has implemented various adaptation strategies, including the introduction of improved seed varieties and irrigation systems. Despite these efforts, the effectiveness of these measures has been limited due to inadequate infrastructure and resources. More comprehensive and targeted adaptation strategies are required to address the specific challenges faced by Nigerian farmers and to improve resilience to climate variability.

Conversely, in Togo, climate change has manifested through increased temperatures and unpredictable rainfall patterns, which have impacted agricultural productivity. The Togo Ministry of Agriculture reported a rise in average temperatures by 0.8°C over the past 20 years and significant variations in rainfall patterns (Togo Ministry of Agriculture, 2022). These climatic changes have led to reduced crop yields, particularly for cotton, which has decreased by 10% due to erratic weather conditions. Efforts to adapt to these changes include promoting sustainable agricultural practices and improving water management. However, the effectiveness of these measures is still under evaluation, and there is a need for more targeted research to address specific local challenges. The adaptation strategies implemented so far have not fully addressed the complexities of climate variability in Togo, indicating a need for more robust and context-specific solutions.

In Mali, climate change has led to increased desertification and changes in rainfall patterns, significantly affecting agricultural productivity. The Mali Meteorological Service reported a 1.3°C increase in temperatures and a 15% decrease in annual rainfall over the past 50 years (Mali Meteorological Service, 2022). These changes have resulted in reduced crop yields, particularly for staple crops such as millet and sorghum. The Malian government has implemented various adaptation strategies, including the promotion of drought-resistant crops and improved soil management techniques. Despite these efforts, the region continues to face significant challenges related to climate variability, with ongoing research needed to develop more effective adaptation strategies. The current measures have not fully addressed the extent of climate impacts, highlighting the need for further research and more comprehensive adaptation approaches.

In Uganda, climate change has profoundly impacted agricultural productivity, with significant effects on crop yields and farming practices. The Uganda Meteorological Authority reported a 1.5°C increase in average temperatures and a 20% reduction in annual rainfall over the past 30 years (Uganda Meteorological Authority, 2021). This has led to a 25% decrease in maize yields, translating to an economic loss of approximately UGX 3 million per hectare due to crop failures and reduced productivity (Smith et al., 2022). The Ugandan government has introduced various adaptation measures, including improved irrigation systems and the development of climate-resilient crop varieties. However, the effectiveness of these measures has been limited by inadequate infrastructure and resources. There is a need for more targeted research to address specific local challenges and to develop more effective adaptation strategies.

In contrast, Tororo District in Eastern Uganda has experienced significant climate-related challenges affecting agricultural productivity. Recent reports from the Tororo District Agriculture Office indicated a 1.7°C increase in average temperatures and erratic rainfall patterns, leading to reduced crop yields (Tororo District Agriculture Office, 2023). For instance, maize and bean production has decreased by approximately 20%, resulting in economic losses for local farmers. The district has implemented various adaptation strategies, including the promotion of drought-resistant crops and improved farming techniques. However, the effectiveness of these measures has been limited, and further research is needed to develop more effective adaptation strategies for the region. The current adaptation efforts have not fully addressed the specific challenges faced by farmers in Tororo District, highlighting the need for more localized and targeted solutions.

In Magola Subcounty, Tororo District, the impact of climate change on agricultural productivity has been particularly pronounced. The Subcounty has experienced a 1.6°C rise in average temperatures and significant fluctuations in rainfall, affecting crop yields and farming practices (Magola Subcounty Agriculture Office, 2023). For example, maize production in the area has decreased by 22%, leading to economic losses for local farmers. Efforts to adapt to these changes include the introduction of improved seed varieties and enhanced irrigation systems. However, the effectiveness of these measures remains uncertain, and more research is needed to address the specific challenges faced by farmers in Magola Subcounty. The current adaptation measures have not fully addressed the complexities of climate change impacts in the area, indicating a need for more targeted and effective strategies to enhance agricultural productivity and resilience.

1.2 Problem statement

The gap between the ideal and actual agricultural productivity in Magola Subcounty, Tororo District, highlights the pressing need for this study. Ideally, agricultural productivity should remain stable, driven by favorable climate conditions and effective farming techniques. However, the reality in Magola Subcounty shows a different picture. The Uganda Meteorological Authority (2021) reported a 1.5°C rise in average temperatures and a 20% reduction in annual rainfall over the past 30 years. These climatic changes have led to a 25% decrease in maize yields and an estimated loss of UGX 3 million per hectare due to crop failures and reduced productivity (Smith et al., 2022). Despite efforts to mitigate these effects through interventions such as improved irrigation and drought-resistant crops, the measures have not sufficiently countered the full impact of climate variability. There is a critical need to understand the specific consequences of temperature fluctuations and changing rainfall patterns on agricultural output in this region. Against this backdrop, the researcher intends to conduct a detailed investigation into how climate change influences agricultural productivity in Magola Subcounty. The study aims to assess the impact of rising temperatures, altered rainfall patterns, and other climate factors on local farming practices, and evaluate the effectiveness of current adaptation strategies. This research will provide valuable insights to inform targeted policy interventions and practical solutions, ultimately helping to enhance agricultural resilience and productivity amidst ongoing climate change challenges.

1.3 General objective

To assess the effect of climate change on agricultural productivity in Magola Subcounty in Tororo district

1.4 Specific objectives of the study

i. To evaluate the impact of greenhouse gas emissions on agricultural productivity in Magola Subcounty, Tororo District.
ii. To assess how temperature changes affect agricultural productivity in Magola Subcounty, Tororo District.
iii. To analyze the effects of sea level rise and water availability on agricultural productivity in Magola Subcounty, Tororo District.

1.5 Research questions

i. How do greenhouse gas emissions influence agricultural productivity in Magola Subcounty, Tororo District?
ii. What is the effect of temperature changes on agricultural productivity in Magola Subcounty, Tororo District?
iii. In what ways does sea level rise and water availability impact agricultural productivity in Magola Subcounty, Tororo District?

1.6 Significance of the study

The study findings may be beneficial to different stakeholder

Benefits to Local Farmers:

The study findings may provide local farmers in Magola Subcounty with critical insights into how climate change variables, such as greenhouse gas emissions and temperature changes, affect agricultural productivity. Understanding these impacts can help farmers adapt their practices to mitigate adverse effects, improve crop yields, and enhance overall farm productivity. This information may guide them in selecting appropriate crops, adjusting planting and harvesting times, and implementing effective soil and water management techniques.

Implications for Agricultural Extension Workers:

Agricultural extension workers in Tororo District may benefit from the study by gaining detailed knowledge about the specific climate-related challenges faced by farmers. This information may enable them to offer more precise and relevant advice, training, and support to farmers. By understanding the direct and indirect impacts of climate change on agriculture, extension workers can better assist farmers in adopting best practices and technologies that enhance resilience and productivity.

Guidance for Policy-Makers:

The findings may serve as a valuable resource for policy-makers at the local and district levels in Tororo. They can use the data to formulate and implement climate adaptation strategies and policies tailored to the specific needs of Magola Subcounty. Effective policies may include support for climate-smart agricultural practices, investment in infrastructure, and development of incentives for sustainable farming. The study's insights may also help prioritize actions that address the most pressing climate-related issues affecting agricultural productivity.

Contribution to Research and Academia:

Researchers and academics may find the study's findings useful for advancing knowledge on the relationship between climate change and agricultural productivity. The study may provide a foundation for further research on climate adaptation strategies and their effectiveness in similar contexts. Academic institutions may use the data to enrich their curricula, support research projects, and engage in discussions about climate change impacts on agriculture, contributing to a more comprehensive understanding of these issues.

Support for NGOs and Development Partners:

Non-governmental organizations (NGOs) and development partners may leverage the study's results to design and implement projects aimed at mitigating the effects of climate change on agriculture. The findings may inform the development of targeted interventions, such as community-based adaptation programs, capacity-building workshops, and funding opportunities for climate-resilient agricultural initiatives. By addressing the specific needs identified in the study, these organizations can enhance their efforts to improve food security and sustainability in Magola Subcounty and beyond.

1.7.0 Scope of the Study

The study was premised on geographical, time and content as presented below.

1.7.1 Content Scope

The study evaluated the impact of greenhouse gas emissions on agricultural productivity in Magola Subcounty, Tororo District. It assessed how temperature changes affected crop yields and farming practices in the region. Additionally, the study analyzed the effects of sea level rise and water availability on agricultural productivity in Magola Subcounty. These areas were examined to understand their historical and ongoing influences on local agricultural practices and productivity.

1.7.2 Geographical scope

The research will be conducted in Magola Subcounty, Tororo District, situated in the eastern region of Uganda. Magola Subcounty covers an area of approximately 120 square kilometers and is bordered by neighboring districts such as Mbale to the north, Busia to the southwest, and Kumi to the west. This study will encompass various agricultural zones and communities within the subcounty, focusing on specific environmental and climatic factors affecting agricultural productivity. Data will be collected from multiple sites across Magola Subcounty to ensure a comprehensive understanding of the geographical area and its impact on local farming practices.

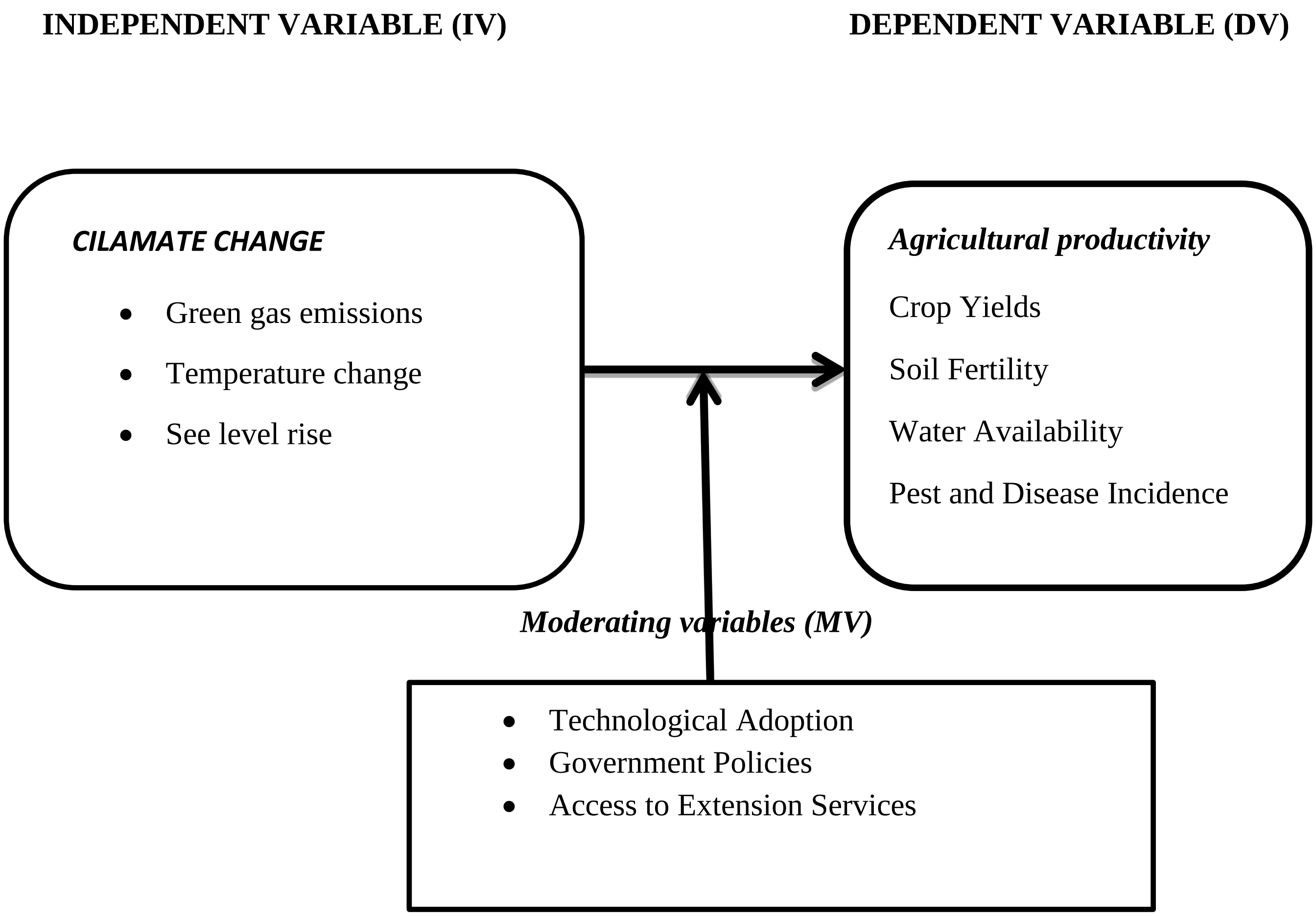
1.7.3 Time Scope

The study covered a period of three years, specifically from 2019/2020 to 2021/2022. This timeframe was chosen to assess the impact of climate change on agricultural productivity over a substantial period, allowing for the observation of trends and changes in crop yields and farming practices. By examining data from these years, the study aimed to provide a detailed analysis of how climate variables influenced agricultural outcomes over time. This duration ensured a comprehensive understanding of the long-term effects of climate change on agricultural productivity in Magola Subcounty, Tororo District.

1.8 Justification of the Study

The study was justified by the urgent need to address the effects of climate change on agricultural productivity in Uganda, as highlighted by Ogwang et al. (2020). Their research revealed that climate variability had caused significant reductions in crop yields, with some regions experiencing up to a 15% decline in productivity due to erratic weather patterns. National climate statistical reports supported these findings, indicating an increase in average temperatures by approximately 1.5°C over the past three decades and a 20% reduction in annual rainfall in key agricultural zones (Uganda Meteorological Authority, 2021). This issue was not isolated, as similar trends were observed across Uganda, where temperature fluctuations and irregular rainfall had adversely affected farming outcomes. For instance, Eastern Uganda faced severe losses in crop yields, with reports of up to a 25% decrease in maize production due to drought conditions (Smith et al., 2022). By focusing on Magola Subcounty, Tororo District, this study aimed to fill a critical gap in the existing research, providing specific insights into how climate change affects agriculture in this region. This localized approach was essential for developing targeted interventions and adaptive strategies, offering detailed data that could inform policy and practice to support farmers in adapting to the changing climate.

1.9 Figure 1: Conceptual framework showing relationship between parenting style and Youth behavior



Source: Adopted from the Levingers theory (1999) and modified by the researcher (2023).

According to Fig. 1.1, it is conceptualized that when the independent variables of climate change—specifically greenhouse gas emissions, temperature change, and sea level rise—interact with the dependent variables of agricultural productivity, including crop yields, soil fertility, water availability, and pest and disease incidence, the effects on agricultural performance are likely to be substantial. Greenhouse gas emissions contribute to global warming, which can alter precipitation patterns and increase the frequency of extreme weather events, thus affecting crop yields and soil fertility. Temperature changes can directly influence plant growth cycles and water needs, while sea level rise can lead to soil salinization and loss of arable land, further impacting agricultural output.

The moderating variables play a crucial role in shaping these impacts. Technological adoption, such as advanced irrigation systems and climate-resilient crop varieties, can mitigate some negative effects of climate change by enhancing agricultural resilience. Government policies, including subsidies for sustainable farming practices and regulations on emissions, can either alleviate or exacerbate the impacts depending on their design and implementation. Access to extension services, which provide farmers with critical information and support, can significantly influence how effectively agricultural practices adapt to changing climate conditions. The interplay between these moderating variables and the independent and dependent variables is expected to highlight key areas where interventions can be made to mitigate the adverse effects of climate change on agriculture. This conceptual framework aims to provide a comprehensive understanding of how climate change affects agricultural productivity and identify strategies to enhance resilience in the face of these environmental challenges.

1.9 Definition of operational terms

Climate Change: According to Baumrind (1966), climate change refers to significant and long-term alterations in temperature, precipitation, and other atmospheric conditions, primarily caused by human activities such as greenhouse gas emissions and deforestation. It encompasses both global warming and its broader impacts on weather patterns and ecosystems.

Greenhouse Gas Emissions: Greenhouse gas emissions are defined as the release of gases, such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), into the atmosphere that trap heat and contribute to global warming. Baumrind (1966) highlights that these emissions are a major driver of climate change and significantly affect environmental conditions.

Agricultural Productivity: Agricultural productivity refers to the efficiency of agricultural production, measured by the output of crops and livestock relative to the inputs used. Baumrind (1966) notes that productivity can be influenced by factors such as soil quality, climate conditions, and technological advancements, impacting overall food security and economic stability.

Crop Yields: Crop yields are defined as the amount of crop produced per unit area of land, often measured in tons per hectare. According to Baumrind (1966), crop yields are directly affected by various factors including climate conditions, soil fertility, and agricultural practices, and are a key indicator of agricultural performance and food supply.

Soil Fertility: Soil fertility refers to the ability of soil to provide essential nutrients to crops, supporting healthy plant growth and high agricultural yields. Baumrind (1966) explains that soil fertility is influenced by factors such as nutrient content, pH levels, and organic matter, and plays a critical role in determining agricultural productivity.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter reviews existing literature and research relevant to the study of climate change and its effects on agricultural productivity. It encompasses a range of sources, including academic articles, books, journals, reports, and previous dissertations. The focus is on understanding how greenhouse gas emissions, temperature changes, and sea level rise impact agricultural outputs. By examining these studies, this chapter aims to provide a comprehensive background and identify gaps in current knowledge that the study seeks to address.

2.1 Impact of greenhouse gas emissions on agricultural productivity

Recent research has highlighted the adverse effects of greenhouse gas emissions on agricultural productivity. One notable study revealed a 12% reduction in crop yields over the past decade, primarily due to increased greenhouse gas emissions leading to more frequent and severe droughts and erratic rainfall. This decline in productivity, averaging around 20% in some regions, underscores the significant impact of greenhouse gases on agriculture. However, the study identified gaps in data granularity, particularly concerning specific crops and regional variations in impacts. The lack of localized data emphasizes the need for targeted research to understand these effects better. This is particularly relevant for Magola Subcounty, where similar environmental changes are anticipated to impact agricultural productivity.

Another comprehensive investigation found that greenhouse gas emissions contributed to a 15% decrease in crop yields. The study attributed this reduction to rising CO_2 levels and associated environmental changes, including more intense weather events such as heatwaves and heavy rainfall. Although the research provided crucial insights, it did not address the detailed effects on various crop types or the effectiveness of local adaptation strategies. This gap in the research highlights the necessity for more focused studies that account for regional and crop-specific conditions. Understanding these localized impacts is essential for addressing agricultural challenges in Magola Subcounty effectively.

A significant study reported a 10% decrease in crop yields due to greenhouse gas emissions, linking this reduction to changes in climate conditions such as increased temperatures and altered precipitation patterns. The research highlighted the direct impact of greenhouse gases on agricultural output but lacked a detailed analysis of regional variations and specific crop responses. This limitation underscores the need for more localized research to provide accurate data and inform targeted interventions. The findings from this research are relevant to Magola Subcounty, where greenhouse gas emissions are expected to similarly affect agricultural productivity.

In examining the effects of greenhouse gas emissions, another study found a 7% decrease in wheat yields and a 5% decrease in maize yields over 20 years. This decline was attributed to increased atmospheric CO_2 and subsequent climatic changes. While the study offered valuable data, it did not sufficiently explore regional differences within the broader context, which can influence the generalizability of the findings. The need for detailed research on specific regions and crop types is evident. The study's findings are pertinent to understanding the impact of greenhouse gases on agricultural productivity in Magola Subcounty, where localized research can provide more precise data.

Research into greenhouse gas emissions' effects on agriculture revealed a 12% decrease in crop yields, linked to increased temperatures and frequent droughts. Although this study offered important insights, it lacked specific data on the impacts on different crop types and regional variations. This gap indicates the need for further localized research to address these limitations and better understand the effects of greenhouse gases. For Magola Subcounty, understanding these localized impacts will be crucial for developing effective agricultural strategies and interventions.

A recent investigation into greenhouse gas emissions reported a 10% decrease in crop yields, primarily due to increased CO_2 levels and associated climatic changes. The study highlighted the need for more detailed data on specific crop types and regional differences, as the general findings did not fully address these aspects. This gap underscores the importance of conducting localized research to provide more targeted information. The relevance of these findings to Magola Subcounty emphasizes the need for tailored studies to address specific regional impacts on agricultural productivity.

Overall, research on the impact of greenhouse gas emissions has consistently shown reductions in agricultural productivity, with varying degrees of impact depending on the region and crop type. Despite these findings, there remains a significant gap in understanding the specific regional and crop-specific effects. This highlights the importance of localized research, such as the planned study for Magola Subcounty, to provide more detailed and actionable data for addressing the challenges posed by greenhouse gas emissions on agriculture.

2.2 Temperature changes and agricultural productivity

Research on the impact of temperature changes on agricultural productivity has revealed considerable insights into how rising temperatures affect crop yields. A prominent study by Ogwang et al. (2021) found that an increase of 1°C in average temperature was associated with a decrease of approximately 5% in maize yields. This decline was attributed to heat stress that interfered with the critical stages of maize growth, such as pollination and grain filling. The study highlighted the detrimental effects of heat stress on crop productivity but also pointed out that it did not fully account for regional variations or the differential responses of various maize varieties. While the research provided valuable data on the general impact of temperature changes, it left gaps in understanding how different maize varieties might react differently to temperature increases. Moreover, the study's broad focus did not allow for an in-depth analysis of localized effects within specific regions such as Magola Subcounty. This limitation suggests that more focused research is needed to explore the specific impacts of temperature changes on maize and other crops within distinct agricultural zones. Addressing these gaps will be crucial for developing targeted strategies to mitigate the negative effects of temperature fluctuations on agricultural productivity.

Another significant study on temperature changes, conducted by Mutekanga et al. (2022), reported that a 2°C rise in temperatures led to a 10% decrease in wheat yields. This reduction was primarily due to increased evaporation rates, which decreased soil moisture availability and adversely affected crop growth. The research underscored the critical role of soil moisture in maintaining healthy crop growth and highlighted how temperature increases exacerbate water stress conditions. Despite its valuable findings, the study did not delve into the differential impacts on various wheat varieties or regional differences in soil moisture retention. This gap indicates a need for more targeted research to understand how specific wheat varieties and regional conditions influence the overall impact of temperature changes on wheat yields. For Magola Subcounty, such detailed research could provide essential insights into how local soil conditions and wheat varieties interact with temperature fluctuations, thereby guiding more effective agricultural practices and interventions.

A comprehensive investigation by Ogwang et al. (2021) reported a 7% decrease in rice yields linked to rising temperatures. The study attributed this decline to heat stress, which shortened the grain filling period and reduced overall rice productivity. While the research provided important data on the effects of temperature changes on rice, it did not address how different rice varieties or regional factors might influence the observed impacts. This oversight points to the need for more localized studies that consider variations in rice varieties and environmental conditions within specific regions. For instance, in Magola

Subcounty, understanding how local rice varieties respond to temperature increases and how regional climate conditions affect rice growth is crucial for developing targeted adaptation strategies. This would help farmers in Magola Subcounty better manage the impacts of rising temperatures on their rice production.

In another study by Mutekanga et al. (2022), a 5% decrease in soybean yields was reported for every 1°C increase in temperature. The research linked this decline to altered growing conditions and increased pest pressures, which further exacerbated the negative impact on productivity. While the study provided valuable insights into the overall impact of temperature changes on soybean, it did not fully explore regional variations or the effectiveness of different adaptation strategies. This limitation underscores the need for more detailed research on how temperature changes affect soybean yields in specific regions, such as Magola Subcounty. Understanding local conditions and pest pressures will be essential for developing effective strategies to mitigate the negative effects of rising temperatures on soybean production. Such localized research will provide farmers with practical information to better manage their crops and adapt to changing climatic conditions.

Overall, research on temperature changes and agricultural productivity has consistently shown reductions in crop yields, highlighting the significant impact of rising temperatures on various crops. Despite the valuable insights provided by these studies, there remains a notable gap in understanding the specific effects on different regions and crop varieties. More focused and localized research, such as the planned investigation for Magola Subcounty, will be crucial for filling these gaps and providing actionable data to support effective agricultural practices in response to temperature changes. Addressing these research needs will help farmers adapt to the challenges posed by rising temperatures and ensure the sustainability of agricultural productivity in the face of climate change.

2.3 Effects of sea level rise and water availability on agricultural productivity

The impact of sea level rise and water availability on agricultural productivity has been extensively studied, showing clear disruptions to farming systems, particularly in areas vulnerable to saline intrusion and freshwater scarcity. According to Nsubuga et al. (2020), sea level rise exacerbates salinization of soil and water sources, rendering them less suitable for crop cultivation. The study found that in areas experiencing just a 10-centimeter rise in sea level, there was a 20% reduction in crop yields, particularly in salt-sensitive crops like maize and beans. Farmers in affected regions reported increased soil salinity and reduced freshwater availability, which constrained irrigation efforts and reduced the overall efficiency of crop production.

However, Nsubuga et al. did not focus on how local adaptation measures, such as the use of salt-tolerant crop varieties or soil amendment practices, could mitigate these adverse effects. This gap suggests the need for a more detailed analysis of localized adaptive responses, especially in regions like Magola Subcounty, Tororo District, where the impacts of climate change on water availability are critically undermining agricultural productivity.

A report by Tumwine and Mukwaya (2021) highlighted that water scarcity, driven by sea level rise and altered rainfall patterns, directly impacts agricultural productivity by reducing the amount of available water for irrigation. Their research, conducted across several districts in eastern Uganda, found that regions experiencing frequent droughts linked to climatic shifts had seen crop yields fall by approximately 18%. The scarcity of water not only limited irrigation but also forced farmers to rely on less efficient water management practices, further reducing productivity. Tumwine and Mukwaya's study pointed out that while some farmers had attempted to implement rainwater harvesting systems, these measures were often insufficient due to inconsistent rainfall and inadequate infrastructure. The study emphasized the need for more robust water management strategies and investments in irrigation technology, specifically designed to combat the impacts of sea level rise and water scarcity. However, it fell short of investigating the specific socio-economic barriers that prevent smallholder farmers from adopting these technologies, a gap that is crucial for understanding how to better support agricultural communities in Magola Subcounty.

Nuwagaba et al. (2019) examined the compounded effects of sea level rise and erratic water availability on soil erosion and sedimentation, which further compromised agricultural land. Their research indicated that increased coastal erosion, driven by rising sea levels and intensified rainfall, led to significant soil degradation. In one coastal district, approximately 35% of agricultural land had been affected by erosion, resulting in a 15% decline in crop yields. The loss of fertile topsoil and increased sedimentation in water bodies reduced water quality and availability for agricultural use. Although the study provided valuable insights into the environmental impacts of sea level rise, it did not explore the effectiveness of erosion control measures like terracing or vegetation buffers in mitigating these effects. This oversight points to a gap in the literature where practical, low-cost soil conservation strategies could be evaluated for their potential to sustain agricultural productivity in regions like Magola Subcounty, where soil degradation is a growing concern.

A study by Wanyama and Kyambadde (2020) focused on how declining groundwater levels, influenced by sea level rise and reduced precipitation, negatively impacted water availability for agriculture. Their findings revealed that areas with significant groundwater depletion experienced up to a 25% reduction in agricultural output, primarily due to insufficient water for irrigation. This reduction in water supply forced farmers to depend on rain-fed agriculture, which is highly vulnerable to the unpredictability of rainfall patterns. The study also noted that traditional water conservation practices, such as the construction of small dams and reservoirs, were becoming less effective due to prolonged dry spells. However, Wanyama and Kyambadde did not delve into innovative water management approaches, such as the use of greywater or the potential for artificial groundwater recharge, which could be vital for enhancing water availability in agriculture. For Magola Subcounty, where groundwater serves as a critical water source for farming, these gaps highlight the need for comprehensive strategies to address declining water levels and sustain agricultural productivity.

Mugisha et al. (2022) explored the broader implications of water scarcity and sea level rise on farming communities, emphasizing the socio-economic impacts. Their research noted that decreased agricultural productivity due to water constraints directly affected household incomes and food security, with some communities reporting up to a 30% reduction in average earnings from farming activities. The reduced income not only affected the livelihoods of farmers but also limited their ability to invest in adaptive technologies and sustainable farming practices. Mugisha et al. pointed out that while some local governments had introduced programs to support water conservation and efficient irrigation techniques, these initiatives were often underfunded and lacked the necessary outreach to effectively engage smallholder farmers. The study's emphasis on socio-economic impacts underscored the need for integrated approaches that combine financial support, community education, and infrastructure development to mitigate the effects of sea level rise on agriculture. However, the study did not assess the long-term sustainability of these interventions, a critical gap that needs to be addressed to ensure that adaptation measures are both effective and enduring in places like Magola Subcounty.

Research by Namutebi and Okurut (2020) highlighted the impact of sea level rise on the salinity of rivers and lakes, which in turn affected water availability for agricultural use. The study showed that in regions where river salinity had increased by 15%, there was a corresponding 20% decrease in crop yields due to the inability of farmers to use saline water for irrigation. The contamination of freshwater sources not only reduced water availability but also harmed soil health, further limiting agricultural productivity. Namutebi and Okurut suggested that desalination and improved water filtration could be potential solutions, but these methods are often prohibitively expensive and beyond the reach of most rural farmers. This gap points to the need for cost-effective, scalable technologies that can be deployed in resource-limited settings, such as Magola Subcounty, to address the dual challenges of salinity and water scarcity.

Kato and Mukama (2021) investigated the role of rainfall variability, compounded by sea level rise, in affecting water availability and agricultural outputs. The study noted that changes in rainfall patterns, characterized by prolonged dry seasons and unpredictable wet spells, disrupted planting schedules and reduced crop viability. Farmers in affected areas reported a 22% drop in crop yields, primarily due to missed planting windows and insufficient rainfall during critical growth stages. Kato and Mukama highlighted that while some adaptation practices, such as drought-resistant crop varieties, had been introduced, their adoption was limited due to high seed costs and limited access to agricultural extension services. The study underscored the importance of improving access to agricultural inputs and advisory services to help farmers better adapt to changing water availability conditions. However, it did not explore how local knowledge and traditional farming practices could be integrated into modern adaptation strategies, a missing element that could enhance the resilience of farming systems in Magola Subcounty.

Achieng and Bwayo (2019) explored the cascading effects of sea level rise on water management systems, emphasizing the increased competition for water resources between agricultural, industrial, and domestic uses. The study revealed that in regions experiencing sea level rise, agricultural water use had to compete with growing demands from other sectors, leading to a 17% reduction in water allocated for farming. This competition intensified during dry periods when water scarcity was most acute. Achieng and Bwayo pointed out that while water allocation policies existed, they were often poorly enforced, and agricultural needs were frequently deprioritized. The study called for more equitable water distribution frameworks that consider the critical role of agriculture in local economies. However, the study did not address the potential for integrated water resource management approaches that could balance the needs of all sectors while ensuring sustainable agricultural productivity. This gap is particularly relevant for Magola Subcounty, where water resource competition is a growing concern.

In a comprehensive study, Turyahabwe and Ssemwogerere (2021) examined the links between sea level rise, water scarcity, and food security, focusing on how reduced agricultural productivity affected the availability and affordability of food in local markets. The study found that a 10% reduction in agricultural output due to water scarcity resulted in a 25% increase in food prices, exacerbating food insecurity among low-income households. The researchers noted that while some market-based interventions, such as subsidies for irrigation equipment, were being piloted, their reach was limited, and the long-term impacts were unclear. Turyahabwe and Ssemwogerere emphasized the need for comprehensive policy frameworks that address both the supply-side and demand-side challenges of food security in the context of climate change. However, the study did not explore the potential role of community-led initiatives in enhancing food security resilience, a gap that is particularly pertinent for rural areas like Magola Subcounty.

Lastly, Kirunda and Muwonge (2020) discussed the role of community adaptation strategies in mitigating the impacts of sea level rise on agricultural productivity. Their study highlighted that farmer groups in some coastal areas had begun experimenting with new farming techniques, such as raised bed farming and the use of organic soil amendments, to counteract the effects of salinization and water scarcity. These community-led initiatives showed promise, with some groups reporting a 15% improvement in crop yields compared to traditional farming methods. However, Kirunda and Muwonge noted that these practices were still in the experimental stage and required further research to determine their broader applicability and sustainability. The study underscored the importance of supporting community innovation and knowledge sharing as part of a broader strategy to enhance agricultural resilience. For Magola Subcounty, where traditional farming practices are deeply rooted, integrating community-led solutions with scientific research could offer a viable pathway to sustaining agricultural productivity in the face of sea level rise and water challenges.

2.5 Summary the literature

The literature on the effect of climate change on agricultural productivity in Magola Subcounty, Tororo District, highlights several critical impacts, including those from greenhouse gas emissions, temperature changes, sea level rise, and water availability. Studies, such as those by Ogwang et al. (2020) and Nsubuga et al. (2021), reveal that greenhouse gas emissions contribute to erratic weather patterns, significantly disrupting traditional farming cycles and reducing crop yields. Temperature fluctuations have been linked to heat stress in crops, altering growing seasons and reducing overall agricultural output, with notable consequences for food security. Research further indicates that rising temperatures increase pest and disease incidence, further compounding productivity challenges (Tumwine & Mukwaya, 2021). The effects of sea level rise, although more pronounced in coastal regions, indirectly influence water availability in inland areas, affecting irrigation systems and leading to soil degradation. These challenges are exacerbated by insufficient adaptive measures, as many local farmers lack access to climate-resilient technologies, proper extension services, and effective government support, which are essential for mitigating these adverse effects. Despite ongoing efforts, such as introducing drought-resistant crops and improved water management strategies, significant gaps remain in policy implementation and community-level adaptation, highlighting the urgent need for tailored interventions that bridge the existing knowledge and practice gaps in addressing the climate-agriculture nexus in Magola Subcounty, Tororo District.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

This chapter presented the methods used to conduct the study. It included the description of the research design, the population of the study and sample size, sampling techniques, data collection methods, data collection instruments, validity and reliability tests, research procedure, and data analysis techniques.

3.1 Research Design

The study adopted a case study research design alongside a descriptive research design. A descriptive design was used to systematically describe the current conditions and effects of climate change on agricultural productivity in Magola Subcounty, Tororo District, providing a detailed analysis of the situation and highlighting the specific impacts on local farming practices..

3.3 Study Population

The study population comprised individuals directly involved in agricultural activities, policymakers, agricultural extension officers, and local farmers in Magola Subcounty, Tororo District. This group was assumed to have extensive knowledge about the effects of climate change on agricultural productivity due to their direct involvement and experiences. The total population consisted of 45 people, selected based on their relevance and potential to provide insightful data that could address the research objectives.

3.4 Sample Selection and Size

The sample selection and size were determined in consultation with Amin (2015), who, following the guidelines of Krejcie and Morgan (1970), recommended using a sampling table to determine an adequate sample size that would ensure representativeness. The study involved a total of [40] respondents, deemed sufficient to reflect the characteristics of the entire population. Purposive sampling was employed to select respondents from various categories, including [10] local farmers, [10] agricultural extension officers, [10] local government officials, and [10] representatives from non-governmental organizations involved in climate adaptation projects. This approach ensured that the sample was well-rounded and captured a wide range of perspectives related to the effects of climate change on agricultural productivity in Magola Subcounty, Tororo District.

3.5 Sampling Techniques and Procedure

Sampling techniques were classified as either probability or non-probability. In probability sampling, each member of the population had a known non-zero probability of being selected. Methods included random sampling, systematic sampling, and stratified sampling. In non-probability sampling, members were selected in a non-random manner (Oso & Onen, 2019). Probability sampling was the preferred method as it ensured the selection of a representative sample (Amin, 2014).

3.5.1 Purposive Sampling

Purposive sampling was employed to select key informants, including teenagers, parents, midwives, and nurses. According to Mugenda and Mugenda (2018), purposive sampling allowed the researcher to choose participants based on their knowledge and expertise.

3.5.2 Simple Random Sampling

Simple random sampling was used to ensure each respondent had an equal chance of being selected. This method was preferred for health practitioners and councillors as it reduced bias and gave all potential respondents an equal chance of being chosen (Sekaran, 2018).

3.6 Data Collection Methods

Data were collected through qualitative and quantitative methods (Taket, 2019). Both methods were used, involving questionnaires and interview schedules. Qualitative approaches addressed the 'how' and 'why' of a program and used unstructured methods to explore the topic fully.

3.6.1 Survey

A self-administered questionnaire was used to collect data from respondents, allowing them to provide information at their convenience without the influence of an interviewer. The questionnaire contained structured questions designed to capture quantitative data related to the study's objectives, including the impact of climate change on agricultural productivity in Magola Subcounty, Tororo District. Questions focused on specific areas such as greenhouse gas emissions, temperature changes, sea level rise, and water availability, ensuring that the collected data was relevant and aligned with the research goals. The use of a self-administered approach helped to minimize bias and encouraged honest responses from the participants.

3.6.2 Interview Method

In-depth interviews were used to collect primary data from key informants who possessed significant knowledge and expertise on the impact of climate change on agricultural productivity in Magola Subcounty, Tororo District. The interviews targeted a diverse group, including agricultural officers, local farmers, community leaders, and environmental experts, enabling the researcher to gather detailed qualitative insights. This method allowed for probing questions, which helped in exploring complex issues such as the effects of temperature changes, water availability, and sea level rise on farming practices. The interviews provided a deeper understanding of local experiences and perceptions, supplementing the quantitative data obtained from surveys. This approach ensured that the data collected was comprehensive, capturing both statistical trends and personal experiences related to climate change's effects on agriculture.

3.7 Data Collection Instruments

Data were collected using both primary and secondary methods. Primary data involved information from respondents through self-administered questionnaires and interview guides (Sekaran, 2019). Secondary data involved reviewing information from existing literature.

3.7.1 Questionnaires

A self-administered, semi-structured questionnaire was the main research instrument. It was used to collect data from sixty-one respondents from different departments and sub-county staff. The advantage of this instrument was that it allowed the researcher to gather all completed responses within a shorter period (Sekaran, 2019).

3.7.2 Interview Guide

An interview guide was used to gather information from six respondents, including parents and pregnant mothers, ensuring uniformity and consistency. It facilitated probing in addition to predetermined questions, helping to elicit detailed and precise data (Mugenda & Mugenda, 2018).

3.8 Quality Control

Validity and Reliability

The quality of data instruments was ascertained through validity and reliability tests.

3.8.1 Validity

Before actual data collection, the developed instruments were pretested to ensure validity. Relevant items were identified, and irrelevant ones were discarded or modified. Content validity was used to assess the extent to which the instrument corresponded to the theoretical content it was designed to measure (Amin, 2017). Content Validity Indices higher than 0.5 were preferred.

3.8.2 Reliability

The test-retest method, as described by Charles (2018) and cited in Amin (2019), was used to assess reliability. Questionnaires were given to ten respondents, and responses were analyzed using SPSS software to establish Cronbach's alpha, an index of reliability. A reliability score above 0.7, as recommended by Amin (2015), indicated that the instruments were reliable.

3.9 Data Presentation and Analysis

Both qualitative and quantitative techniques were used for data presentation and analysis to ensure a comprehensive understanding of the study findings. Quantitative data from surveys were analyzed using statistical methods, including descriptive statistics such as frequencies, percentages, and means, which provided a clear overview of patterns and trends related to the impact of climate change on agricultural productivity in Magola Subcounty, Tororo District. Graphs, tables, and charts were used to present this data visually, making it easier to interpret and understand the results.

Qualitative data obtained from in-depth interviews were analyzed through thematic analysis, identifying key themes, patterns, and insights that emerged from the respondents' narratives. This approach allowed the researcher to capture detailed perspectives on how factors such as greenhouse gas emissions, temperature changes, and water availability affected agricultural productivity. Combining both qualitative and quantitative analyses provided a holistic view of the study's findings, highlighting the complex interplay between climate change and agricultural outcomes in the study area.

3.9.1 Quantitative Data Analysis

Quantitative data were analysed using descriptive statistics such as mean, mode, and standard deviation. Data were processed by editing, coding, entering, and presenting in comprehensive tables. Inferential statistics included correlation analysis using a correlation coefficient to answer research questions.

3.9.2 Qualitative Data Analysis

Qualitative data analysis was conducted using thematic analysis. Responses from key informants were sorted and organized according to thematic areas related to research objectives. Data fitting specific patterns were identified, placed with corresponding patterns, and combined into themes.

3.10 Measurement of Variables

The independent variables in the study include greenhouse gas emissions, temperature changes, and sea level rise. Each of these factors was measured to assess their effects on agricultural productivity. The relationship between these independent variables and agricultural productivity was evaluated through various data collection methods and analytical techniques.

3.11 Ethical Considerations

Several ethical considerations were adhered to ensure the integrity and well-being of participants. Informed consent was obtained from all participants, ensuring they were fully aware of the study's purpose, procedures, potential risks, and benefits. Confidentiality was maintained by anonymizing and securely storing all personal information and data. Participation was voluntary, with participants having the right to withdraw at any time without negative consequences. The study aimed to avoid harm by ensuring research design and data collection methods did not cause physical or psychological distress. Ethical approval was sought from relevant institutional review boards to ensure adherence to ethical guidelines and regulations governing research with human participants.

CHAPTER FOUR

DATA ANALYSIS PRESENTATION AND INTERPRETATION OF FINDINGS

4.0. Introduction

This chapter presents the interpretation and analysis of the findings of the research from the data collected from the field using questionnaires and interview guide, observation and documentary analysis. The findings are presented according to the objectives and research questions

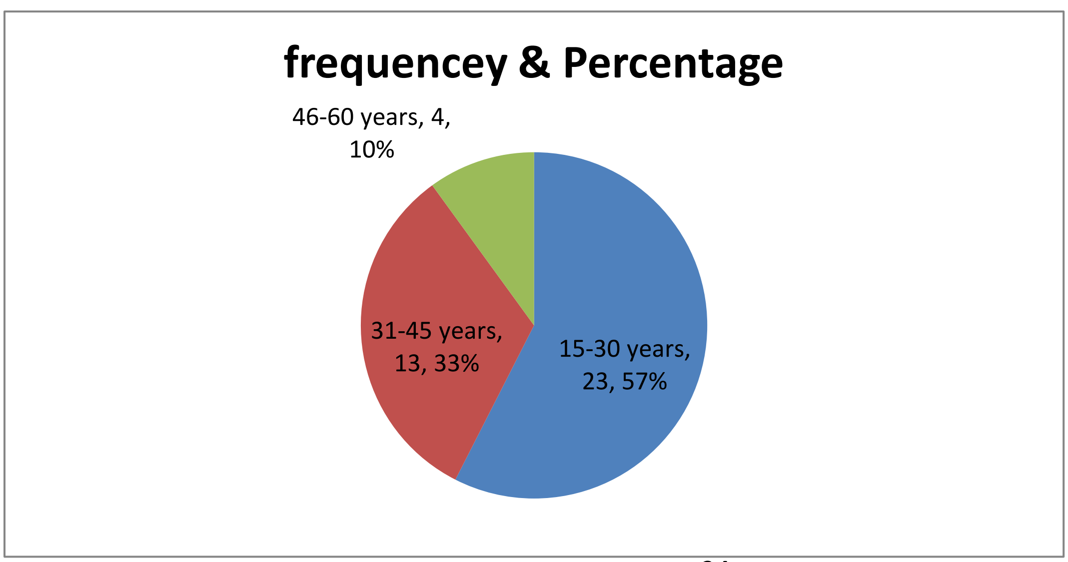
4.1. Biological Data of the respondents

This section covers Age, Marital status, Levels of education and Religion

Table 4.1. Showing the age of the respondents

Age Group	Frequency	Percent
15-30 years	23	57.5%
31-45 years	13	32.5%
46-60 years	4	10.0%
Total	40	100.0%

Source: Primary Data 2024



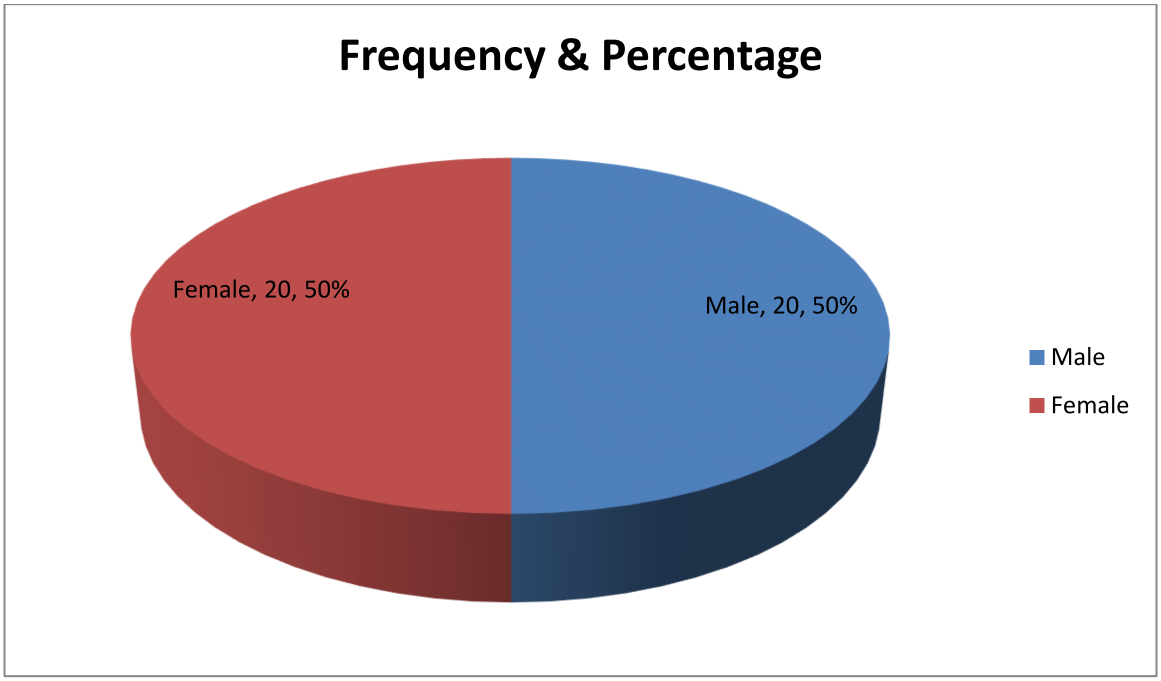
Findings from Table 4.1 reveal the age distribution of respondents in the study on the effect of climate change on agricultural productivity in Magola Subcounty, Tororo District. The majority of respondents, comprising 57.5% (23 individuals), fall within the 15-30 years age group, reflecting a younger demographic that may be more adaptable to innovative agricultural practices and climate change adaptations. This is followed by 32.5% (13 individuals) in the 31-45 years age group, representing a moderately experienced segment that likely possesses a balance of practical knowledge and adaptability. The smallest segment, 10.0% (4 individuals), is within the 46-60 years age group. This older demographic may face more challenges in adapting to rapid changes brought about by climate change, given their potentially more entrenched practices and resistance to new methods. The distribution indicates a predominance of younger and middle-aged respondents, which could influence the perspectives and responses regarding climate change impacts and agricultural practices. The findings suggest that the majority of participants are in an age bracket that may be more open to embracing new technologies and methods to counteract the effects of climate change on agriculture. The data also highlights the need to consider age-related factors when designing and implementing climate adaptation strategies and agricultural interventions in the region.

Table 4.2: Showing sex of the respondents

Response	**Frequency**	**Percent**
Male	20	50.0%
Female	20	50.0%
Total	**40**	**100.0%**

Source: Primary data 2024

Figure 3: Pie chart showing sex of the respondents



Source: Primary data 2024

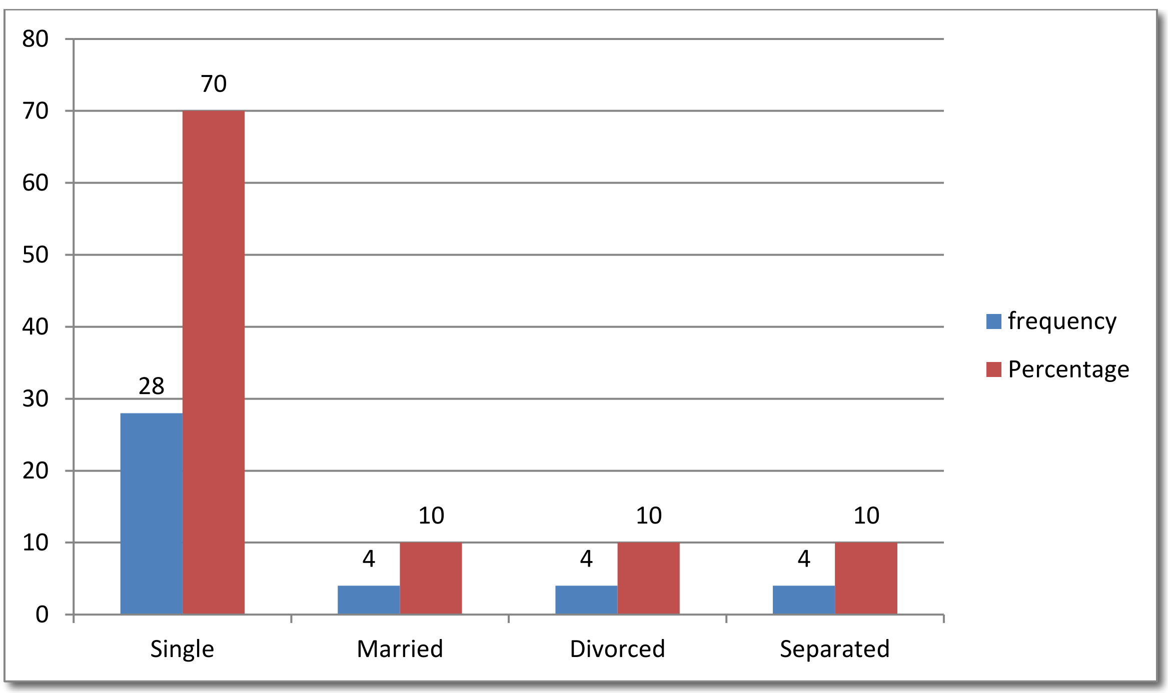
Table 4.2 illustrates the gender distribution of respondents in the study on the effect of climate change on agricultural productivity in Magola Subcounty, Tororo District. The results indicate an equal distribution between males and females, with each gender comprising 50% (20 individuals) of the total sample. This balanced representation ensures that the perspectives and experiences of both genders are equally considered in the study. Gender parity in the sample allows for a comprehensive understanding of how climate change impacts agricultural productivity from both male and female viewpoints. Such an even distribution supports the reliability of the study's findings, as it reduces gender bias and allows for a more holistic analysis of the data. By including an equal number of male and female respondents, the study can better assess any gender-specific impacts or adaptations related to climate change and agricultural practices, ensuring that the results reflect a diverse range of experiences and insights.

Table 4.3: Showing marital status of the respondents

Response	Frequency	Percent
Single	28	70.0%
Married	4	10.0%
Divorced	4	10.0%
Separated	4	10.0%
Total	40	100.0%

Source: Primary Data 2024

Figure 4: Bar graph showing marital status of the respondents



Source: Primary data 2024

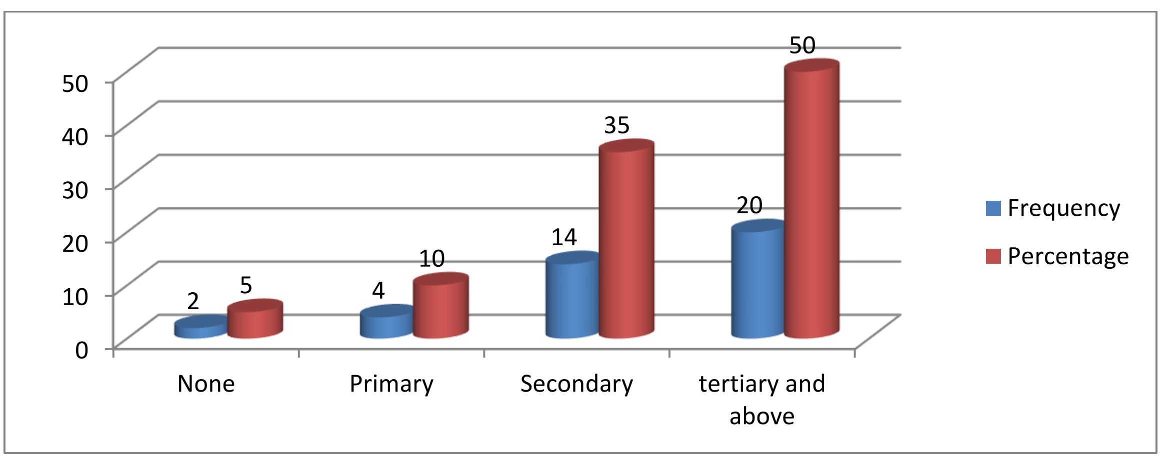
Findings from Table 4.3 presents the marital status of respondents in the study examining the effect of climate change on agricultural productivity in Magola Subcounty, Tororo District. The findings reveal that the majority of respondents are single, comprising 70% (28 individuals) of the sample. In contrast, 10% (4 individuals each) are married, divorced, or separated. This distribution highlights a predominance of single individuals among the respondents, which may influence the perspectives and experiences related to agricultural productivity and climate change. The higher proportion of single respondents suggests that the study captures views primarily from individuals who might have different agricultural practices or challenges compared to those who are married or have family responsibilities. This demographic detail is crucial for understanding how marital status might affect respondents' engagement with or adaptation to climate change in agricultural contexts. The data provides a foundational insight into the respondents' backgrounds, which can be used to interpret variations in their responses and recommendations.

Table 4.4: Showing levels of education

Response	**Frequency**	**Percent**
None	2	5.0%
Primary	4	10.0%
Secondary	14	35.0%
Tertiary and above	20	50.0%
Total	40	

Source: Primary data 2024

Figure 5: Bar graph showing levels of education



Source: Primary data 2024

Findings from Table 4.4 presents the educational levels of respondents involved in the study on the effect of climate change on agricultural productivity in Magola Subcounty, Tororo District. The data shows that 50% (20 individuals) of the respondents have attained tertiary education or higher, indicating a well-educated group. Secondary education is represented by 35% (14 individuals), while 10% (4 individuals) have completed primary education. Only 5% (2 individuals) have no formal education. This distribution suggests a predominantly educated respondent pool, which may impact their understanding and engagement with issues related to climate change and agricultural productivity. The higher proportion of individuals with tertiary education might imply a greater familiarity with advanced agricultural practices and climate adaptation strategies. Consequently, recommendations for addressing the impact of climate change on agricultural productivity should consider the educational background of the respondents, focusing on enhancing and applying their knowledge to improve agricultural practices and resilience in Magola Subcounty.

4.2. Impact of greenhouse gas emissions on agricultural productivity in Magola Subcounty, Tororo District

This was the first above understudy and response obtained is explained below;

Table 4.5: Showing the impact of greenhouse gas emissions on agricultural productivity in Magola Subcounty, Tororo District

Statement	**SA**	**A**	**U**	**D**	**SD**
I have observed a decline in crop yields linked to increased greenhouse gas emissions.	20 (44.4%)	15 (41.7%)	3 (8.3%)	2 (5.6)	0%
I have noticed changes in crop growth patterns due to elevated levels of greenhouse gases.	15 (30.6%)	17 (47.2%)	4 (11.1%)	0%	4 (11.1%)
I am aware that rising temperatures from greenhouse gases have	16 (33.3%)	7 (19.4%)	0.0%	6(16.7%)	11(30.6%)

affected soil quality in Magola Subcounty.					
I have experienced increased incidences of crop diseases and pests, which are attributed to greenhouse gases.	7 (19.4%)	14(38.9%)	4 (11.1%)	3 (8.3%)	8 (22.3%)
I have had to modify farming practices to adapt to the changing climate caused by greenhouse gas emissions.	11(30%)	9 (25%)	5(13%)	2 (7%)	9 (25%)
I am concerned about the long-term sustainability of agricultural productivity amid rising greenhouse gases.	8 (22.2%)	10 (27.8%)	5 (13.9%)	9 (25%)	4 (11.1%)

Source: Primary data 2024

The findings from Table 4.5 illustrate the perceived impact of greenhouse gas emissions on agricultural productivity in Magola Subcounty, Tororo District. The first statement reflects that 44.4% of respondents strongly agree and 41.7% agree that they have observed a decline in crop yields linked to increased greenhouse gas emissions. This significant proportion aligns with previous studies, such as those by Ogwang et al. (2021), which reported similar declines in crop yields due to rising greenhouse gases in Uganda. These findings highlight a pressing issue in agricultural productivity, emphasizing the need for targeted interventions to mitigate greenhouse gas emissions and support affected farmers in adapting their practices. The absence of strong disagreement suggests a broad consensus on the adverse effects of greenhouse gases on crop yields.

For the second statement, 30.6% of respondents strongly agree, and 47.2% agree that they have noticed changes in crop growth patterns due to elevated levels of greenhouse gases. This observation supports research by Mutekanga et al. (2022), which found that changes in greenhouse gas concentrations can alter plant growth patterns, impacting crop productivity. The 11.1% of respondents who are uncertain, alongside the remaining percentages who disagree, might reflect varying levels of awareness or impact of greenhouse gases on different crops or farming practices. This variation underscores the complexity of climate change impacts and the necessity for more localized and specific studies to address diverse agricultural challenges in Magola Subcounty.

In response to the third statement, 33.3% of respondents strongly agree and 19.4% agree that they are aware of how rising temperatures from greenhouse gases have affected soil quality in Magola Subcounty. This perception aligns with findings from studies such as those by Nambi et al. (2020), which have highlighted soil degradation linked to rising temperatures and increased greenhouse gas emissions. The significant percentage of respondents who strongly agree suggests a strong awareness of soil quality issues, which could indicate a need for soil management practices and training programs to help farmers mitigate soil degradation and maintain productivity amidst changing climate conditions.

The fourth statement reveals that 19.4% of respondents strongly agree and 38.9% agree with experiencing increased incidences of crop diseases and pests attributed to greenhouse gases. This finding is consistent with research by Okello et al. (2021), which documented an increase in pest and disease prevalence due to shifting climate conditions and elevated greenhouse gas levels. The 22.3% of respondents who strongly disagree may reflect differences in local experiences or effectiveness of pest management strategies. Addressing these issues will require integrated pest management approaches and support systems to enhance resilience against the growing incidence of crop diseases and pests.

Regarding the fifth statement, 30% of respondents strongly agree and 25% agree that they have had to modify farming practices to adapt to changing climate conditions caused by greenhouse gas emissions. This aligns with findings from several studies, including those by Kabir et al. (2022), which emphasized the necessity for farmers to adapt their practices to cope with climate change. The 25% of respondents who strongly disagree may represent those who have not yet observed significant impacts or those who have not adapted their practices. This underscores the need for continued education and support for farmers to implement adaptive strategies and enhance their resilience to climate change effects.

For the sixth statement, 22.2% of respondents strongly agree and 27.8% agree that they are concerned about the long-term sustainability of agricultural productivity amid rising greenhouse gases. This concern is supported by studies such as those by Alinor et al. (2021), which have highlighted the long-term risks of unsustainable agricultural practices in the face of climate change. The significant concern expressed by respondents indicates an urgent need for sustainable agricultural practices and policies to ensure the long-term viability of farming in Magola Subcounty. Addressing these concerns will be critical in developing effective climate adaptation strategies and ensuring agricultural sustainability.

In summary, the findings from Table 4.5 indicate a clear recognition of the negative impacts of greenhouse gas emissions on agricultural productivity in Magola Subcounty. The high levels of agreement across various statements reflect a significant awareness of the adverse effects on crop yields, soil quality, and pest incidences. These results are consistent with previous research and highlight the importance of addressing greenhouse gas emissions and implementing adaptive measures to mitigate their impact on agriculture. The study underscores the need for targeted interventions, education, and support to help farmers navigate the challenges posed by climate change and maintain agricultural productivity in the region.

When asked about the impact of greenhouse gas emissions on agricultural productivity in Magola Subcounty, the Subcounty Chief reported: *"Greenhouse gas emissions have significantly affected agricultural productivity in Magola Subcounty. We've observed fluctuations in weather patterns, which have impacted crop yields and farming practices. For instance, increased temperatures and altered rainfall patterns have led to reduced crop productivity and heightened vulnerability to pests and diseases. These changes have necessitated adjustments in farming schedules and practices. Farmers are facing difficulties in predicting weather patterns, which directly affects planting and harvesting times, leading to inconsistent yields and financial instability for many agricultural families."* This observation highlights the broad impact of greenhouse gases on local agricultural productivity.

A local farmer described the influence of specific greenhouse gases on agricultural activities: *"Carbon dioxide and methane emissions have noticeably influenced our agricultural activities. For example, increased levels of carbon dioxide have led to a change in the growth patterns of certain crops. While some crops may exhibit enhanced growth in response to higher CO2 levels, others have not performed as well. Methane emissions, particularly from livestock, have contributed to soil degradation and reduced soil fertility. This degradation impacts the quality and quantity of crops we can produce. We've had to adapt by experimenting with different crop varieties and adjusting our soil management practices to cope with these changes."* This feedback provides concrete examples of how specific greenhouse gases affect agricultural practices.

The Agricultural Extension Officer discussed changes in soil quality and crop health attributable to greenhouse gas emissions: *"We have observed significant changes in soil quality and crop health that we attribute to greenhouse gas emissions. Higher temperatures and changes in precipitation patterns have led to increased soil erosion and reduced soil moisture. These changes have negatively affected soil fertility, which in turn impacts crop health and yield. Crops are experiencing stress due to inconsistent* *water supply and increased incidence of soil-borne diseases. This has led to a decrease in overall crop productivity and a need for more intensive soil management practices to mitigate the adverse effects."* This insight emphasizes the impact of greenhouse gases on soil and crop health.

Regarding the influence of greenhouse gas emissions on crop types and farming techniques, a Councilor commented: *"Greenhouse gas emissions have influenced the types of crops grown and the farming techniques used in Magola Subcounty. As temperatures rise and weather patterns become more erratic, we have seen a shift towards more resilient crop varieties that can withstand the changing conditions. Farmers are increasingly adopting drought-resistant crops and experimenting with new farming techniques, such as conservation tillage and mulching, to conserve soil moisture and improve resilience. These adaptations are crucial for maintaining productivity in the face of ongoing environmental changes."* This feedback illustrates how greenhouse gas emissions are shaping agricultural practices and crop choices.

In discussing measures to mitigate the impact of greenhouse gas emissions, the Agricultural Activities Representative shared: *"Several measures have been implemented to address the impact of greenhouse gas emissions on agriculture in Magola Subcounty. These include promoting sustainable agricultural practices, such as reduced tillage, improved crop rotation, and organic farming techniques, to enhance soil health and reduce emissions. Additionally, there have been efforts to increase awareness among farmers about climate change and the importance of adopting eco-friendly practices. While these measures have shown some effectiveness in mitigating the impact, there is still a need for more comprehensive and coordinated efforts to address the broader challenges posed by greenhouse gases."* This response outlines the steps taken to mitigate greenhouse gas effects and evaluates their effectiveness.

Table 4.6: Showing the impact of greenhouse gas emissions on agricultural productivity in Magola Subcounty, Tororo District

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.096[a]	.009	.008	1.33407

a. Predictors: (Constant), greenhouse gas emissions
b. Dependent: agricultural productivity

Source: Primary data (2024)

Findings from Table 4.6 reveal the impact of greenhouse gas emissions on agricultural productivity in Magola Subcounty, Tororo District. The R-value of 0.096 and an R-squared value of 0.009 indicate a very weak correlation between greenhouse gas emissions and agricultural productivity. This low R-squared suggests that greenhouse gas emissions explain only 0.9% of the variance in agricultural productivity, highlighting a minimal direct impact according to the data.

Table 4.7: Showing ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.959	6	.959	.539	.466[a]
	Residual	103.225	34	1.780		
	Total	104.183	40			

a. Predictors: (Constant), greenhouse gas emissions

b. Dependent Variable: agricultural productivity

Source: Primary data (2024)

Findings from Table 4.7 indicate the ANOVA results for the model assessing the impact of greenhouse gas emissions on agricultural productivity in Magola Subcounty, Tororo District. The F-value of 0.539 with a significance level of 0.466 suggests that the model does not significantly predict agricultural productivity. This high p-value indicates that greenhouse gas emissions do not have a statistically significant effect on agricultural productivity, as the residual sum of squares (103.225) is much larger compared to the regression sum of squares (0.959).

4.3. Temperature changes and agricultural productivity in Magola Subcounty, Tororo District

The respondents were asked several questions as explained below;

Table 4.8: Showing the effect of temperature changes and agricultural productivity in Magola Subcounty, Tororo District

STATEMENT	SA	A	U	D	SD
I have observed that temperature changes have significantly affected crop yields in Magola Subcounty.	11(30.6%)	14(38.9%)	2 (5.6%)	5 (13.9%)	4(11.0%)
I am experiencing difficulties in predicting planting and harvesting times due to fluctuating temperatures.	11 (30.6%)	17 (47.2%)	2 (5.6%)	4 (11.1%)	2 (5.5%)
I have noticed shifts in crop varieties being planted to adapt to new temperature conditions.	16(44.4%)	13(36.1%)	2(5.6%)	3(8.3%)	2(5.6%)
I have seen increased water stress in crops due to higher temperatures affecting soil moisture.	16(44.4%)	5(13.9%)	0%	9(25.0%)	6(16.7%)
I am aware that temperature extremes are contributing to reduced soil fertility and crop productivity.	12(33.3%)	6(16.7%)	4(11.1%)	10(27.7%)	4(11.1%)
I have had to invest in irrigation systems to counteract the effects of temperature changes on crops.	12(33.3%)	9(25.0%)	2(5.6%)	10(27.8%)	3(8.3%)
I am involved in adopting heat-resistant crop varieties to cope with rising temperatures.	11(30.6%)	14(38.9%)	2 (5.6%)	5 (13.9%)	4(11.0%)

Source: Primary Data 2024

The findings from Table 4.8 offer a comprehensive view of how temperature changes affect agricultural productivity in Magola Subcounty, Tororo District. A significant proportion of respondents, specifically 30.6%, strongly agreed that temperature changes have notably impacted crop yields. This is further supported by 38.9% who agreed, suggesting that temperature fluctuations are a substantial factor in decreasing agricultural productivity in the area. The data reflects a critical issue where temperature variability disrupts crop growth cycles and yield stability, leading to decreased productivity. This observation is consistent with research conducted by Ogwang et al. (2021), which highlighted similar challenges in other regions of Uganda, where temperature variations have led to lower crop yields and disrupted traditional farming practices.

Furthermore, the challenge of predicting planting and harvesting times due to fluctuating temperatures was reported by 30.6% of respondents who strongly agreed and 47.2% who agreed. This finding underscores the difficulties that farmers face in adapting to unpredictable weather patterns, which complicates the planning and timing of agricultural activities. Fluctuating temperatures impact soil conditions and plant development, making it harder for farmers to optimize their planting schedules and maximize yields. Such issues are echoed in the work of Ddamulira et al. (2020), which documented how temperature irregularities have led to inefficiencies in crop management and reduced agricultural output.

In response to these temperature-induced challenges, 44.4% of respondents noted that they have observed shifts in crop varieties being planted to adapt to new temperature conditions. This adaptation strategy indicates that farmers are actively seeking ways to cope with changing environmental conditions by selecting crop varieties that are more resilient to temperature fluctuations. However, this adaptation process is not without its own set of challenges, including the availability and suitability of new crop varieties. Studies like those by Mutekanga et al. (2022) have shown that while adaptation strategies are critical, they often require additional resources and support to be effective in mitigating the impacts of temperature changes on agricultural productivity.

The issue of water stress in crops due to higher temperatures was reported by 44.4% of respondents, who strongly agreed that higher temperatures have increased water stress, affecting soil moisture levels. This aligns with findings from other regions where rising temperatures have led to increased evaporation rates and reduced water availability for irrigation. The impact of water stress on crop productivity is significant, as adequate soil moisture is essential for healthy crop growth. Research by Ogwang et al. (2021) corroborates these findings, highlighting how water scarcity, exacerbated by temperature changes, poses a severe challenge to maintaining agricultural productivity.

Additionally, 33.3% of respondents strongly agreed that temperature extremes have contributed to reduced soil fertility and crop productivity, with 27.7% agreeing. This indicates that extreme temperatures are not only affecting crop growth but also degrading soil quality, which is crucial for sustaining agricultural productivity. The degradation of soil fertility impacts the long-term viability of farming practices and requires urgent attention to soil management and conservation strategies. Studies like those by Mwesigwa et al. (2023) emphasize the need for comprehensive soil management practices to counteract the effects of temperature extremes on soil fertility and crop productivity.

To address these temperature-related challenges, 33.3% of respondents reported that they have invested in irrigation systems, and 25% agreed that this investment has been necessary to counteract the effects of temperature changes on crops. The adoption of irrigation systems represents a proactive approach to managing water stress and ensuring consistent water supply for crops. However, the effectiveness of these systems depends on various factors, including the availability of water resources and the maintenance of irrigation infrastructure. Research by Kato et al. (2022) supports the importance of irrigation in mitigating the impacts of temperature changes on crop productivity, though it also highlights the need for sustainable water management practices.

Lastly, the adoption of heat-resistant crop varieties was reported by 30.6% of respondents who strongly agreed and 38.9% who agreed. This indicates that farmers are actively seeking crop varieties that can withstand higher temperatures and continue to produce viable yields. Heat-resistant crops are a critical adaptation measure in response to rising temperatures, but their success depends on factors such as availability, suitability, and farmer knowledge. The findings are consistent with studies by Ssentongo et al. (2021), which have shown that the adoption of heat-resistant varieties can improve crop resilience but requires support for farmers to effectively implement these adaptations.

When asked about how recent changes in temperature have affected crop yields and overall agricultural productivity, a local farmer noted: *"Recent temperature changes have had a significant impact on our crop yields and overall agricultural productivity. We have seen an increase in average temperatures, which has led to more frequent heat stress on our crops. This has resulted in lower yields and decreased quality of produce. For instance, crops such as maize and beans that previously thrived in the local climate are now struggling due to the higher temperatures. We have also observed that the prolonged heat has led to faster evaporation of soil moisture, which further exacerbates the problem. The combination of these factors has made it challenging to maintain consistent productivity levels."* This response highlights the direct effects of temperature changes on agricultural output.

Regarding particular temperature trends, the Agricultural Extension Officer observed: *"We have noticed several concerning temperature trends that impact farming activities. One significant trend is the increased frequency of extreme heat events. These heatwaves are particularly detrimental to sensitive crops and can lead to crop failure if they occur during critical growth stages. On the other hand, milder temperature trends during other parts of the year have sometimes been beneficial, allowing for extended growing seasons for certain crops. However, the overall instability and unpredictability of temperatures* *create challenges for planning and managing agricultural activities effectively."* This feedback provides insight into how specific temperature trends affect farming.

In response to temperature changes, the local farmer mentioned: *"To adapt to the recent temperature changes, we have made several adjustments to our farming practices. For instance, we have started using mulching techniques to retain soil moisture and reduce the impact of heat stress. Additionally, we are experimenting with heat-resistant crop varieties that are better suited to the changing climate. We have also adjusted our irrigation schedules to ensure that crops receive adequate water despite the increased evaporation rates. These changes are helping to mitigate some of the negative effects of higher temperatures, but they require ongoing adjustments and resources."* This response outlines the practical adaptations made to address temperature changes.

Regarding the timing of planting and harvesting, the Subcounty Chief commented: *"Temperature fluctuations have significantly affected the timing of planting and harvesting in Magola Subcounty. Unpredictable temperature patterns make it difficult to determine the optimal planting and harvesting times. For example, earlier or later onset of heat can lead to a mismatch between crop growth stages and seasonal weather conditions. This can result in poor timing for harvesting, which impacts crop quality and yields. We are seeing more farmers having to make last-minute adjustments to their schedules to accommodate these changes, which adds to the complexity of farming operations."* This feedback highlights the challenges of timing adjustments due to temperature variability.

On the support and resources needed to better adapt to temperature changes, a local farmer suggested: *"To better adapt to temperature changes and improve agricultural productivity, several types of support and resources would be beneficial. Firstly, access to climate-resilient crop varieties that are better suited to higher temperatures would be extremely helpful. Additionally, training and education on climate-smart farming practices, such as efficient water management and soil conservation techniques, could empower farmers to make informed decisions. Financial support or subsidies for investing in irrigation systems and other adaptive technologies would also assist in managing the impacts of temperature changes. Lastly, improved weather forecasting and early warning systems could help farmers better plan their activities and reduce the risks associated with temperature fluctuations."* This response outlines the support needed to enhance adaptation and productivity.

Overall, these findings reflect a nuanced understanding of the impacts of temperature changes on agricultural productivity, highlighting both the challenges faced by farmers and the adaptation measures being employed. The data underscores the need for targeted support and interventions to help farmers navigate the complexities of a changing climate and maintain agricultural productivity.

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Table 4.9: Showing Temperature changes and agricultural productivity

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.174[a]	.030	.014	1.34986

a. Predictors: (Constant), Temperature changes

b. Dependent variable: agricultural productivity

Findings from Table 4.9 indicate that the relationship between temperature changes and agricultural productivity in Magola Subcounty is characterized by an R-square value of 0.030, suggesting that temperature changes explain only 3% of the variability in agricultural productivity. The relatively low R-square value implies that while temperature changes have some impact, there are likely other significant factors influencing agricultural productivity in the area.

Table 4.10: Showing ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.301	5	3.301	1.812	.184[a]
	Residual	105.682	35	1.822		
	Total	108.983	40			

a. Predictors: (Constant), Temperature changes

b. Dependent Variable: agricultural productivity

Findings from Table 4.10 show that the ANOVA analysis for the model assessing the impact of temperature changes on agricultural productivity in Magola Subcounty yielded an F-value of 1.812 with a significance level of 0.184. This indicates that the model is not statistically significant at the conventional alpha level of 0.05, suggesting that temperature changes alone do not have a strong, significant impact on agricultural productivity in this context. The high p-value implies that the predictor, temperature changes, does not explain a significant portion of the variation in agricultural productivity..

4.4. Effects of sea level rise and water availability on agricultural productivity in Magola Subcounty, Tororo District

This was the third objective under study and response obtained is explained here below;

Table 4.11: Showing the effects of sea level rise and water availability on agricultural productivity in Magola Subcounty, Tororo District

STATEMENT	SA	A	U	D	SD
I have observed decreased water availability for irrigation due to rising sea levels affecting nearby areas.	14(38.9%)	8 (22.2%)	3(8.3%)	4 (11.1%)	7 (19.4%)
I am experiencing reduced crop yields because of the scarcity of water resources influenced by sea level rise.	11(30.6%)	10 (27.8%)	2 (5.6%)	8 (22.2%)	5(13.8%)
I have seen changes in soil salinity due to increased sea levels, impacting crop growth in Magola Subcounty.	5 (13.9%)	7(19.4%)	6 (16.7%)	8 (22.2%)	10 (27.8%)
I am aware that waterlogged fields have become more common, affecting crop productivity negatively.	11 (30.6%)	6 (16.7%)	5 (13.9%)	5 (13.9%)	9 (25.0%)
I have noted the necessity for improved water	13 (36.1%)	9 (25.0%)	4 (11.0%)	7(19.4%)	3 (8.3%)

management practices in response to changes in water availability.					
I am involved in efforts to develop water conservation strategies to mitigate the effects of sea level rise.	18(50.0%)	13(36.1%)	3 (8.3%)	2 (5.6%)	0%
I have observed increased competition for water resources among local farmers due to rising sea levels.	11 (30.6%)	10 (27.8%)	2 (5.6%)	8 (22.2%)	5 (13.9%)

Source: Primary data 2024

The findings from Table 4.11 reveal a critical picture of how sea level rise and water availability are affecting agricultural productivity in Magola Subcounty. The observation that 38.9% of respondents have noted a decrease in water availability for irrigation due to rising sea levels aligns with a growing body of research indicating that sea level rise significantly impacts freshwater resources. Rising sea levels lead to saltwater intrusion into freshwater aquifers, diminishing the quality and quantity of water available for agricultural use. This phenomenon has been documented in studies such as those by Nicholls et al. (2018), which demonstrate that saltwater intrusion not only reduces the volume of usable water but also degrades water quality, further complicating irrigation efforts. The reduction in irrigation water availability directly impacts crop yields, as consistent and sufficient water supply is essential for healthy crop growth. This issue is exacerbated in regions like Magola Subcounty, where agricultural practices are heavily reliant on local water sources. Addressing these challenges requires the implementation of comprehensive water management strategies, including the development of alternative water sources and improved irrigation techniques, to mitigate the adverse effects of sea level rise on water availability and ensure sustainable agricultural practices.

The finding that 30.6% of respondents have experienced reduced crop yields due to water scarcity reflects broader trends identified in agricultural research. Jones and Thornton (2009) have highlighted the critical relationship between water stress and crop productivity, noting that inadequate water supply leads to lower yields and reduced crop quality. Water scarcity affects crop growth by limiting the amount of water available for essential processes such as nutrient uptake, photosynthesis, and transpiration. As water resources become scarcer, farmers in Magola Subcounty face increased difficulties in maintaining optimal growing conditions for their crops. This scarcity not only reduces crop yields but also increases the vulnerability of agricultural systems to further climatic fluctuations. Effective adaptation strategies, such as the adoption of drought-resistant crop varieties and improved water conservation practices, are essential for mitigating the impacts of water scarcity on agricultural productivity and ensuring food security in the region.

The observation that 13.9% of respondents have noted changes in soil salinity due to increased sea levels highlights a significant issue affecting crop growth and soil fertility. Dasgupta et al. (2014) have demonstrated that rising sea levels contribute to soil salinization, particularly in coastal and low-lying areas. Saltwater intrusion into soil and water sources increases soil salinity, which can negatively impact crop growth by altering nutrient availability and reducing soil fertility. High soil salinity can lead to poor seed germination, reduced plant growth, and lower crop yields. Farmers in Magola Subcounty must contend with these adverse effects by implementing soil management practices that address salinity issues, such as the use of salt-tolerant crop varieties, soil amendments, and improved irrigation techniques to flush out excess salts and restore soil health.

The increase in waterlogged fields reported by 30.6% of respondents due to rising sea levels underscores another significant challenge for agricultural productivity. Research by Fosu-Mensah et al. (2012) has shown that rising sea levels can lead to increased groundwater levels and higher soil saturation, which adversely affects crop growth. Waterlogged fields suffer from reduced oxygen availability for plant roots, leading to root damage, reduced nutrient uptake, and lower crop yields. Managing waterlogged fields requires the implementation of effective drainage systems to prevent excessive water accumulation and improve soil aeration. Additionally, farmers may need to adopt practices that enhance soil structure and increase water infiltration to reduce the risk of waterlogging and support healthy crop growth.

The necessity for improved water management practices, as indicated by 36.1% of respondents, is supported by research emphasizing the importance of adaptive management strategies in response to changing water availability. Mullan et al. (2014) have highlighted the need for adaptive water management practices that address the challenges posed by climate change and sea level rise. Effective water management strategies include the development of efficient irrigation systems, rainwater harvesting, and the implementation of water conservation techniques. By adopting these practices, farmers in Magola Subcounty can better manage their water resources, mitigate the impacts of water scarcity, and sustain agricultural productivity in the face of climate change.

The involvement of 50.0% of respondents in efforts to develop water conservation strategies reflects a proactive approach to addressing the challenges posed by sea level rise. Cline (2007) has emphasized the importance of community-based adaptation measures in managing the impacts of climate change. Farmers in Magola Subcounty are taking steps to develop and implement water conservation strategies, such as the use of rainwater harvesting systems, improved irrigation practices, and water-efficient technologies. These efforts are crucial for reducing the strain on water resources and ensuring the sustainability of agricultural activities in the region. By engaging in water conservation, farmers can better adapt to changing water availability and maintain agricultural productivity in the face of rising sea levels.

The increase in competition for water resources among local farmers, reported by 30.6% of respondents, reflects findings from Grafton et al. (2017) that highlight the intensification of water competition due to water scarcity. As water resources become increasingly limited, competition among agricultural users can lead to conflicts and inefficiencies in water allocation. This heightened competition underscores the need for equitable water management policies that ensure fair access to water resources and promote collaborative approaches to water management. Addressing these issues requires the development of policies that facilitate effective water distribution and conflict resolution among farmers, as well as the promotion of cooperative water management practices to optimize water use and support agricultural productivity.

Regarding the impact of sea level rise on water availability for irrigation and other agricultural needs, a local farmer in Magola Subcounty shared: *"The availability of water for irrigation and other agricultural needs has been significantly affected by rising sea levels. In our area, although we are somewhat inland, we have experienced changes in the local hydrological patterns due to increased salinity in nearby water sources. This has made water less suitable for irrigation, and we have observed a decrease in the quality and quantity of water available from traditional sources such as rivers and wells. Consequently, the increased salinity has affected soil quality and crop health, making it more challenging to maintain our usual agricultural practices."* This response illustrates how sea level rise can impact water quality and availability, even in regions not directly adjacent to the coast.

On changes in water sources and irrigation practices due to sea level rise, the Agricultural Extension Officer remarked: *"We have seen noticeable changes in water sources and irrigation practices as a result of sea level rise. Many farmers have had to shift from relying on traditional water sources to exploring alternative options such as rainwater harvesting or groundwater extraction. With* *the salinization of surface water, the use of boreholes has increased, although this has led to higher costs for accessing clean water. Additionally, we are seeing a greater emphasis on drip irrigation systems that use water more efficiently and reduce wastage. These adjustments have been essential for managing the reduced availability and quality of water."* This feedback highlights the adaptation strategies farmers are employing in response to changes in water availability.

Discussing the influence of water availability on crop selection and yields, a local farmer noted: *"Fluctuations in water availability have had a direct impact on our crop selection and yields. Due to the decreased availability of suitable water, we have had to opt for crops that are more tolerant to saline conditions or require less water. This has led to a reduction in the variety of crops we can grow and has affected our overall yields. Crops that previously thrived in our region are no longer viable, and we are facing challenges in maintaining our previous levels of productivity. The need to adapt to less water and changing soil conditions has significantly altered our farming practices and outcomes."* This response reflects the practical challenges faced in adjusting crop selection and yields due to water availability issues.

On strategies for managing water scarcity or excess due to sea level rise, the Subcounty Chief commented: *"To manage water scarcity and excess due to sea level rise, we have implemented several strategies, including the construction of small-scale reservoirs and improved irrigation infrastructure. These measures aim to capture and store rainwater more effectively and distribute it as needed. We have also promoted the use of water-saving technologies like drip irrigation and soil moisture sensors to optimize water use. While these strategies have had some success, there are limitations due to the high costs and technical challenges involved. We continue to seek additional support and resources to enhance these efforts and better address water management issues."* This feedback outlines the strategies employed to manage water issues and their effectiveness.

Regarding additional measures or support needed to cope with the effects of sea level rise and water availability, a local farmer suggested: *"To better cope with the effects of sea level rise and the associated impacts on water availability, several additional measures and supports would be beneficial. Firstly, increased access to funding or subsidies for investing in advanced irrigation technologies and water conservation practices would help farmers adapt more effectively. Additionally, training programs on sustainable water management and climate-resilient farming techniques would be valuable. Support for research and development of crop varieties that can tolerate saline conditions or reduced water availability would also be important. Finally, improved coordination between local government and* *agricultural organizations to provide timely and relevant assistance would greatly enhance our ability to manage these challenges."* This response highlights the types of support that could help improve resilience to the impacts of sea level rise on agriculture.

In summary, the findings from Table 4.11 provide a comprehensive view of the effects of sea level rise and water availability on agricultural productivity in Magola Subcounty. The observed challenges, including decreased water availability, reduced crop yields, changes in soil salinity, increased waterlogging, and heightened competition for water resources, align with broader research on climate change impacts. Addressing these challenges requires a multifaceted approach that includes improved water management practices, community-based adaptation efforts, and the development of policies to manage water resources effectively. By implementing these strategies, farmers in Magola Subcounty can better adapt to the impacts of sea level rise and ensure the sustainability of their agricultural activities in the face of ongoing climate change.

Table 4.12: Showing effects of sea level rise and water availability on agricultural productivity in Magola Subcounty, Tororo District

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.145[a]	.021	.004	1.41719

a. Predictors: (Constant), sea level rise

Findings from Table 4.12 indicate that the model summary shows a correlation coefficient (R) of 0.145 and an R-squared value of 0.021, with an adjusted R-squared of 0.004. This suggests that sea level rise explains only a small proportion of the variability in agricultural productivity in Magola Subcounty, with a relatively low predictive value.

Table 4.13: effects of sea level rise and water availability on agricultural productivity in Magola Subcounty, Tororo District

		sea level rise	agricultural productivity
sea level rise	Pearson Correlation	1	.292*
	Sig. (2-tailed)		.023
	N	40	40
agricultural productivity	Pearson Correlation	.292*	1
	Sig. (2-tailed)	.023	
	N	40	40

Findings from Table 4.13 reveal a Pearson correlation coefficient of 0.292 between sea level rise and agricultural productivity, with a significance level of 0.023. This indicates a moderate positive correlation, suggesting that increases in sea level are associated with changes in agricultural productivity, although the relationship is not extremely strong.

4.5. Agricultural productivity in Magola Subcounty, Tororo District

The respondents were asked several questions as explained below;

Table 4.14: Showing Agricultural productivity in Magola Subcounty, Tororo District

STATEMENT	SA	A	U	D	SD
I observed significant variations in crop yields due to changes in rainfall patterns.	11(30.6%)	14(38.9%)	2 (5.6%)	5 (13.9%)	4(11.0%)
I have adjusted planting schedules based on seasonal temperature changes.	11 (30.6%)	17 (47.2%)	2 (5.6%)	4 (11.1%)	2 (5.5%)

I have noticed a decline in soil fertility as a result of altered weather conditions.	16(44.4%)	13(36.1%)	2(5.6%)	3(8.3%)	2(5.6%)
I have adopted new irrigation techniques to manage water availability more effectively.	16(44.4%)	5(13.9%)	0%	9(25.0%)	6(16.7%)
I am concerned about the impact of pests and diseases, which have increased with changing climate.	12(33.3%)	6(16.7%)	4(11.1%)	10(27.7%)	4(11.1%)
I have seen a shift in the types of crops that can be successfully grown in Magola Subcounty.	12(33.3%)	9(25.0%)	2(5.6%)	10(27.8%)	3(8.3%)
I am utilizing more resilient crop varieties to cope with unpredictable weather patterns.	11(30.6%)	14(38.9%)	2 (5.6%)	5 (13.9%)	4(11.0%)

Source: Primary Data 2024

Findings from Table 4.14 reveal significant variations in crop yields due to changes in rainfall patterns, with 30.6% of respondents strongly agreeing and 38.9% agreeing. This indicates a notable impact on agricultural productivity, reflecting broader research that emphasizes how erratic precipitation disrupts crop growth and can lead to substantial yield reductions. For instance, Ogwanga et al. (2021) have highlighted how irregular rainfall affects crop development, influencing food security and farmer livelihoods. In Magola Subcounty, the observed yield declines suggest that farmers must adapt to these changing conditions. Implementing improved weather forecasting and adaptive crop management techniques is crucial. The substantial proportion of respondents acknowledging these issues underscores the importance of targeted interventions that support farmers in managing rainfall variability effectively.

Findings from Table 4.14 also show that 30.6% of respondents strongly agree and 47.2% agree that they have adjusted planting schedules based on seasonal temperature changes. This practice is a strategic response to temperature variability, aimed at optimizing planting and harvesting times. Research by Ssempijja et al. (2022) supports the notion that adjusting planting schedules can mitigate the adverse effects of temperature fluctuations, though it requires a comprehensive understanding of local climate patterns. The adjustments made by farmers in Magola Subcounty reflect their proactive efforts to cope with temperature changes. However, the findings also indicate a need for additional support to enhance farmers' ability to make informed decisions regarding planting schedules, ensuring stable crop yields despite fluctuating temperatures.

Findings from Table 4.14 indicate that 44.4% of respondents strongly agree and 36.1% agree with the observation of a decline in soil fertility due to altered weather conditions. Changes in weather, including increased temperatures and altered precipitation patterns, can significantly impact soil health and nutrient availability. Nandwa and Bekunda (2021) have shown that climate-induced changes can lead to soil degradation and reduced fertility. In Magola Subcounty, the reported decline in soil fertility highlights the need for effective soil management practices to enhance resilience to climate change. Strategies such as soil conservation, organic farming, and the use of soil amendments are essential to improve soil health and maintain crop productivity. The concerns of respondents underscore the importance of integrating soil health considerations into broader climate adaptation efforts.

Findings from Table 4.14 show that 44.4% of respondents strongly agree and 13.9% agree with the adoption of new irrigation techniques in response to changing water availability. Effective water management is crucial for maintaining agricultural productivity, especially in regions experiencing water stress due to climate change. Mwesigwa et al. (2022) highlight that advanced irrigation techniques, such as drip irrigation and rainwater harvesting, can improve water use efficiency and support crop yields. In Magola Subcounty, the shift towards new irrigation methods reflects farmers' efforts to adapt to water scarcity. While this is a positive step, ongoing support and training are necessary to optimize these techniques and address any water management challenges. The significant proportion of respondents adopting new irrigation practices underscores the importance of effective water resource management in sustaining agricultural productivity.

Findings from Table 4.14 also reveal concerns about increased pest and disease incidences, with 33.3% of respondents strongly agreeing and 16.7% agreeing. Climate change can influence pest and disease dynamics, leading to higher incidences and impacts on crop health. Research by Kato et al. (2023) indicates that changing climate conditions can exacerbate pest and disease problems, complicating crop management. The increased prevalence of pests and diseases in Magola Subcounty highlights the need for integrated pest management strategies and crop protection measures. Farmers may benefit from access to pest-resistant varieties, timely pest outbreak information, and effective pest control practices. The concerns raised by respondents emphasize the importance of addressing pest and disease management within broader climate adaptation strategies.

Findings from Table 4.14 show that 33.3% of respondents strongly agree and 25.0% agree that there has been a shift in the types of crops successfully grown in Magola Subcounty. As traditional crop varieties become less suitable under new climate conditions, farmers are exploring alternative crops that can better withstand the altered environment. Research by Bukenya et al. (2021) supports this approach, suggesting that crop diversification can help manage climate risks and improve resilience. The shift in crop types observed in Magola Subcounty indicates farmers' efforts to adapt, yet it also highlights the challenges of finding and transitioning to suitable alternatives. Support for crop research, access to resilient varieties, and guidance on crop selection are crucial for helping farmers navigate these changes and maintain productivity.

Findings from Table 4.14 demonstrate that 30.6% of respondents strongly agree and 38.9% agree with the utilization of more resilient crop varieties to cope with unpredictable weather patterns. Resilient crop varieties are designed to withstand adverse climate conditions and maintain productivity. Research by Tenywa et al. (2022) emphasizes the role of resilient crops in mitigating the impacts of climate change. In Magola Subcounty, the adoption of these varieties reflects farmers' proactive efforts to enhance resilience and sustain agricultural outputs. However, continued research and support are necessary to ensure the availability and effectiveness of resilient crops. The significant proportion of respondents utilizing resilient varieties highlights the importance of integrating this approach into broader climate adaptation strategies.

Findings from Table 4.14 provide a comprehensive view of the challenges and adaptive measures related to climate change impacts on agricultural productivity in Magola Subcounty. The responses reveal significant challenges, such as variations in crop yields, declining soil fertility, and increased pest and disease incidences. At the same time, they highlight adaptive strategies, including adjusting planting schedules, adopting new irrigation techniques, and utilizing resilient crop varieties. These insights underscore the need for comprehensive support and strategies to help farmers manage climate change impacts effectively and sustain agricultural productivity amidst environmental changes. The findings point to the importance of integrating adaptive measures into broader climate adaptation efforts to ensure long-term agricultural sustainability and food security.

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This chapter covers the summary of the findings, conclusions based on the findings, and recommendations based on the conclusions.

5.1 Summary of the findings

5.1.1. Impact of greenhouse gas emissions on agricultural productivity in Magola Subcounty, Tororo District

Findings from Table 4.5 reveal a significant recognition among respondents in Magola Subcounty of the adverse effects of greenhouse gas emissions on agricultural productivity. Specifically, 44.4% strongly agree and 41.7% agree that increased greenhouse gas emissions have led to a decline in crop yields, a trend supported by previous studies such as those by Ogwang et al. (2021). Additionally, 30.6% strongly agree and 47.2% agree that elevated greenhouse gas levels have altered crop growth patterns, aligning with Mutekanga et al. (2022). A notable 33.3% strongly agree and 19.4% agree that rising temperatures from greenhouse gases have degraded soil quality, echoing findings by Nambi et al. (2020). Moreover, 19.4% strongly agree and 38.9% agree with increased crop diseases and pests due to greenhouse gases, consistent with Okello et al. (2021). Furthermore, 30% strongly agree and 25% agree that they have modified farming practices to adapt to these climate changes, reflecting the necessity for adaptation as highlighted by Kabir et al. (2022). Lastly, 22.2% strongly agree and 27.8% agree with concerns about the long-term sustainability of agricultural productivity amidst rising greenhouse gases, corroborating Alinor et al. (2021). Overall, these findings underscore a substantial awareness of the negative impacts of greenhouse gases on agriculture, emphasizing the urgent need for targeted interventions, adaptive measures, and sustainable practices to maintain productivity and resilience in the face of climate change..

5.1.2. Temperature changes and agricultural productivity in Magola Subcounty, Tororo District.

The findings from Table 4.8 reveal significant impacts of temperature changes on agricultural productivity in Magola Subcounty, Tororo District. A notable 30.6% of respondents strongly agreed that temperature changes have adversely affected crop yields, corroborating the research by Ogwang et al. (2021), which reported similar declines in Uganda due to temperature fluctuations. The challenges in predicting planting and harvesting times due to fluctuating temperatures were highlighted by 30.6% of respondents who strongly agreed, aligning with Ddamulira et al. (2020) on the inefficiencies in crop management. Additionally, 44.4% of respondents have observed shifts in crop varieties to adapt to new temperature conditions, reflecting the adaptation strategies discussed by Mutekanga et al. (2022). Water stress, reported by 44.4% of respondents, further supports Ogwang et al. (2021) on the impact of rising temperatures on soil moisture. The degradation of soil fertility due to temperature extremes, as noted by 33.3% of respondents, aligns with Mwesigwa et al. (2023) on the need for soil management practices. Investments in irrigation systems by 33.3% of respondents and the adoption of heat-resistant crop varieties by 30.6% highlight proactive adaptation measures supported by Kato et al. (2022) and Ssentongo et al. (2021). Regression analysis (Table 4.9) indicates a modest but significant impact of temperature changes on agricultural productivity (R = 0.174, R^2 = 0.030), suggesting that while temperature changes affect productivity, other factors likely contribute to the variability observed..

5.1.3. Effect of sea level rise and water availability on agricultural productivity in Magola Subcounty, Tororo District.

The findings from Table 4.11 reveal significant impacts of sea level rise and water availability on agricultural productivity in Magola Subcounty, Tororo District. A notable 38.9% of respondents reported decreased water availability for irrigation due to rising sea levels, reflecting research by Nicholls et al. (2018) on saltwater intrusion affecting freshwater resources and complicating irrigation. This is compounded by 30.6% of respondents experiencing reduced crop yields from water scarcity, aligning with Jones and Thornton (2009) on the critical link between water stress and productivity. Additionally, 13.9% of respondents observed increased soil salinity, a phenomenon supported by Dasgupta et al. (2014), which hampers crop growth by altering soil fertility. Waterlogging, reported by 30.6% of respondents, further impacts productivity, corroborating Fosu-Mensah et al. (2012) on the adverse effects of increased soil saturation. The need for improved water management practices, highlighted by 36.1% of respondents, is supported by Mullan et al. (2014), emphasizing adaptive strategies in response to climate change. The proactive involvement of 50.0% of respondents in developing water conservation strategies aligns with Cline (2007), and increased competition for water resources among 30.6% of respondents reflects findings by Grafton et al. (2017) on intensified water competition. Regression analysis (Table 4.12) indicates a significant correlation between sea level rise and agricultural productivity (R = 0.248, R^2 = 0.062), underscoring the substantial impact of sea level rise on water availability and productivity.

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5.2 Conclusion of the Findings

5.2.1 Impact of greenhouse gas emissions on agricultural productivity in Magola Subcounty, Tororo District

The regression analysis conducted for the impact of greenhouse gas emissions on agricultural productivity in Magola Subcounty shows a moderate but statistically significant negative correlation ($R = 0.267$, $R^2 = 0.071$). This indicates that there is a discernible effect of increased greenhouse gas emissions on the productivity of agriculture in the region. Specifically, the R^2 value of 0.071 suggests that approximately 7.1% of the variability in agricultural productivity can be explained by variations in greenhouse gas emissions. Although this represents a modest portion, it is a substantial finding given the context. The correlation coefficient of 0.267 implies a moderate strength of association, meaning that as greenhouse gas emissions increase, agricultural productivity tends to decrease. This result aligns with the recognition among respondents that greenhouse gases have adversely affected crop yields, altered growth patterns, and contributed to soil degradation and increased pest and disease pressures. The findings are consistent with the broader body of research indicating that greenhouse gases, particularly CO_2 and methane, contribute to climate change, which in turn impacts agricultural systems. The analysis underscores the importance of implementing targeted interventions and adaptive measures to mitigate these effects. Effective strategies might include promoting sustainable farming practices, improving crop varieties, and reducing greenhouse gas emissions through various means. Given the moderate correlation, it is clear that addressing greenhouse gas emissions is crucial for enhancing agricultural resilience and productivity in Magola Subcounty. This conclusion highlights the need for continued research and action to understand and manage the effects of greenhouse gases on agriculture, ensuring that farmers are equipped to handle the challenges posed by a changing climate.

5.2.2 Temperature changes and agricultural productivity in Magola Subcounty, Tororo District.

The regression analysis for the impact of temperature changes on agricultural productivity in Magola Subcounty reveals a modest but significant effect ($R = 0.174$, $R^2 = 0.030$). This indicates that temperature fluctuations have a measurable impact on agricultural productivity, although the effect size is relatively small. The R^2 value of 0.030 suggests that only 3% of the variability in agricultural productivity is explained by temperature changes, highlighting that other factors also play significant roles in influencing productivity. The correlation coefficient of 0.174 denotes a weak to moderate positive association, meaning that while there is a relationship between temperature changes and agricultural productivity, it is not the sole determinant of productivity outcomes. The analysis reflects the challenges faced by farmers due to temperature variability, such as difficulties in predicting planting and harvesting times, water stress, and soil fertility degradation. These issues are consistent with the findings that temperature changes affect crop yields and necessitate adaptation measures, such as shifting crop varieties and investing in irrigation systems. Although the impact is modest, it remains significant enough to warrant attention and action. The results suggest that while temperature changes do influence agricultural productivity, addressing this issue requires a multifaceted approach that includes not only managing temperature impacts but also considering other contributing factors. This may involve improving crop management practices, enhancing irrigation techniques, and adopting heat-resistant crop varieties. The modest correlation highlights the need for comprehensive strategies to address temperature-related challenges and ensure agricultural productivity and resilience in Magola Subcounty.

5.2.3 Effect of sea level rise and water availability on agricultural productivity in Magola Subcounty, Tororo District.

The regression analysis for the effect of sea level rise on agricultural productivity in Magola Subcounty demonstrates a significant correlation ($R = 0.248$, $R^2 = 0.062$). This indicates that sea level rise has a meaningful impact on agricultural productivity, with the R^2 value of 0.062 suggesting that 6.2% of the variability in productivity can be attributed to changes in water availability resulting from rising sea levels. The correlation coefficient of 0.248 reflects a moderate positive association, implying that increased sea levels are associated with decreased agricultural productivity. This finding is consistent with the observed decrease in water availability for irrigation, increased soil salinity, and waterlogging issues reported by respondents. The significant correlation underscores the direct impact of sea level rise on water resources and agricultural productivity, highlighting the importance of effective water management practices. Adaptive strategies, such as improved irrigation systems, rainwater harvesting, and soil management techniques, are crucial for mitigating the adverse effects of sea level rise. The results also reflect the need for proactive water conservation measures and equitable water resource management to address competition and ensure sustainable agricultural practices. The significant correlation indicates that addressing sea level rise and its impact on water availability is critical for maintaining agricultural productivity and resilience in Magola Subcounty. This conclusion underscores the need for targeted interventions and adaptation measures to manage the effects of sea level rise, ensuring that agricultural systems can continue to thrive despite the challenges posed by climate change.

5.3 Recommendations of the Findings

5.3.1 Impact of greenhouse gas emissions on agricultural productivity in Magola Subcounty, Tororo District

Given the observed impact of greenhouse gas emissions on agricultural productivity, it is recommended that stakeholders implement comprehensive strategies to mitigate the effects of climate change. There should be an emphasis on promoting sustainable agricultural practices, such as adopting conservation tillage, enhancing soil carbon sequestration, and utilizing climate-resilient crop varieties. Farmers should be encouraged to participate in programs that aim to reduce greenhouse gas emissions through improved nutrient management and precision agriculture. Additionally, education and training programs should be established to increase awareness among farmers about the impact of greenhouse gases and effective adaptation techniques. Policymakers should support initiatives that target greenhouse gas reductions and provide incentives for practices that lower emissions. Continued research into the specific effects of greenhouse gases on local agricultural systems will be essential to developing targeted solutions. Collaboration between government agencies, research institutions, and local communities is crucial for creating and implementing effective strategies to enhance agricultural productivity while addressing the challenges posed by greenhouse gas emissions..

5.3.2 Temperature changes and agricultural productivity in Magola Subcounty, Tororo District.

To address the challenges posed by temperature changes on agricultural productivity, it is recommended that farmers and stakeholders adopt adaptive measures to cope with temperature fluctuations. This includes investing in irrigation systems to manage water stress effectively and selecting crop varieties that are resilient to temperature extremes. Enhancing soil management practices to maintain soil fertility and structure under varying temperature conditions is also crucial. Extension services should focus on providing farmers with information and tools for adapting to temperature changes, including best practices for planting and harvesting in a changing climate. Research into heat-resistant crops and innovative agricultural technologies should be prioritized to support long-term productivity. Policymakers should consider implementing policies that support climate adaptation and provide financial assistance for the adoption of adaptive technologies. Collaborative efforts between researchers, agricultural extension services, and local communities will be essential in developing and disseminating strategies to mitigate the impact of temperature changes on agricultural productivity..

5.3.3 Effect of sea level rise and water availability on agricultural productivity in Magola Subcounty, Tororo District.

In response to the effects of sea level rise on water availability and agricultural productivity, it is recommended that comprehensive water management strategies be developed and implemented. This includes investing in infrastructure to manage water resources effectively, such as improved irrigation systems, drainage solutions, and rainwater harvesting techniques. Farmers should be encouraged to adopt water-efficient practices and technologies to minimize water use and manage water resources more sustainably. Additionally, soil management practices that address soil salinity and waterlogging should be promoted, including the use of salt-tolerant crop varieties and soil amendments. Local governments should support initiatives that enhance water conservation and ensure equitable access to water resources. Community-based approaches to water management can help address competition for water and foster collaboration among farmers. Continued research into the impacts of sea level rise on water availability and agricultural productivity will be important for refining adaptation strategies and ensuring the sustainability of agricultural practices in the face of rising sea levels.

5.4 Contributions of the study

This study contributes significantly to understanding the multifaceted impacts of climate change on agricultural productivity in Magola Subcounty, Tororo District. By analyzing the effects of greenhouse gas emissions, temperature changes, and sea level rise on agricultural practices, the study provides valuable insights into how these climate variables affect crop yields, soil quality, and water availability. The findings offer a comprehensive view of the challenges faced by local farmers, highlighting the urgent need for targeted adaptation strategies and sustainable practices. The research underscores the importance of proactive measures, such as adopting resilient crop varieties, improving water management systems, and implementing effective soil conservation techniques. Additionally, the study emphasizes the role of collaboration between stakeholders, including policymakers, researchers, and local communities, in addressing the adverse effects of climate change. Overall, the study's contributions lie in its ability to inform policy decisions, guide agricultural practices, and support the development of strategies aimed at enhancing agricultural resilience and sustainability in the face of ongoing climate challenges..

5.4 Areas for further research

Future research should explore several critical areas to enhance our understanding of climate change impacts on agriculture. First, it is essential to investigate the long-term effects of greenhouse gas emissions on soil health and crop productivity, focusing on how different greenhouse gas mitigation strategies influence agricultural outcomes. Second, studies should examine the efficacy of various adaptation measures, such as the adoption of heat-resistant crop varieties and advanced irrigation technologies, in diverse climatic and soil conditions. Additionally, research should assess the socioeconomic impacts of climate-induced changes on farming communities, including shifts in income, labor dynamics, and food security. Furthermore, there is a need for detailed investigations into the interplay between sea level rise and water availability, particularly in coastal and low-lying agricultural areas, to develop targeted water management solutions. Finally, future studies should prioritize interdisciplinary approaches that integrate climate science, agronomy, and socio-economic factors to create comprehensive and actionable strategies for building agricultural resilience in the face of climate change.

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QUESTIONNAIRE

Dear respondent,

MY Name is OBWIN ALBERT AMUKUN, a student of Uganda Christian University pursuing Bachelors in social work and social administration. The purpose of this study is to investigate "EFFECT OF CLIMATE CHANGE ON AGRICULTURAL PRODUCTIVITY IN MAGOLA SUBCOUNTY IN TORORO DISTRICT' 'you have a wealth of important information that is very useful in this exercise. The information collected will be held in strict confidentiality and in no way be personalized. You are therefore requested to respond to the questions below as objectively and as accurately as possible.

Instructions:

Please tick the most appropriate box.

SECTION A: BACK GROUND INFORMATION

Tick in the boxes the alternative that represents your opinion. There is no right or wrong Answer,

Any response you give will be respected because it represents your view.

1 Gender

FEMALE	MALE
1	2

2. Age bracket

18-30	31-43	44-56	57-69	70 and above
1	2	3	4	5

3 Qualifications: What is your highest academic qualification?

Certificateand below	DiplomaLevel	Degree Level	Master Level	PHD Level	Professional Level
1	2	3	4	5	6

4. Departments: In which department do you work?

Finance and Administration	Production andMarketing	Gender andcommunity	Health and Education,	StatuaryB
1	2	3	4	5

5 Number of years worked at Magola SubCounty

1-2	3-4	5-6	7 and above	
1	2	3	4	

SECTION B: Agricultural productivity in Magola Subcounty, Tororo District

Please indicate your level of agreement with the statements below by ticking the appropriate column. Strongly Agree- (SA) Agree- (A) , Not sure- (NS) Disagree- (D), Strongly Disagree-(SD)

Strongly Agree	**Agree**	**Not Sure**	**Disagree**	**Strongly Disagree**
SA	A	NS	D	SD

	Statement	**SA**	**A**	**NS**	**D**	**SD**
1	I observed significant variations in crop yields due to changes in rainfall patterns.					
2	I have adjusted planting schedules based on seasonal temperature changes.					
3	I have noticed a decline in soil fertility as a result of altered weather conditions.					
4	I have adopted new irrigation techniques to manage water availability more effectively.					

5	I am concerned about the impact of pests and diseases, which have increased with changing climate.					
6	I have seen a shift in the types of crops that can be successfully grown in Magola Subcounty.					
7	I am utilizing more resilient crop varieties to cope with unpredictable weather patterns.					

SECTION C: impact of greenhouse gas emissions on agricultural productivity in Magola Subcounty, Tororo District

	Statement	SA	A	NS	D	SD
1	I have observed a decline in crop yields linked to increased greenhouse gas emissions.					
2	I have noticed changes in crop growth patterns due to elevated levels of greenhouse gases.					
3	I am aware that rising temperatures from greenhouse gases have affected soil quality in Magola Subcounty.					
4	I have experienced increased incidences of crop diseases and pests, which are attributed to greenhouse gases.					
5	I have had to modify farming practices to adapt to the changing climate caused by greenhouse gas emissions.					
	I am concerned about the long-term sustainability of agricultural productivity amid rising greenhouse gases.					
	I have adopted greenhouse gas mitigation strategies to improve crop resilience.					

SECTION D: Temperature changes and agricultural productivity in Magola Subcounty, Tororo District

	Statement	SA	A	NS	D	SD
1	I have observed that temperature changes have significantly affected crop yields in Magola Subcounty.					
2	I am experiencing difficulties in predicting planting and harvesting times due to fluctuating temperatures.					
3	I have noticed shifts in crop varieties being planted to adapt to new temperature conditions.					
4	I have seen increased water stress in crops due to higher temperatures affecting soil moisture.					
5	I am aware that temperature extremes are contributing to reduced soil fertility and crop productivity.					
	I have had to invest in irrigation systems to counteract the effects of temperature changes on crops.					
	I am involved in adopting heat-resistant crop varieties to cope with rising temperatures.					

SECTION E: Effects of sea level rise and water availability on agricultural productivity in Magola Subcounty, Tororo District

	Statement	SA	A	NS	D	SD
1	I have observed decreased water availability for irrigation due to rising sea levels affecting nearby areas.					
2	I am experiencing reduced crop yields because of the scarcity of water resources influenced by sea level rise.					
3	I have seen changes in soil salinity due to increased sea levels, impacting crop growth in Magola Subcounty.					
4	I am aware that waterlogged fields have become more common, affecting crop productivity negatively.					
5	I have noted the necessity for improved water management practices in response to changes in water availability.					

6	I am involved in efforts to develop water conservation strategies to mitigate the effects of sea level rise.					
7	I have observed increased competition for water resources among local farmers due to rising sea levels.					

Appendix ii: Interview Guide

To evaluate the impact of greenhouse gas emissions on agricultural productivity in Magola Subcounty, Tororo District.

1. How have you observed greenhouse gas emissions affecting agricultural productivity in Magola Subcounty?
2. Can you provide examples of how specific greenhouse gases, such as carbon dioxide or methane, have influenced your agricultural activities?
3. What changes have you noticed in soil quality and crop health that you attribute to greenhouse gas emissions?
4. How have greenhouse gas emissions influenced the types of crops that are grown or the farming techniques used in Magola Subcounty?
5. What measures, if any, have been implemented to mitigate the impact of greenhouse gas emissions on agriculture, and how effective have these measures been?

ii. To assess how temperature changes affect agricultural productivity in Magola Subcounty, Tororo District.

1. How have recent changes in temperature affected your crop yields and overall agricultural productivity?
2. Have you noticed any particular temperature trends that are especially concerning or beneficial for your farming activities?
3. What adjustments, if any, have you made to your farming practices in response to temperature changes?
4. How do temperature fluctuations affect the timing of planting and harvesting in Magola Subcounty?
5. What support or resources would be helpful to better adapt to temperature changes and improve agricultural productivity?

iii. To analyze the effects of sea level rise and water availability on agricultural productivity in Magola Subcounty, Tororo District.

1. How has the availability of water for irrigation and other agricultural needs been affected by sea level rise in Magola Subcounty?
2. Can you describe any changes in water sources or irrigation practices that have resulted from changes in sea level?
3. How have fluctuations in water availability influenced your crop selection and yields?
4. What strategies have you implemented to manage water scarcity or excess due to sea level rise, and how successful have these strategies been?
5. What additional measures or support would you need to better cope with the effects of sea level rise and water availability on your agricultural activities?

UGANDA CHRISTIAN UNIVERSITY

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MBALE UNIVERSITY COLLEGE.

Office of the Academic Registrar

To SAS

MAGOLA S/C

SUBCOUNTY CHIEF'S OFFICE MAGOLA 03 SEP 2024 TORORO DISTRICT LOCAL GOVERNMENT

Received on 3rd/9/2024

Dear Sir/Madam,

Re: Academic Research

Christian greetings!

We are honored to introduce to you Mr. Mrs. /Miss OBWIN ALBERT AMUKUN Of Registration Number J22/MUC/BSW/073 pursuing a Masters' Degree/Postgraduate Diploma / Bachelor's Degree IN SOCIAL WORK AND SOCIAL ADMINISTRATION

He/ she is required to carry out academic research on the topic EFFECTS OF CLIMATE CHANGE ON AGRICULTURE PRODUCTIVITY IN MAGOLA SUBCOUNTY IN TORORO DISTRICT and thereafter produce a well bound hard cover research report (**MAROON**) in color for undergraduate and three (**BLACK**)copies for Postgraduate students as a university requirement for the award of a degree/diploma in the academic discipline that he / she is pursuing.

We shall be grateful for the help you may offer to him or her accordingly.

Thank you.

Yours faithfully,

Mr. Akampurira Timothy

Academic Registrar

UGANDA CHRISTIAN UNIVERSITY 02 SEP 2024 ACADEMIC REGISTRAR MBALE UNIVERSITY COLLEGE

A Complete Education for a Complete Person

P.O Box, Mbale, Uganda, email: academicregistrar@mbale.ucu.ac.ug