DROUGHT ADAPTATION STRATEGIES AND SUSTAINABILITY OF FOOD SECURITY IN MANDERA COUNTY, KENYA

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MOUNT KENYA UNIVERISTY

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DECLARATION AND APPROVAL

Declaration by Student

This is my original work and has not been submitted for examination in any study program in any university.

Sign..... **Date:** 14/04/2025

HASSAN ROBOW MOHAMED

MPAM/2014/62356

Approval by Supervisor

This work has been done by the student under my supervision as a University supervisor.

Sign ..... **Date:** 14/04/2025

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DEDICATION

I would like to dedicate this research study to my family members who have endured a lot throughout this research process.

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ACKNOWLEDGEMENT

I would like to acknowledge the contribution of my supervisor Dr. Christopher Mutembei for his continued guidance, my family and friends for their valued contribution and input towards this study. I am grateful to all the Mount Kenya University staff for helping me access necessary information and materials for development of this research.

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ABSTRACT

Food security projects are created to accomplish the legislative goals of improving food access in low-income communities. They help develop proactive approaches for the welfare of low-income communities by creating their own comprehensive and sustainable food systems. In this regard, numerous food security projects have been initiated in most Kenyan Counties by both state and non-state prayers in Kenya. However, sustainability of food projects has been a challenge in the sense that some projects remain partially operational after the withdrawal of the main donor while others become defunct. This study thus established the extent to which drought adaptation strategies affect food security sustainability. The study sought to establish the effect of crop diversification, integrated water management and supplemental feeding on food security sustainability. In addition, the study examined how the moderating role of stakeholder engagement on drought adaptation strategies and sustainability of food security in Mandera County, Kenya. The study is anchored on Systems theory, Stakeholder theory and Anthropogenic global warming theory. A descriptive research design was adopted. The target population for this study was government funded food security projects in Mandera County. According to NDMA (2022) there are two main projects for food security in Mandera County which include Kutulo Water Pan and Irrigation project in Kutulo Sub-County, Mandera County and Koromey Irrigation project. The main study subjects was project supervisors, government officials and community leaders. Data was collected using a structured questionnaire to obtain quantitative data. The quantitative data was analyzed through descriptive and inferential statistics using multiple regression models. The study found that crop diversification significantly improves food security sustainability, with each unit increase in efforts increasing food security by 0.086 units. The study reveals that most community members in Mandera County have adopted supplemental feeding for their livestock to a low extent, with most respondents indicating limited adoption. The study reveals a negative relationship between integrated water management and food security sustainability, possibly due to implementation challenges or resource allocation inefficiencies. The study found that most community members in Mandera County have adopted supplemental feeding for their livestock to a low extent. The study found a statistically significant positive effect of supplementary feeding on the sustainability of food security in Mandera County. The study shows that most respondents feel that stakeholders are engaged in food security projects to a low extent, with a significant majority (71.5%) reporting suboptimal engagement levels. The study reveals a negative relationship between integrated water management and food security sustainability, indicating a need for reassessment of current strategies. The County Government of Mandera formulated policies that ensure farmers have access to a variety of seed options, including drought-resistant and hybrid crops, to promote crop diversification and improve food security.

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LIST OF ABBREVIATIONS AND ACRONYMS

FAO	Food and Agriculture Organization
GoK	Government of Kenya
IWRM	Integrated Water Resource Management
NDMA	National Drought Management Authority
NGOs	Non-Governmental Organizations
SSA	Sub-Saharan Africa
UNSDG	United Nations Sustainable Development Goal
WFP	World Food Program
WHO	World Health Organization

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The last three decades has witnessed substantial strides in increasing global food production by the world's governments. However, the world still face challenges to feed 9.8 billion people by 2050, especially over drought-prone and dry areas of the developing world (Bindraa, Hamid, Salem, Hamuda, & Abulifa, 2017). Moreover, food security has received much attention in recent years, from both academics and non-academics (Lang & Barling 2012; Allen 2013). This increase in attention is particularly noticeable after the 2007–2008 and 2010 world food price crises and the 2008 World Development Report, which called for greater investment in agriculture in developing countries. These events made clear that, in spite of decades of efforts to eradicate hunger and malnutrition, food insecurity is still a significant problem. Furthermore, it has become increasingly clear that food security is strongly interlinked with other issues, such as global environmental change and energy markets, and that its policy environment is undergoing transformation and globalization (Lang et al. 2012).

With more effective adaptation strategies and actions, the impact of elevated drought risk due to climate change (Berg, 2018) can be reduced and help facilitate progress towards hitting the second United Nations Sustainable Development Goal (SDG) (i.e. zero hunger). Synchronous challenges are emerging if multiple inter-related SDG goals are to be achieved simultaneously (e.g. SDG2 to ensure food security, SDG6 to ensure water security, SDG13 to foster resilience), as they interact across a range of spatial and temporal

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scales, leading to diverse trade-offs, synergies and even competing policy responses with impacts that are also scale-dependent (Gao &Brian, 2017). Understanding such cross-scale interactions is key for policymakers and stakeholders to develop adaptation policies that can effectively reduce the impacts of drought on agricultural production, and to increase societal resilience to future drought-induced emergencies, while still meeting competing demands and enhancing environmental sustainability.

Drought mitigation activities are aimed at preserving livelihoods and typically planned for the early stages or onset of drought. However, mitigation activities are generally still practiced only on a pilot scale, and largely by NGOs, because of high transaction costs that the careful planning and in-depth knowledge of local conditions requires (Scoones, 2010). . If mitigation activities are successful, they are preferable to food relief, because they are more cost-effective, strategically provide inputs to livelihoods and let people feed themselves and take place early in the drought cycle before people are totally destitute. In principle, mitigation activities should involve low levels of subsidy, at least explicit subsidy, per benefiting household. They provide a better basis for sustainable livelihoods post-drought, and they are generally regarded as preferable, morally and in terms of human dignity, to mass distribution of free food (Heath, 2011).

Globally, droughts caused 1820 million Mg loss of cereal (maize, rice, and wheat) production over the past four decades (Lesk, Rowhani, & Ramankutty, 2017). The extent to which various types of droughts affect food security is highly linked to their spatio-temporal footprint (Xu, Tian, He, Sun, Fan, Fischer, Wang, Pope, Kent, & Zhong, 2019). In 2015, severe drought caused $2.7 billion in economic losses in California alone

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(Howitt, 2017). Drought directly affects agriculture, the landscaping industry, and even hardware retailers. Agricultural losses due to drought conditions resulted in $787.2 million in losses for Georgia in 2007. In addition, recreational activities are impacted, including hunting, fishing, skiing and snowmobiling—all of which can significantly impact local economies (Knutson, Redmond, & Svoboda, 2015). Drought can also cause costly structural damage such as drying soil shifts, damaging foundations and underground infrastructure

Agriculture in Africa is highly vulnerable to climate change and variability (Schlenker and Lobell, 2010). The occurrence of climate-induced rainfall shock in general and drought shock in particular affects food security in many developing countries (Wossen et al., 2016). As a result of climate change, droughts have become more severe, longer, and more frequent (Hyman et al., 2008). The economic costs can, therefore, be enormous as drought has the potential to cause a severe food crisis, hunger and malnutrition, as well as sustained long-term poverty traps due to the limited adaptive capacity of smallholders (Collier et al., 2008, Bryan et al., 2013).

Food and Agriculture Organization (2017) has indicated the importance of food security in the world over almost a century ago. According to FAO (2017), food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life. Household food security is the application of this concept to the family level, with individuals within households as the focus of concern. On the other hand, food insecurity exists when people do not have adequate physical, social or economic access to

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food etc. World Bank (2016) has shown the importance of FSP in the 21st century by indicating that food security is a central indicator of economic development in developing countries in Asia, Africa and South America.

Sustainable food security is a relatively new food security-promoting strategy that considers all the factors within a region or community's food system that influence the availability, cost, and quality of food to area households, particularly those in lower income communities (Tauber & Fisher, 2015). They argue that since sustainable community food security focuses on regional and local food systems, it is concerned with the full range of food chain events including agriculture, the availability of supermarkets and other affordable outlets for quality food, the involvement of the wider citizenry and local and state governments in searching for solutions to food insecurity, and the services and environments that encourage healthy food choices including schools, nutrition service providers, and commercial food operations. Based on these broader conceptualizations, it is evident that sustainable community food security projects encompass a wide variety of community-based efforts to increase the quantity, quality, and affordability of food for local residents, especially for poor members of the community.

Sustainable management of food insecurity thus requires a new paradigm that focuses on the role of the state in a determined attack on poverty and hunger as a way of protecting the basic rights of people (Bindraa, Hamid, Salem, Hamuda, & Abulifa, 2017). Since small-scale farmers in rural areas provide more than 70% of food in developing countries, focus in this paradigm shift should be on their needs and potential. Special attention should be given to rural semi-arid small holders that are persistently dealing with the indignity of

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drought-driven food insecurity. The ERA-Net SUSFOOD (Sustainable FOOD production and consumption) project defines sustainability in the food area as a food system that supports food security, makes optimal use of natural and human resources and respects biodiversity and ecosystems for present and future generations, is culturally acceptable and accessible, environmentally sound and economically fair and viable, and provides the consumer with nutritionally adequate, safe, healthy and affordable food (The ERA-Net SUSFOOD, 2018).

In their study that focused on influencing factors of food security in China, Tang, Baiand Tang, (2015) has shown that there are a number of determinants influencing the implementation of food security in the country and these factors have placed the country in a better position of managing its food production for over decades. These factors include: agricultural mechanization, chemical fertilizer, efficient irrigation and food policy. Besides, the agricultural labor force, national financial allocation for agricultural science and technology, rural electricity consumption among others influence the performance of food security in the country. Another study by has indicated that, China's past success in grain self- sufficiency doesn't reflect its future vulnerability to food insecurity since the demand for crops for nonfood use is rising enormously.

Regionally, a report by the In On Africa (2018) has shown that despite the fact that most African countries are food insecure, there are a number of these countries that have made a number of strides in achieving food security. The list indicates that, Tunisia leads in terms of food security in Africa with a mean food security score of 68.2%, followed by Mauritius with a score of 67.33%, Morocco with a score of 64.38%, Algeria- 63.86%, Egypt-

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60.03%,Gabon-58.81%, South Africa-57.88%, Ghana53.57%, Senegal-52.16% and Namibia-51.42%. In the report, it is argued that political will by governments to prioritize food security, combined with use of new crops and food production technologies, has allowed some of the abovementioned countries to break the chains of food insecurity. In addition, other factors like crop diversification, use of modern technology in both irrigation and pests and diseases control, use of modern methods of water management, education and training to the farmers and many more have increased food security in Mauritius and Tunisia.

In East Africa, a report by FAO (2018) has shown East Africa as one region that rates high in terms of food insecurity. According to the report, factors such as climate change, droughts and frequent floods, diversion of food products for production of biofuels, piracy, and increasing demand for food products from emerging countries have led to sharp increases in the prices of food products in the region; making them uniquely vulnerable to food insecurity. According to Global Action Programme on Food Security (2017), in Uganda for example, a number of factors have posed a lot of threats to this country becoming food insecure. These factors include: limited land mass and population; fragile natural environments and lack of arable land; high vulnerability to climate change, external economic shocks, and natural disasters; typically, high dependence on food imports; dependence on only one or two economic pillars; and distance from global markets.

Studies in Kenya have indicated that the country has a very big index of food insecurity despite the fact that there are a number of strategies and advances that have been made to address this issue (FAO, 2018 and KARI, 2017). Kenya Agricultural Research Institute

(2017) for example has shown that in the recent decade, and especially starting from 2008, the country has been facing severe food insecurity problems. These are depicted by a high proportion of the population having no access to food in the right amounts and quality. In 2017 Kenya drought led to a national emergency and left 2.5 million people facing food insecurity (IFRC, 2018).Official estimates indicate over 10 million people are food insecure with majority of them living on food relief. Households are also incurring huge food bills due to the high food prices. Maize being staple food due to the food preferences is in short supply and most households have limited choices of other food stuff; calling for urgent measures of tackling this problem.

According to NDMA (2017), reflecting the substantial decline in food security, the KFSSG short rains assessment that was conducted in 23 counties in January 2017 estimated that a total of 2.6 million people is acutely food insecure and require urgent humanitarian assistance, mainly in Kenya‘s pastoral and marginal agricultural areas. This represents an increase in needs by about 100 percent from the last long rains assessment in July 2016. FAO (2017) has shown that, in pastoral areas in Kenya, including northwestern (Turkana, Samburu, West Pokot, Baringo), northeastern (Mandera, Wajir, Isiolo), northern (Marsabit), southeastern (Garissa, Tana River), and southern (Narok, Kajiado) regions, continue to experience an atypical decline in household food security, a situation that started even before the October – December 2016 short rains.

Due to the state of food insecurity in the country, various bodies and government agencies have come up with sustainability strategies to address the issue of food security in the country (NDMA, 2017). A number of these strategies were proposed in early 2008 when

the national drought management authority was formed and placed under the ministry of agriculture. Some of these strategies include: Education strategy; Crop diversification; Tackling climate change; integrated water management strategy; integrated nutrient management strategy; improved varieties and many more. However, despite the fact the government and other agencies have come up with a number of strategies; there still exist challenges since food insecurity is persistent and increases each day in Kenya.

Mandera County is an arid area with sensitive ecological systems whose main economic activity is pastoralism. It is practiced in a sensitive and insecure environment characterized by highly spatial and temporal rainfall distribution, which often result in long, dry periods. The livelihoods of pastoralist communities largely depend on livestock. The County has experienced recurrent droughts, human conflicts, terrorism, epidemics, human wildlife conflicts and animal disease whose impacts have increased immensely. Currently, climate change poses a threat to human development in terms of security and livelihood in Mandera as climate change and pastoralists' livelihood are interlinked processes making it one of the greatest and most complex challenges Kenya has to deal with today and in the years to come in order to achieve vision 2030.

1.2 Statement of the Problem

Most North Eastern inhabitants derive their food and income needs from livestock. However, droughts cause a decline in livestock product quality and sometimes death of herds due to increased disease coupled with the poor body condition of livestock during the dry season, thus, increasing the community vulnerability levels and exposing many households to food insecurity and starvation (NDMA, 2018). Contextually, Mandera

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County is characterized by fragile and sensitive ecosystems with persistent droughts, floods, epidemics, livestock diseases and conflicts. Various food security projects have been implemented across the county. However, the achievement of their sustainability has been a big challenge as indicated by quite a number of projects which have failed and their impacts among the community have not been felt.

Management Authority (NDMA) reported that nearly 62% of livestock in Mandera had been lost due to a combination of lack of water and grazing land. The prolonged dry seasons severely impacted the availability of pastures, leading to weakened animals and large-scale deaths. The Food and Agriculture Organization (FAO) also reported that in Northern Kenya, including Mandera, over 2.4 million livestock were lost by the end of 2022 due to drought across affected counties. This directly affects the livelihoods of many families in Mandera County, where over 70% of income comes from pastoralism.

Various studies have been conducted on drought adaptation strategies in Arid areas. Mugalavai and Tawane (2018) did an investigation on evaluation of mitigation strategies for climate change adaptation in Mandera County, Kenya. Waswa and Makoti (2015) investigated rural community coping strategies with drought-driven food insecurity in Kwale County. Micheni (2015) did a study on the factors influencing household food security among the pastoral communities: the case of Pokot North District in Kenya and found out that factors like: drought, insecurity, illiteracy; poverty, cultural beliefs and poor market structures influence food security. However, this study focused on food security at household levels and did not tackle the concept of sustainability of the whole process. Kabubo-Mariara and Karanja (2007) carried a study on the economic impact of climate on

crop agriculture and the results showed that climate affects crop revenue negatively. M'Mboroki (2018) did a study on climate change impacts and adaptive mechanisms of pastoral communities in Mukogodo forested areas of Laikipia County, Kenya and the findings showed that variability in rainfall and temperatures has contributed to change in land use. However, based on the reviewed empirical literature, there is empirical paucity on the literature directed towards addressing the issue of food security sustainability through drought mitigation strategies. It is against this background that this study investigates the effect of drought adaptation strategies on food security sustainability in Mandera County, Kenya.

1.3 Purpose of the Study

The purpose of the study was to investigate the drought adaptation strategies and sustainability of food security in Mandera County, Kenya.

1.4 Objectives of the study

i. To determine the effect of crop diversification on sustainability of food security in Mandera County, Kenya.
ii. To establish the effect of integrated water management on sustainability of food security in Mandera County, Kenya.
iii. To find out the effect of supplementary feeding on sustainability of food security in Mandera County, Kenya.
iv. To evaluate the moderating effect of stakeholder engagement on the relationship between drought mitigation strategies and food security sustainability in Mandera County, Kenya

1.5 Research Hypothesis

The study sought to test the following null hypotheses:

H_{01}: There is no significant effect of crop diversification on sustainability of food security in Mandera County, Kenya.

H_{02}: There is no significant effect of integrated water management on sustainability of food security in Mandera County, Kenya.

H_{03}: There is no significant effect of supplementary feeding on sustainability of food security in Mandera County, Kenya.

H_{04}: There is no moderating effect of stakeholder engagement on the relationship between drought mitigation strategies and sustainability of food security in Mandera County, Kenya.

1.6 Significance of the Study

This study is expected to benefit the national government by allowing it to have firsthand information about the various factors that influence the performance of the food security programmes in the country. The study findings may specifically give the required information of what needs to be done to ensure food security currently and in the future without interfering with the environment negatively. The Ministry of Agriculture and the NDMA was able to understand why the food security issue has been deteriorating over time and what needs to be done to address the situation currently without having bad future effects.

The county government shall be able to get first-hand information that may help the Department in charge of agriculture and natural resources management, and the department

in charge of special programmes to come up with measures that can address the current situation of food insecurity in the county while taking care of the future situation.

The study may also be of beneficial to scholars in related future investigation as it can form a basis for discussions in studies related to the issues leading to unsustainable food security projects hence food insecurity in Kenya. The study may inform the academicians of the present gaps in knowledge on the sustainability of food projects and how those gaps could be addressed

1.7 Scope of the Study

The conceptual scope of the study is to investigate the relationship between drought adaptation strategies and sustainability of food security in Mandera County. Contextual scope of the study was food security programmes in Mandera County, Kenya. Specifically, the study looked at crop diversification, integrated water management, supplemental feeding and stakeholder engagement on food security sustainability. The study targeted government funded food security projects which include Koromey Irrigation project and Kutulo Water Pan and Irrigation project in Kutulo Sub-County, Mandera County. The study considered data for 5 years, that is, 2020-2024.

1.8 Study Limitations and Delimitation

The researcher made considerate efforts in ensuring the success of the study. However despite these efforts the study may encounter several limitations. Accessibility to information may not be very easy because the senior county staff and stakeholders may not easily accessible and when accessed they may not be willing to give out information

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sought. This challenge was mitigated by presenting an authorization letter from the University and explaining the purpose of the research study.

1.9 Study Delimitation

The study was delimited to investigating the effect of drought adaptation strategies on food security in Mandera County. The drought adaptation strategies constructed are crop diversification, integrated water management, supplementary feeding and stakeholder engagement only. The study also delimited to food security projects within Mandera County and excludes all other projects not related to food security.

1.10 Assumptions of the Study

The study is based on the following assumptions. One of the assumptions is that the recurrent drought strategies used by the pastoralist are effective on food security in Mandera County. It is also assumed that there are drought mitigation strategies carried out by the pastoralists to mitigate the effects of drought on food security among the pastoralists in Mandera County. The methodologies and instruments that was employed for the collection of data was appropriate and relevant for the purpose and objective of this research. The study also assumes that the respondents would be honest in responding to the data collection instruments.

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1.11 Operationalization of Terms

Drought is defined as a trend away from a precipitation norm toward persistent reduced precipitation, causing a reduction in water supplies.

Drought adaptation strategies Refers to a procedure undertaken to reduce the adverse impacts of drought on the environment.

Food security refers to ensuring that there is availability, stability and accessibility of food supplies in the county.

Integrated Water Management is a coordinated, goal-directed process for controlling the development and use of rivers, lakes, ocean, wetland, and other water assets

Supplementary feeding Refers to a programme in which feed is provided to selected animals to prevent starvation.

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CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature related to the study drawn from the study objectives. The thematic areas include: empirical literature review on drought mitigation strategies, theoretical framework, conceptual framework, and summary of literature review.

2.2 Empirical Literature

This section reviews studies related to drought adaptation strategies and food security with an aim of identifying research gaps thus directing future research efforts.

2.2.1 Crop Diversification and Sustainability of Food Security

Douyon (2018) researched on the impact of crop diversification on household food and nutrition security in Southern and Central Mali. The methodological approach initially consisted of collecting all the information available on household food and nutritional security. Subsequently, a survey was carried out to verify the hypotheses. The bibliographic review also enabled us to better define the theme on the one hand and to take stock of the results of research and studies relating to the subject on the other hand. In this study, multinomial logistic regression (MLR) was used. The findings indicated that crop diversification has a significant effect on household food security.

Appiah-Twumasi and Asale (2022) did a study to assess crop diversification and farm household food and nutrition security in Northern Ghana. This study uses primary data and an ordered probit model to examine how crop diversification impacts the food security outcomes of rural farmers in northern Ghana. The findings revealed that along with other

factors like access to extension services and use of soil fertility management practices, crop diversification increased food access and reduced the food insecurity experience of households.

2.2.2 Integrated Water Management and Sustainability of Food Security

Bindraa, Hamid, Salem, Hamuda, and Abulifa (2017) researched on sustainable integrated water resources management for energy production and food security in Libya. The study adopted Technical Background Document Strategic Framework for Water Security and Climate Resilient that provides a Development Capacity Building Plan for the Framework Policy Briefs. The study added that water planning, policies for water conservation, water recycling, water harvesting, technology use in water management and many other initiatives influence the water amounts that have a direct influence on sustainable food security.

Kivuva (2018) investigated the effects of integrated water resource management on food security in drylands. To address the study objectives, both primary and secondary data was collected and analyzed. The study applied qualitative and quantitative data collection methods. Primary data was collected from a sample of 99 households drawn from 16400 households of Kikuu River Sub-catchment by use of an open-ended questionnaire. A Simple random sampling method was used to recruit the study respondents. The data collected was analyzed both using descriptive statistics such as the mean, percentages and elaborated in tables and graphs. The study results revealed that adoption of water irrigation efficient methods such as basin/Zypit and terraces promoted livelihood and household food production.

2.2.3 Supplementary Feeding and Sustainability of Food Security

Guyo (2015) investigated the effects of drought management strategies used to improve livestock production during drought in Isiolo County. Descriptive study design was adopted. The sample was 6 government line officials, 5 NGO officials 5 veterinary officials, 4 community leaders and 204 farmers. In total the sample size was 224. Data was analyzed both qualitatively and quantitatively by use of statistical package for social sciences. The study results revealed that the majority of the farmers practice supplementary feeding and that they did it timely and by so doing they realized value addition from the practice.

Sahal (2014) researched on the effectiveness of intervention strategies for mitigating drought effects in Kenyas pastoral livelihood. The study employed descriptive survey design using both qualitative and quantitative approaches. In this study the researcher selected the stakeholders involved in drought intervention which included GoK line departments, NGOs and the pastoral community members. The study employed cluster sampling. Data was analyzed both qualitatively and quantitatively. The findings established that supplementary livestock feeding influenced mitigation of drought on livestock.

Aklilu and Wekesa (2006) in their analysis of a drought related small ruminant grain supplementation programme in Kenya concluded that this intervention, built on pastoralists own resources and capacities, reduced losses and had a positive effect on lactation in the recovery period. They further suggested the need for cost benefit analysis of supplementing

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livestock for sustained livelihoods as opposed to large-scale grain transfers for human consumption.

2.2.4 Stakeholder Engagement on Food Security Sustainability

Nyakoyo and Odhiambo (2020) examined the relationship between stakeholder involvement and implementation of sustainable community food security projects. This study was conducted in the Nyando basin in three community projects involved in hybrid cassava, sorghum and sweet potatoes farming. Two hundred and forty-five stakeholders involved in sustainable community food security projects in Nyando basin were interviewed using a questionnaire. Respondents included community farmers drawn from three food community self-help groups, county government officials, agricultural extension officers, managers of community based and non-governmental organizations involved in cassava, sorghum and sweet potato farming within the basin. Descriptive and inferential data were analyzed. Descriptive data included frequencies, means and standard deviation. Inferential statistics included correlation coefficient, coefficient of determination, ANOVA and regression coefficient. The study found a statistically significant relationship between stakeholder involvement and implementation of sustainable community food security projects.

Gatumi, Ngugi, and Kinoti (2022) investigated influence of stakeholder engagement on the sustainability food security projects in arid lands, Kenya. Cross-sectional descriptive survey was used. The study target 413 food security projects implemented by UN Agencies within 8 Counties in Arid Lands in Kenya with a sample of 203 food security projects. Stratified sampling was used and primary data was collected using self-administered

questionnaire. Descriptive statistics such as mean and standard deviation was computed to explain the characteristics of the distribution. Correlation analysis and standard multiple regression models will assist in assessing the degree of relationship between the study variables. The study findings revealed that stakeholder engagement significantly influences sustainability of food security projects in arid lands positively.

2.3 Theoretical Literature

Theoretical literature refers to interrelated concepts collected to guide the study but are not adequately refined (Kothari, 2014). The study is anchored on Systems theory, Stakeholder theory and Anthropogenic global warming theory. These theories presented a strong perspective of drought adaptation strategies from a public policy angle.

2.2.1 Systems Theory

The systems theory was pioneered by Ludwig von Bertalanffy, a biologist, in the 1940s. A system may be defined as a set of social, biological, technological or material partners cooperating on a common purpose. System theory is a philosophical doctrine describing systems as abstract organizations independent of substance, type, time and space. Systems theories are connected to both ontological and epistemological views. The ontological view imply that the world consist of "systems" or "integrative levels". The epistemological view implies a holistic perspective emphasizing the interplay between the systems and their elements in determining their respective functions (Loehle, 2004).

Due to natural disasters, such as drought and famine, there is a need to create a network for applied research, implementation, and dissemination in the field of disaster risk management. The planned work should shift away from the post-disaster response towards

an integrated risk management and sustainable risk prevention culture. The starting point of an integral risk management concept is the relation between hazard, vulnerability, risk and risk management (Scafetta, 2010). The system's theory support integrated water management variables.

2.2.2 Stakeholder Theory

Stakeholder theory was propounded by Freeman in 1984. The theory emphasizes the importance of the relationship between project managers and other project stakeholders. "It portrays that a manager should understand that the success of the projects can be influenced greatly by the participation of various stakeholders"; and their participation depends on the relationship they foster with the top management. When managers want to understand the firms and its environment, they may use the stakeholders" approach, which enhances proper description of the firm (Okoth, 2016). He added that „the approach is intended to broaden the management's vision of its roles and responsibilities beyond the profit maximization function and stakeholders identified in input-output models of the firm, to also include interests and claims of non-stockholding groups. Freeman (1984) indicated that an organization/ project manager has to put into consideration stakeholders such as potential employees and customers as well as related corporations and the whole public.

According to Okoth (2016), the main aim of the stakeholder's theory is to enable project managers to understand stakeholders and to strategically and hence accomplish the intended outcome. This means that if stakeholders are managed properly, then the project would be able to have a long-term survival in this dynamic environment. The main focus

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and emphasis of this stakeholder's theory is that project managers should have a good relationship with the stakeholders to enable it to maximize on the return. Managers should understand that the success of the projects can be influenced greatly by the participation of various stakeholders. The level of participation of the stakeholders depends on the relationship the project managers are having with the project's other stakeholders. The theory supports stakeholder engagement variable.

2.2.3 Anthropogenic Global Warming Theory

Anthropogenic (man-made) global warming theory holds that man-made greenhouse gases, primarily carbon dioxide (CO2), are the predominant cause of the global warming that occurred during the past 50 years. The theory contends that human emissions of green-house gases, principally carbon dioxide (CO2), methane, and nitrous oxide, are causing a catastrophic rise in global temperatures. The mechanism whereby this happens is called the enhanced greenhouse effect (Essex & McKitrick, 2005).

Energy from the sun travels through space and reaches Earth. Earth's atmosphere is mostly transparent to the incoming sunlight, allowing it to reach the planet's surface where some of it is absorbed and some is reflected back as heat out into the atmosphere. Certain gases in the atmosphere, called "greenhouse gases," absorb the outgoing reflected or internal thermal radiation, resulting in Earth's atmosphere becoming warmer than it otherwise might be (Green & Armstrong, 2007).

Earth's climate also responds to several other types of external influences, such as variation in solar radiation and in the planet's orbit, but these "forcings," according to the proponents of AGW, cannot explain the rise in Earth's temperature over the past three decades. The

forcing caused directly by man-made greenhouse gases is also small, but the AGW theory posits that positive feedback increase the effects of these gases between two- and four-fold (Essex & McKitrick, 2005). A small increase in temperature causes more evaporation, which places more water vapor in the atmosphere, which causes more warming. The theory supports crop diversification variable in the study.

2.4 Theoretical Framework

In summary, the study was anchored on the Systems theory, Stakeholder theory and Anthropogenic global warming theory as documented in the following theoretical framework.

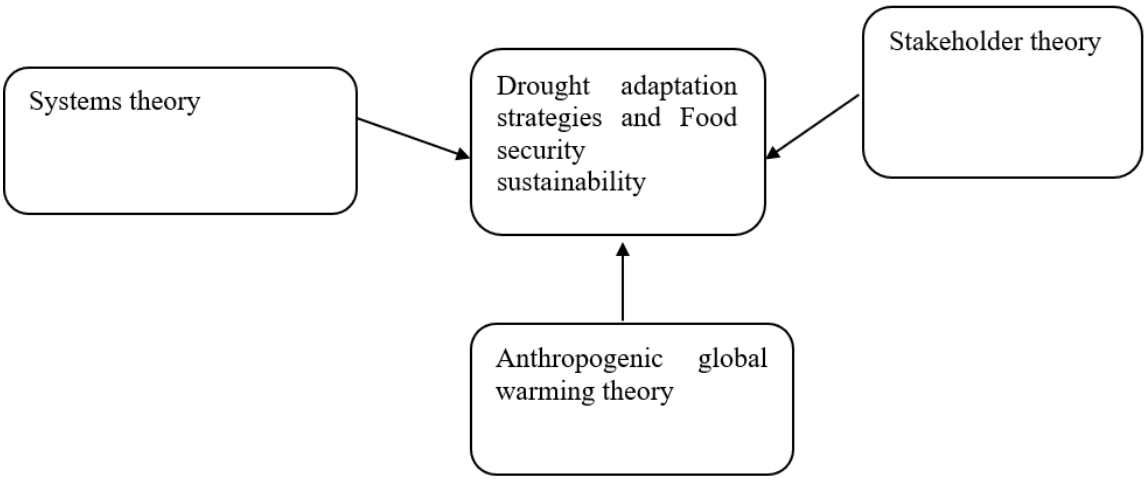

Figure 1 Theoretical Framework

Source: Researcher (2022)

2.5 Conceptual Framework

Conceptual framework is a structure of variables that the researcher operates so as to accomplish the set objectives (Kothari, 2014). The study links drought adaptation strategies constructs which include crop diversification, integrated water management and supplemental feeding on food security sustainability.

The measurement of food security sustainability was captured through the indicators of food supply resilience, Food waste reduction, and Food availability.

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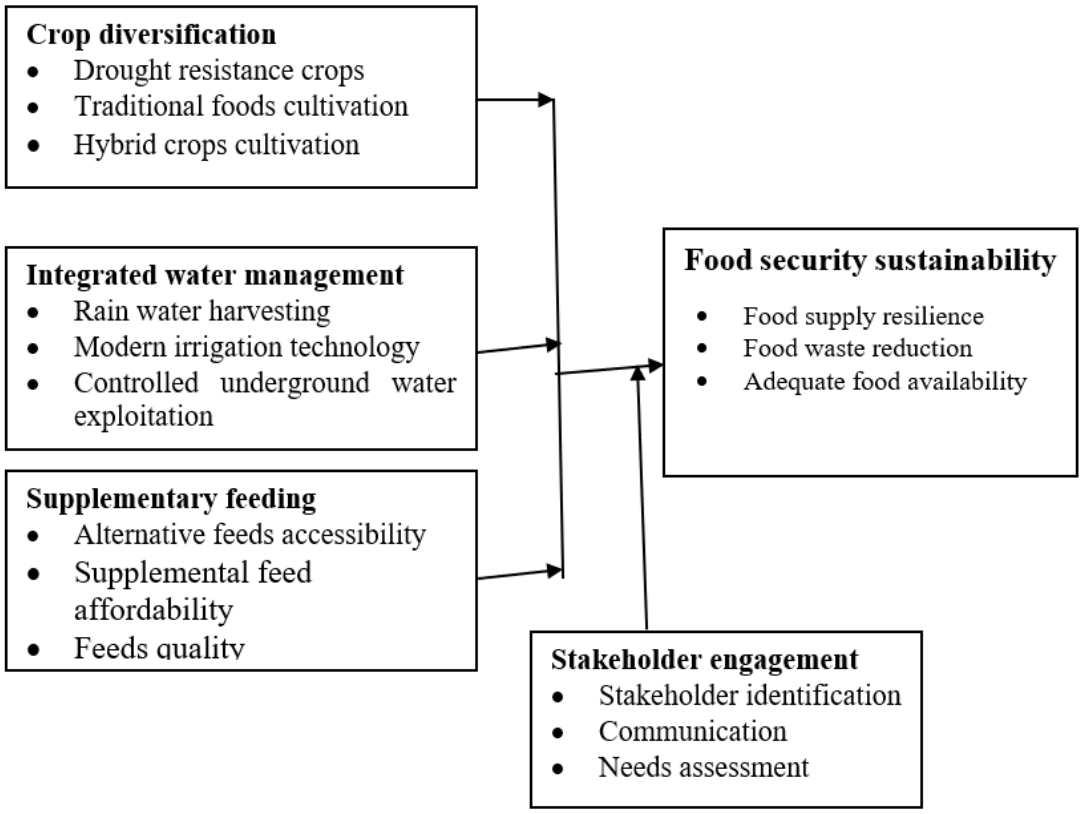

Figure 2 Conceptual Framework

Source: Researcher (2023)

The conceptual framework demonstrates the link between independent variables and dependent variable. The general study objective was to investigate the drought adaptation strategies and sustainability of food security in Mandera County. The conceptual framework shows the independent variables such as crop diversification, integrated water management and supplemental feeding. The moderating variable considered in the study

is stakeholder engagement. These predictors are influencing the dependent variable which is the food security sustainability.

2.6 Research Gaps

Despite the extensive literature on drought adaptation strategies and food security, several notable research gaps exist that this study aims to address. First, while studies like Douyon (2018) and Appiah-Twumasi and Asale (2022) have demonstrated the positive impact of crop diversification on food security, there is limited research focusing specifically on arid regions like Mandera County, where environmental conditions present unique challenges for agricultural diversification.

Second, although Bindraa et al. (2017) and Kivuva (2018) highlight the importance of integrated water management for food security in drylands, there remains insufficient investigation into the specific water management techniques most effective in the unique ecological and socioeconomic context of Mandera County. The existing literature lacks context-specific applications for extreme arid conditions.

Third, while studies by Guyo (2015), Sahal (2014), and Aklilu and Wekesa (2006) address supplementary feeding interventions, there is a notable gap in understanding the sustainability and long-term impacts of these strategies, particularly in relation to cost-effectiveness and integration with other drought adaptation measures.

Finally, despite research by Nyakoyo and Odhiambo (2020) and Gatumi et al. (2022) on stakeholder engagement, the moderating role of stakeholder engagement in enhancing the effectiveness of combined drought adaptation strategies remains underexplored, especially in the context of Mandera County's unique pastoral and agro-pastoral communities.

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2.7 A Recap of Literature Review

A thorough review of literature has revealed various key pivotal success factors in food security sustainability. The study has reviewed the literature on crop diversification, integrated water management and supplemental feeding and related it to sustainability of food security projects. The literature has shown that nearly 45% of food security projects fail annually (FAO, 2013). However, most of the reviewed studies have presented conceptual gaps as well as contextual gaps. For instance, M'Mboroki (2018) investigated impact of climate change and adaptive mechanisms of pastoral communities in Mukogodo forested areas of Laikipia County, Kenya and the findings showed that variability in rainfall and temperatures has contributed to change in land use. However, a study by M'Mboroki focused on adaptive mechanisms of households and not food security sustainability.

Consequently, a study by Gatumi, Ngugi, and Kinoti (2022) looked at the influence of stakeholder engagement on the sustainability food security projects in arid lands, Kenya and revealed that stakeholder engagement significantly influences sustainability of food security projects in arid lands positively. However, the study is narrow in scope as it focused on a single aspect of drought adaptation strategy. The current study sought to bridge the research gaps by holistically investigating drought adaptation strategies and their effect on sustainability of food security in Mandera County, Kenya.

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CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The chapter depicts the methods to be used to prepare the research study. It contains research design, target population, sample size and sampling procedures, data collection methods, data analysis and presentation.

3.2 Research Design

Research design is basically the collection of data and the process of analyzing collected data (Creswell, 2015). The study will employ descriptive survey design where data was collected to aid in achieving the study objectives. The choice of survey design is that they tend to be more flexible hence lead to collection of a wider range of information (Cooper & Schindler, 2013). The choice of the research design has been motivated by the capability of the design to offer practical framework for accessing large groups to sample its ability to provide reliable data (Kothari, 2014).

3.3 Target Population

Kothari (2014) argues that population is the group of elements that possess the information sought and about which inferences were made. The target population for this study was government funded food security projects in Mandera County. According to NDMA (2022) there are two main projects for food security in Mandera County which include Kutulo Water Pan and Irrigation project in Kutulo Sub-County, Mandera County and Koromey Irrigation project. This is considered the empirical case of food security measures in the region which forms the basis of the desired information to answer the research

questions in this study. The unit of analysis was project supervisors, government officials and community leaders as presented in Table 1.

Table 1 Population of the Study

Strata	Population	Percentage (%)
Project Supervisors	19	21.6
Government officers	31	35.2
Community leaders	38	43.2
Total	**88**	**100**

Source: Mandera County Government (2023)

3.4 Sample Population

A sampling technique involves a procedure used to obtain a portion of the population from the target population which is believed to have the characteristics of the population (Ngozwana, 2018). This study purposively selected targets who were deemed to have the required information regarding food security sustainability. Basias and Pollalis (2018) support the use of purposive sampling in a situation where there is a need for deliberate choice of the targets deemed to have the information being sought.

The Cochran formula was used to obtain the number of the respondents who will later be sampled using simple random sampling. The formula is highly recommended in calculating sample size for populations that are large (Cochran, 1977). The procedure of sample determination is demonstrated below.

$$n_0 = \frac{Z^2 pq}{e^2}$$

Where n_o, Z, p, q, and e represent sample size, abscissa of normal curve, estimated proportion of an attribute present in the population, 1-p, and desired precision level respectively. Notably, the value of Z is obtained from statistical tables and represents the areas under the normal curve. The Cochran's formula is interpreted as follows;

$n_0 = (1.96^2 \times 0.5 \times 0.5) / (0.05^2)$

$n_0 = 384.16$

Cochran's correction formula, when pop. <50.000 is: $n_1 = 384/(1+384/88) = 83.06$

$n_1 = 72$

The distribution of this sample size was conducted through stratified random sampling procedures. This is suitable in giving each unit of observation an equal chance of being sampled (Kothari, 2014), hence suitable for this study. It also reduced the sampling error. Table 2 showed the stratification of the sample size. After stratification, the sample was obtained through simple random procedures in each stratum.

Table 2 Stratification of the Sample Size

Strata	Population	Sample Size
Project Supervisors	19	16
Government officers	31	25
Community leaders	38	31
Total	**88**	**72**

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3.5 Construction of Research Instruments

Fletcher (2017) defines a research instrument as tool that can be put in practice to collect research data. The study used quantitative primary data. The primary data collection instrument in this study was hence a structured questionnaire. This is because questionnaires allowed the respondents to present their facts on the subject matter independently enabling a greater depth of response. The study also collected primary data using structured questions and captured information through a 5-point Likert scale type.

3.6 Pilot Study

Pilot test is a prototype exercise carried out prior to full-scale preparation of the final study with the aim of examining the main data collection tools' reliability and validity (Mugenda & Mugenda, 2012). Eight respondents were selected randomly to pilot test data collection tools. The choice of 8 participants is echoed by Riel (2010) who asserts that for pilot testing, 10% of the population can be used sufficiently. The pilot study findings did not form part of the final results.

3.6.1 Validity of Research Instruments

Validity is the ability of a data collection instrument to actually measure what is supposed to be measured (Kothari, 2014). In this case, the questionnaire items was related to the research questions as they are constructed. The research supervisor will evaluate the face and content validity of the items in the questionnaire.

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3.6.2 Reliability of Research Instruments

Reliability is the extent to which a particular procedure gives similar results of multiple trials (Mugenda & Mugenda, 2012). Eight questionnaires was piloted by issuing them to respondents who were not included in the final study sample. The questionnaires were then coded and responses input into SPSS which was used to generate the reliability coefficient. The researcher used the most common internal consistency measure known as Cronbach's Alpha (α) which were generated by SPSS. The instrument is considered to be reliable to the extent that its measurements are free from nonsystematic (random) errors. The threshold for testing instruments' reliability was set to 0.70 Cronbach's Alpha.

3.7 Data Collection Methods and Procedures

Data collection procedure refers to an information gathering process specifically to refute or accept study facts (Cooper & Schindler, 2013). The local community leaders, project supervisors and government officials in the target area was briefed on the purpose of the study. The procedures of data collection will involve getting authorization letters from the University. The questionnaire distribution was carried out by use of 'drop-and-pick later' technique.

3.8 Data Analysis Techniques

After the questionnaires have been filled and collected, the researcher will sieve through the data and thoroughly check for errors in responses, exaggerations or omissions. The study will adopt descriptive analysis and inferential analysis where the study data was analyzed, presented and interpreted based on the study objectives. Descriptive statistics

aim at providing the pattern of the responses and their consistency in each of the hypothesized variables. Inferential statistics provides more insight into the research findings. The research findings are presented using frequency and descriptive tables.

3.8.1 Model Specification of the Study

The following multiple regression models was adopted;

$$Y=1\beta_0 1+\beta_1 X_1+\beta_2 X_2+\beta_3 X_3+1\beta_4 X_4+\varepsilon$$

Where:

Y= Sustainability of food security

$\boldsymbol{\beta_0}$ = y-intercept

β_1-β_4)are)the)coefficient)function)of)the)independent)variables,

X_1= Crop diversification

X_2= Integrated water management

X_3= Supplemental feeding

X_4= Stakeholder engagement

ε= Error term

3.9 Ethical Considerations

To make sure that everyone taking part in the study is doing so voluntarily, the researcher asked study participants for permission before collecting any data. The researcher also maintained the participants' privacy and confidentiality. This was made possible by the

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requirement that participants maintain anonymity while the data is being collected, rendering it impossible to associate any response with a particular respondent. The researcher asked the Mount Kenya University and NACOSTI for permission to conduct the study in an authorization letter, which was given to the respondents and outline the goal of data collecting.

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CHAPTER FOUR

RESEARCH FINDINGS AND DISCUSSIONS

4.1 Introduction

This chapter presents the study findings specifically derived from the primary data collected through questionnaires from the sampled Project Supervisors, Government officers and Community leaders. The chapter starts with the response rate indicating the questionnaire return rate. The chapter then gives the demographics of the study participants. The chapter then presents the study finding per objective and interpreter. The chapter ends with regression analysis to depict the relationship between the independent variables and the dependent variables.

4.2 Response Rate

From the sample of 88 participants, the study managed a total of 77 completely filled questionnaires. This made up a response rate of 87.5% as presented in Figure 3.

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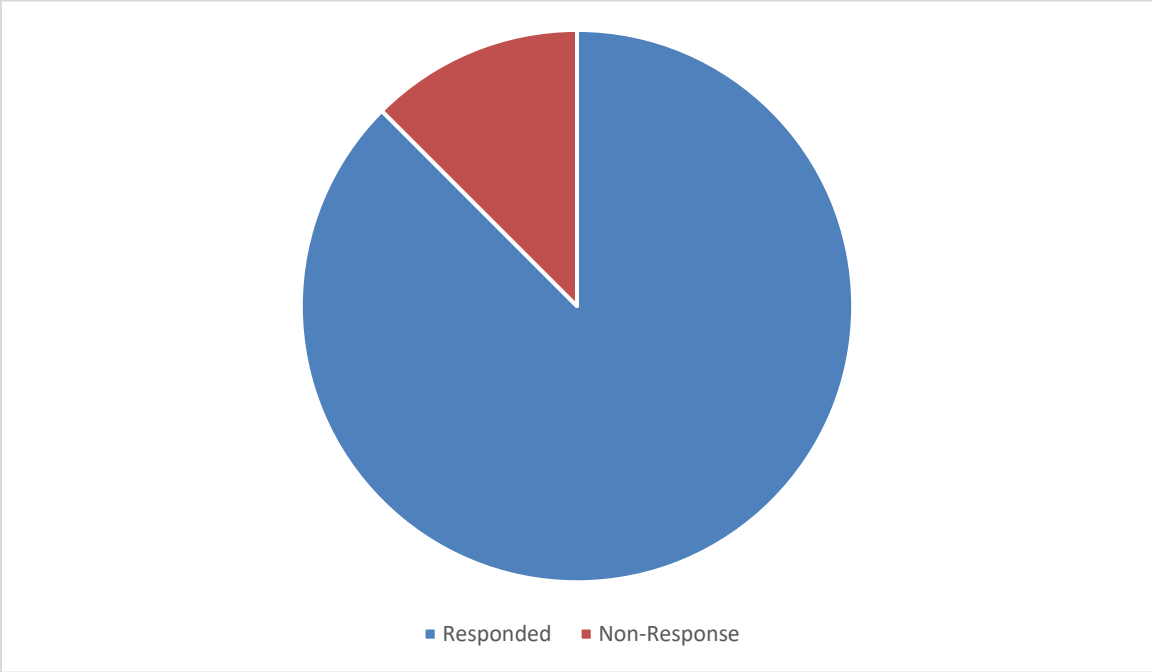

Figure 3 Response Rate

Statistically, this response rate is considered excellent, as it exceeds the generally accepted threshold of 70% for social science research. This high rate strengthens the validity and reliability of your findings, making your conclusions more credible and generalizable to the broader population of Mandera County.

The strong participation rate suggests that the research topic resonates deeply with local stakeholders, indicating their recognition of the importance of food security and drought adaptation in their region. This engagement level implies that participants are likely to have provided thoughtful, meaningful responses that reflect the actual situation on the ground.

From a methodological perspective, having only 11 incomplete questionnaires minimizes non-response bias, which could have otherwise skewed your results. This robust response rate provides a solid foundation for analyzing the relationships between your variables

(crop diversification, water management, supplementary feeding, and stakeholder engagement) and their impacts on food security sustainability.

This high completion rate also enhances your study's contribution to existing literature and its potential value for policymakers and practitioners working on food security initiatives in arid and semi-arid regions.

4.3 Background information

Information about the research participants describing their various backgrounds is present in this section. Table 3 shows the category of position held by the respondents.

Table 3 Category of position held by the respondents

	Frequency	Percent
Project Supervisor	16	20.8
Government Representative	36	46.8
Community Leaders	25	32.5
Total	77	100

According to the data from Table 3, the most significant proportion of respondents were Government Representatives, comprising 46.8% (36 individuals) of the total respondents. This was followed by Community Leaders, representing 32.5% (25 individuals). Lastly, Project Supervisors comprised 20.8% (16 individuals) of the respondents. Thus, government representatives were the dominant group in the survey, reflecting their critical

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role in the research context, while community leaders and project supervisors also contributed significantly.

The respondents were asked to indicate for how long they had been involved in Food security programs. The findings are presented in Table 4.

Table 4 For how long have you been involved in Food security programs?

	Frequency	Percent
Less than a year	9	11.7
one year	15	19.5
two years	24	31.2
three years	18	23.4
more than three years	11	14.3
Total	77	100

Table 4 shows that the majority of respondents (31.2%) reported having been involved in food security programs for two years (24 individuals), followed by 23.4% (18 individuals) who had three years of experience. A smaller group (19.5%) had one year of involvement (15 individuals). Those with more than three years of experience accounted for 14.3% (11 individuals), while the smallest group, 11.7% (9 individuals), had been involved for less than a year. The distribution suggests a balanced mix of relatively new and more experienced program participants.

Table 5 shows how the respondents believed about food security sustainability has been achieved.

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Table 5 Do you believe that food security sustainability has been achieved?

	Frequency	Percent
Yes	38	49.4
No	39	50.6
Total	77	100

Table 5 shows that the respondents were almost evenly split in their views on whether food security sustainability had been achieved. A slight majority of 50.6% (39 individuals) believed it had not been achieved, while 49.4% (38 individuals) felt it had been achieved. This near-even division highlights differing perceptions regarding the success of food security initiatives among those surveyed.

4.4 Sustainability of Food Security

The respondents were asked to indicate the extent to which they agreed or disagreed with the statements regarding the sustainability of food security. The scale of measurement was 1 to 5 where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Strongly Agree. The collected data was analyzed and presented in Table 6.

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Table 6 Sustainability of Food Security

	N	Minimum	Maximum	Mean	Std. Deviation
The food supply resilience has been enhanced in the county	771	5		3.01	1.230
The food waste has significantly minimized	771	5		3.25	1.269
There is adequate food availability in the county	771	5		3.23	1.287
The food security projects initiated in the county have survived beyond funding	771	5		3.01	1.272

Table 6 shows the results of the respondents when they were asked to rate their agreement with several statements regarding food security sustainability on a scale of 1 (Strongly Disagree) to 5 (Strongly Agree). The mean responses and standard deviations for each statement are as follows:

The statement, ‘the food supply resilience has been enhanced in the county,' had a mean score of 3.01 (SD = 1.230), indicating a neutral stance overall, with some variation in responses. For "The food waste has significantly minimized," the mean was slightly higher at 3.25 (SD = 1.269), suggesting modest agreement with this statement, though variability among responses remained. The statement, "There is adequate food availability in the county," also had a mean score of 3.23 (SD = 1.287), reflecting a similar moderate level of agreement. Finally, for "The food security projects initiated in the county have survived beyond funding," the mean was neutral at 3.01 (SD = 1.272), implying that respondents were divided. Overall, these results suggest a generally neutral to mildly positive view of

food security sustainability in the county, with notable variation in responses across individuals.

The findings reveal moderate levels of food security sustainability across all measured indicators, with mean scores hovering around 3 on a 5-point scale. The minimization of food waste scored highest (M=3.25, SD=1.269), followed closely by food availability (M=3.23, SD=1.287). Both food supply resilience and project survival beyond funding scored equally (M=3.01), indicating room for improvement in these areas.

The relatively high standard deviations (ranging from 1.230 to 1.287) suggest considerable variation in respondents' perceptions, indicating that food security experiences differ significantly across the county. This aligns with Opiyo et al. (2015) findings that food security outcomes in arid regions can vary substantially based on local conditions and intervention effectiveness.

The moderate scores for project survival beyond funding (M=3.01) highlight sustainability challenges, supporting Cervigni and Morris's (2016) assertion that long-term viability of food security initiatives in drought-prone areas often depends on continued resource allocation and stakeholder support.

4.5 Effect of Crop Diversification on Sustainability of Food Security in Mandera County

The questionnaire respondents were asked to rate the extent to which the community in Mandera adopted crop diversification. From a Likert scale 1=Not at all, 2=Shallow extent, 3= Low extent and 4=High extent, the findings were presented in Table 7.

Table 7 To what extent does the community in Mandera adopt crop diversification?

	Frequency	Percent
Not at all	10	13
Shallow extent	26	33.8
Low extent	29	37.7
High extent	12	15.6
Total	77	100

The results from Table 5 show that most respondents indicated that the community in Mandera had adopted crop diversification to a low extent (37.7%, 29 individuals), followed by those who reported adoption to a shallow extent (33.8%, 26 individuals). A smaller percentage (15.6%, 12 individuals) felt that crop diversification had been significantly adopted, while 13% (10 individuals) believed there had been no adoption. These findings suggest that crop diversification in the community is generally limited, with few individuals perceiving significant progress in this area.

The results indicate relatively low adoption rates of crop diversification strategies in Mandera County. The majority of respondents (71.5%) reported either a low extent (37.7%) or shallow extent (33.8%) of crop diversification adoption. Only 15.6% indicated high adoption rates, while 13% reported no adoption at all. These findings align with Recha et al. (2016) observations that despite the potential benefits, crop diversification adoption in arid and semi-arid regions faces significant challenges.

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The low adoption rates could be attributed to various factors identified by Bryan et al. (2019), including limited access to diverse seed varieties, traditional farming practices, and insufficient knowledge about alternative crops suitable for the region's climate. Additionally, Mwungu et al. (2018) suggest that socio-economic constraints and risk aversion among smallholder farmers often influence their willingness to diversify crops.

The findings reveal that crop diversification in Mandera County remains underutilized, with 71.5% of respondents perceiving its adoption to be either at a low extent (37.7%) or a shallow extent (33.8%). Only a small proportion (15.6%) reported significant adoption, and 13% believed no adoption had occurred. These figures indicate limited progress in implementing crop diversification, an important strategy for enhancing agricultural resilience in arid and semi-arid regions (Recha et al., 2016).

Several factors contribute to this low adoption rate. Bryan et al. (2019) highlight challenges such as restricted access to diverse seed varieties, which are essential for diversifying crop production in regions with harsh climatic conditions. Additionally, traditional farming practices persist, as many farmers may lack awareness or resources to shift toward more diverse and climate-adapted agricultural strategies. Insufficient knowledge about the benefits and suitability of alternative crops also hinders broader adoption.

Socio-economic barriers further exacerbate the issue. Mwungu et al. (2018) emphasize that smallholder farmers, who dominate the agricultural landscape in Mandera, are often constrained by limited financial resources, risk aversion, and lack of access to markets for diversified crops. These constraints reduce their ability and willingness to experiment with new crops, especially when faced with the uncertainty of climatic conditions.

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Addressing these challenges requires targeted interventions, such as improving access to climate-resilient seed varieties, enhancing farmer education through extension services, and providing financial incentives to mitigate risks. Encouraging local research on suitable crop varieties and fostering market linkages could also drive adoption. The findings underline the need for holistic, community-focused strategies to make crop diversification a viable and widely adopted practice in Mandera County.

In another dimension, the respondents were asked to indicate the extent to which you agree or disagree with the statements regarding crop diversification. Use a scale of 1 to 5 where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Strongly Agree. The findings were presented in Table 8.

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Table 8 Level of agreement about crop diversification

	N	Minimum	Maximum	Mean	Std. Deviation
The community has transitioned to cultivating drought resistance crops	77	1	5	2.99	1.153
There is increased usage of traditional food cultivation to withstand drought in the area	77	1	5	3.17	1.129
The community members are embracing hybrid crop cultivation in the county	77	1	5	3.09	1.114
The county government provides genuine drought-resistance crops to the local community	77	1	5	3.36	1.123

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Table 6 shows the results when the respondents were asked to indicate their level of agreement with several statements regarding crop diversification using a scale of 1 (Strongly Disagree) to 5 (Strongly Agree). The mean scores and standard deviations are as follows:

The statement, "The community has transitioned to cultivating drought-resistant crops," had a mean of 2.99 (SD = 1.153), indicating a neutral stance overall, with some variation in responses. For "There is increased usage of traditional foods cultivation to withstand drought in the area," the mean was slightly higher at 3.17 (SD = 1.129), suggesting mild agreement with this statement. The statement, "The community members are embracing

hybrid crops cultivation in the county," had a mean score of 3.09 (SD = 1.114), reflecting a similar level of moderate agreement. Finally, the highest mean score was "The county government provides genuine drought-resistant crops to the local community," at 3.36 (SD = 1.123), suggesting a more substantial agreement among respondents. Overall, the responses indicate neutral to mild agreement on crop diversification efforts, with the most vital support for the role of the county government in providing drought-resistant crops.

The findings reveal moderate adoption levels of various crop diversification strategies in Mandera County. The provision of drought-resistant crops by the county government received the highest mean score (M=3.36, SD=1.123), suggesting relatively positive government involvement in supporting agricultural adaptation. This aligns with Omoyo et al. (2015) findings that institutional support is crucial for successful implementation of climate-smart agriculture in arid regions.

Traditional food cultivation showed the second-highest mean score (M=3.17, SD=1.129), indicating a moderate retention of indigenous agricultural practices. This supports Gebru et al. (2019) assertion that traditional farming methods often serve as valuable adaptation strategies in drought-prone areas.

The adoption of hybrid crop cultivation (M=3.09, SD=1.114) and transition to drought-resistant crops (M=2.99, SD=1.153) showed slightly lower means, suggesting potential barriers to adoption. These findings echo Mwongera et al. (2017) observations that farmers often face challenges in transitioning to new crop varieties despite their potential benefits. The consistent standard deviations (ranging from 1.114 to 1.153) indicate relatively

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uniform variation in responses across all measures, suggesting similar levels of agreement/disagreement among respondents about different aspects of crop diversification.

The results of the study on crop diversification strategies in Mandera County highlight several key findings. The highest mean score (M=3.36, SD=1.123) for the provision of drought-resistant crops by the county government indicates substantial governmental support in enhancing agricultural resilience. This outcome aligns with Omoyo et al. (2015), who emphasized the importance of institutional support for the successful implementation of climate-smart agriculture in arid regions. Such support not only promotes adaptation to climate change but also enhances food security.

The second-highest mean score (M=3.17, SD=1.129) for traditional food cultivation reflects a moderate adherence to indigenous agricultural practices. This supports Gebru et al. (2019), who asserted that traditional farming methods serve as effective adaptation strategies in drought-prone areas. The retention of these practices underscores their perceived value and reliability among farmers in Mandera County.

Hybrid crop cultivation (M=3.09, SD=1.114) and the transition to drought-resistant crops (M=2.99, SD=1.153) recorded slightly lower means, suggesting challenges in adopting new crop varieties. These findings echo Mwongera et al. (2017), who noted that despite their benefits, farmers face obstacles such as lack of knowledge, resources, and support in transitioning to new crop varieties.

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The consistency in standard deviations (ranging from 1.114 to 1.153) across all measures suggests uniformity in responses, indicating similar levels of agreement or disagreement among respondents on various aspects of crop diversification. This consistency implies that while there are moderate levels of adoption, the perceptions and experiences of farmers regarding these strategies are fairly aligned.

Overall, the results point to a moderate adoption of crop diversification strategies, with significant governmental support and the ongoing value of traditional practices. However, challenges in adopting new crop varieties highlight the need for enhanced support and resources to facilitate this transition.

4.6 Effect of Integrated Water Management on Sustainability of Food Security in Mandera County

The second objective of the study was to establish the effect of integrated water management on sustainability of food security in Mandera County, Kenya. The researcher explored this objective by a questionnaire item asking the respondents to rate the extent water resources had been integrated into the county. The findings are presented in Table 9.

Table 9 To what extent have water resources integrated into the county

	Frequency	Percent
Not at all	13	16.9
Shallow extent	23	29.9
Low extent	31	40.3

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High extent	10	13
Total	77	100

Table 9 shows that most respondents indicated that water resources had been integrated into the county to a low extent (40.3%, 31 individuals). In comparison, 29.9% (23 individuals) felt the integration occurred to a shallow extent. A smaller percentage (13%, ten individuals) believed water resources had been integrated extensively, and 16.9% (13 individuals) felt no integration. These results suggest that water resource integration in the county is generally perceived to be limited, with only a small portion of respondents reporting significant progress in this area.

The findings reveal patterns in water resource integration within Mandera County. A significant majority (70.2%) of respondents reported either a low extent (40.3%) or shallow extent (29.9%) of water resource integration. Only 13% indicated high levels of integration, while 16.9% reported no integration at all. These results suggest substantial gaps in the implementation of integrated water management strategies in the region.

The low integration levels align with Nicol et al. (2015) findings that arid and semi-arid regions often face significant challenges in implementing comprehensive water management systems. According to Komakech and de Bont (2018), such limited integration can severely impact food security, particularly in drought-prone areas.

The high percentage of respondents reporting low or shallow integration (70.2%) indicates potential systemic barriers to effective water resource management. This supports Mganga

et al. (2020) observations that successful water integration in ASALs requires substantial infrastructure development and community engagement. These findings have significant implications for food security sustainability, as Muller (2017) emphasizes that integrated water management is crucial for agricultural resilience in drought-prone regions.

The research on water resource integration in Mandera County unveils a critical challenge facing arid and semi-arid lands (ASALs) in Kenya, highlighting significant systemic barriers to effective water management strategies. The study's findings reveal a stark landscape of water resource governance, with profound implications for regional development and community resilience.

The data presents a concerning picture: 70.2% of respondents reported either low (40.3%) or shallow (29.9%) levels of water resource integration. Only a mere 13% indicated high integration levels, while 16.9% reported complete absence of integration. These statistics underscore the extensive gaps in implementing comprehensive water management approaches.

These findings resonate with existing literature on water resource management in challenging environmental contexts. Nicol et al. (2015) have previously highlighted the complex challenges faced by arid regions in developing integrated water management systems. The research confirms their observations, demonstrating the persistent difficulties in creating holistic water resource strategies.

The limited integration levels have significant consequences for food security and community sustainability. Komakech and de Bont (2018) emphasize that such integration challenges directly impact agricultural productivity and community resilience. Mganga et

al. (2020) further suggest that successful water integration in ASALs demands substantial infrastructure development and meaningful community engagement.

Muller (2017) argues that integrated water management is fundamental to agricultural resilience in drought-prone regions. The Mandera County findings validate this perspective, revealing the critical need for comprehensive water resource strategies that go beyond traditional management approaches.

Further, the respondents were asked to indicate how much you agree or disagree with the statements regarding integrated water management. Use a scale of 1 to 5 where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Strongly Agree. The findings are presented in Table 10.

Table 10 Level of Agreement about Integrated Water Management

	N	Min	Max	Mean	Std. Deviation
The community has been equipped with rainwater harvesting tools	77	1	5	3.19	1.203
The community members have embraced modern irrigation technologies to water their crops during the drought season	77	1	5	3.03	1.063
The county government has developed guidelines aimed at controlling underground water exploitation in the community	77	1	5	3.21	1.139

The county government has installed infrastructure to supply water from the source to all the community members	77	1	5	3.27	1.120

Table 10 shows the results from when the respondents were asked to rate their agreement with several statements about integrated water management using a scale of 1 (Strongly Disagree) to 5 (Strongly Agree). The mean scores and standard deviations for each statement are as follows:

The statement, "The community has been equipped with rainwater harvesting tools," had a mean of 3.19 (SD = 1.203), indicating moderate agreement, with noticeable variation among responses. For "The community members have embraced modern irrigation technologies to water their crops during the drought season," the mean was 3.03 (SD = 1.063), suggesting a neutral to slightly positive view. The statement, "The county government has developed guidelines aimed at controlling underground water exploitation in the community," had a mean of 3.21 (SD = 1.139), reflecting moderate agreement. Lastly, for "The county government has installed infrastructure to supply water from the source to all community members," the mean was 3.27 (SD = 1.120), indicating mild agreement with this statement.

Overall, respondents expressed moderate agreement regarding implementing integrated water management practices, particularly concerning water supply infrastructure and rainwater harvesting tools. However, the relatively neutral responses highlight some uncertainty or variation in perceptions across the community.

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The findings reveal moderate levels of implementation across various integrated water management strategies in Mandera County. The highest mean score (M=3.27, SD=1.120) for water supply infrastructure development by the county government suggests some progress in establishing basic water access systems. This aligns with Oates et al. (2018) findings that institutional involvement is crucial for developing sustainable water infrastructure in arid regions.

The relatively positive response to guidelines for underground water exploitation (M=3.21, SD=1.139) indicates emerging regulatory frameworks. However, as Mosello et al. (2017) argue, the effectiveness of such guidelines often depends on enforcement capacity and community buy-in.

Rainwater harvesting tools distribution (M=3.19, SD=1.203) shows moderate implementation, though the higher standard deviation suggests uneven distribution or adoption across the community. This supports Waswa et al. (2021) observations that equitable access to water harvesting technologies remains a challenge in Kenya's ASAL regions.

The lowest mean score for modern irrigation technologies adoption (M=3.03, SD=1.063) suggests potential barriers to technological integration. As noted by Njeru et al. (2019), factors such as cost, technical knowledge, and cultural preferences often influence irrigation technology adoption in rural areas.

The findings of the study on integrated water management strategies in Mandera County demonstrate moderate levels of implementation across different initiatives. The highest mean score (M=3.27, SD=1.120) for water supply infrastructure development by the

county government indicates progress in providing basic water access systems. This outcome aligns with Oates et al. (2018), who emphasized the critical role of institutional involvement in developing sustainable water infrastructure in arid regions. This involvement is essential for establishing reliable and long-term water solutions, which are crucial for the socio-economic development of arid and semi-arid areas.

The relatively positive response to guidelines for underground water exploitation (M=3.21, SD=1.139) reflects the establishment of regulatory frameworks for water resource management. However, as Mosello et al. (2017) suggest, the success of such guidelines largely depends on enforcement capacity and the extent of community buy-in. This underscores the importance of not only creating regulations but also ensuring their effective implementation and acceptance by the local communities.

The distribution of rainwater harvesting tools (M=3.19, SD=1.203) indicates a moderate level of adoption. However, the higher standard deviation suggests variability in distribution or uptake across the community. This variability supports the observations by Waswa et al. (2021) that equitable access to water harvesting technologies remains a significant challenge in Kenya's arid and semi-arid lands (ASALs). Addressing this disparity requires targeted interventions to ensure that all community members benefit from such initiatives.

The lowest mean score for modern irrigation technologies adoption (M=3.03, SD=1.063) highlights potential barriers to the integration of advanced irrigation methods. Factors such as cost, technical knowledge, and cultural preferences, as noted by Njeru et al. (2019), play a significant role in the adoption of these technologies in rural areas. Overcoming these

barriers requires comprehensive strategies that include training, financial support, and culturally sensitive approaches to encourage the uptake of modern irrigation technologies.

4.7 Effect of Supplementary Feeding on Sustainability of Food Security in Mandera County

Objective 3 of the study was to find out the effect of supplementary feeding on sustainability of food security in Mandera County, Kenya. The study used questionnaire items to answer the research question related to this research objective. The research participants were asked to what extent the community members had adopted supplemental feeding for their livestock. The responses were put on a 4-point Likert scale, 1=Not at all, 2= Shallow extent, 3= Low extent and 4= High extent. The data was analyzed and presented in Table 11.

Table 11 To what extent have the community members adopted supplemental feeding for their livestock

	Frequency	Percent
Not at all	12	15.6
Shallow extent	18	23.4
Low extent	33	42.9
High extent	14	18.2
Total	77	100

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Table 11 shows that most respondents (42.9%, 33 individuals) indicated that the community members had adopted supplemental feeding for their livestock to a low extent. This is followed by 23.4% (18 individuals) who reported adoption to a shallow extent. A smaller proportion, 18.2% (14 individuals), felt that supplemental feeding had been adopted extensively, while 15.6% (12 individuals) indicated that it had not been adopted. These results suggest that supplemental feeding for livestock is not widely practiced, with most respondents indicating limited adoption within the community.

The findings reveal a concerning pattern in the adoption of supplemental feeding practices for livestock in Mandera County. The majority of respondents (66.3%) reported either a low extent (42.9%) or shallow extent (23.4%) of supplemental feeding adoption. Only 18.2% indicated high adoption rates, while 15.6% reported no adoption at all. These results suggest significant challenges in implementing supplemental feeding as a drought adaptation strategy.

The low adoption rates align with Opiyo et al. (2015) findings that pastoralists in arid regions often face substantial barriers in implementing supplemental feeding programs, including cost constraints and limited access to feed resources. The high percentage of respondents reporting low or shallow adoption (66.3%) indicates potential systemic challenges that echo Mutua et al. (2020) observations about the complexities of changing traditional livestock management practices.

The implications of these findings are significant for food security sustainability. As noted by Nyariki and Amwata (2019), limited adoption of supplemental feeding can increase livestock vulnerability during drought periods, potentially leading to significant losses and

reduced household food security. Furthermore, Wasonga et al. (2016) suggest that low adoption of supplemental feeding can impact milk production and livestock market value, directly affecting household income and food access.

The findings reveal a concerning pattern in the adoption of supplemental feeding practices for livestock in Mandera County. A significant proportion of respondents (66.3%) reported either low (42.9%) or shallow (23.4%) adoption of supplemental feeding, indicating substantial challenges in implementing this drought adaptation strategy. Only 18.2% indicated high adoption rates, while 15.6% reported no adoption at all.

These low adoption rates are consistent with Opiyo et al. (2015), who found that pastoralists in arid regions face considerable barriers to implementing supplemental feeding programs, including cost constraints and limited access to feed resources. The high percentage of respondents reporting low or shallow adoption suggests systemic challenges, as noted by Mutua et al. (2020), who highlighted the complexities involved in changing traditional livestock management practices.

The implications of these findings for food security sustainability are significant. Limited adoption of supplemental feeding increases livestock vulnerability during drought periods, potentially leading to substantial losses and reduced household food security (Nyariki & Amwata, 2019). Additionally, Wasonga et al. (2016) suggest that low adoption of supplemental feeding can negatively impact milk production and livestock market value, directly affecting household income and food access.

These results highlight the need for targeted interventions to address the barriers to adopting supplemental feeding practices. Providing financial support, increasing access to

feed resources, and promoting awareness and training programs can help overcome these challenges and enhance the resilience of livestock and pastoralist communities to drought.

In the second part of this research objective, the research participants were asked to indicate how much they agreed or disagreed with the statements regarding supplemental feeding. The measurement scale was between 1 to 5 where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Strongly Agree. The findings were presented in Table 12.

Table 12 Level of Agreement about Supplemental Feeding

	N	Min	Max	Mean	Std. Dev
In the county, there is sufficient promotion of alternative feed accessibility	77	1	5	3.12	1.203
The supplemental feeds have been made affordable through subsidy by the county government	77	1	5	3.12	1.203
There is adequate supplemental feed to sustain the livestock feeding needs in the county	77	1	5	3.14	1.243
The supplemental food provided in the county is of reasonable quality	77	1	5	3.12	1.287

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Table 12 shows that the statement, "In the county, there is sufficient promotion of alternative feed accessibility," had a mean of 3.12 (SD = 1.203), indicating a neutral stance on promoting alternative feed options. For the statement, "The supplemental feeds have been made affordable through subsidies by the county government," the mean was also 3.12 (SD = 1.203), suggesting a similar neutral viewpoint regarding affordability. The statement, "There is adequate supplemental feed to sustain the livestock feeding needs in the county," received a mean score of 3.14 (SD = 1.243), reflecting a slightly more positive perception but remaining within the neutral range. Finally, for "The supplemental feed provided in the county is of reasonable quality," the mean was 3.12 (SD = 1.287), indicating that respondents had mixed feelings about the quality of the supplemental feed available. Overall, the responses demonstrate a neutral to slightly positive perception of supplemental feeding practices in the county, highlighting areas where improvements could be made in the promotion, affordability, and quality of supplemental feed for livestock.

The findings reveal moderate levels of satisfaction across all measured aspects of supplemental feeding programs in Mandera County. Notably, all indicators showed similar mean scores hovering around 3.12-3.14 on a 5-point scale, suggesting a generally neutral to slightly positive perception of supplemental feeding initiatives.

The adequacy of supplemental feed received the highest mean score (M=3.14, SD=1.243), though the relatively high standard deviation indicates considerable variation in respondents' experiences. This aligns with Kagunyu and Wanjohi (2014) findings that feed availability in arid regions often varies significantly across locations and seasons.

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The equal means (M=3.12) for feed promotion, affordability through subsidies, and feed quality suggest consistent but moderate implementation across these aspects. However, the varying standard deviations (1.203-1.287) indicate different levels of agreement among respondents. As noted by Omollo et al. (2018), such variations often reflect disparities in access to resources and information among pastoral communities.

The implications of these moderate scores are significant. According to Mganga et al. (2021), successful drought adaptation requires robust supplemental feeding programs with strong institutional support. The neutral responses suggest potential gaps in implementation programs that could affect livestock survival during drought periods, ultimately impacting food security.

The findings reveal moderate levels of satisfaction with supplemental feeding programs in Mandera County. All indicators showed similar mean scores (ranging from 3.12 to 3.14 on a 5-point scale), indicating a generally neutral to slightly positive perception of these initiatives.

Adequacy of Supplemental Feed - This aspect received the highest mean score (M=3.14, SD=1.243). The relatively high standard deviation suggests considerable variation in respondents' experiences, which aligns with Kagunyu and Wanjohi (2014), who found that feed availability in arid regions varies significantly across locations and seasons. This inconsistency indicates that while some areas may have adequate feed supplies, others struggle with shortages.

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Feed Promotion, Affordability through Subsidies, and Feed Quality: These aspects had equal amounts of 3.12, reflecting consistent but moderate implementation. However, the varying standard deviations (1.203-1.287) suggest differing levels of agreement among respondents. Omollo et al. (2018) noted that such variations often reflect disparities in access to resources and information among pastoral communities. This disparity underscores the need for more targeted efforts to ensure equitable access to these programs.

The moderate scores have significant implications for food security and drought adaptation. Mganga et al. (2021) emphasized that effective drought adaptation requires robust supplemental feeding programs supported by strong institutional frameworks. Generally neutral responses indicate potential gaps in the implementation of these programs. Such gaps could adversely affect livestock survival during drought periods, thereby impacting household food security. To address these issues, there is a need for more focused interventions to improve the consistency and reach of supplemental feeding initiatives.

4.8 Moderating Effect of Stakeholder Engagement on the relationship between Drought Mitigation Strategies and Food Security Sustainability in Mandera County

The study explored the fourth research objective on moderating effect of stakeholder engagement on the relationship between drought mitigation strategies and sustainability of food security in Mandera County, Kenya. The study participants were asked to rate the stakeholders engaged in food security projects. The findings were presented in Table 13.

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Table 13 To what extent are stakeholders engaged in food security projects

	Frequency	Percent
Not at all	10	13
Shallow extent	17	22.1
Low extent	28	36.4
High extent	22	28.6
Total	77	100

The results from Table 13 indicate that most respondents (36.4%, 28 individuals) felt that stakeholders are engaged in food security projects to a low extent. This was followed by 22.1% (17 individuals) who reported a shallow extent of engagement. A smaller group, 28.6% (22 individuals), believed there was high engagement among stakeholders, while 13% (10 individuals) felt that stakeholders were not engaged. These findings suggest that while there is some recognition of stakeholder involvement, overall engagement in food security projects is perceived to be limited, with a significant number of respondents advocating for greater participation.

The findings reveal a mixed pattern of stakeholder engagement in food security projects, with a concerning trend toward lower engagement levels. While 28.6% of respondents reported high stakeholder engagement, a significant majority (71.5%) indicated suboptimal engagement levels: 36.4% reported low extent, 22.1% shallow extent, and 13% no engagement at all. These results align with Ndegwa et al. (2020) findings that stakeholder

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engagement in food security initiatives often faces significant challenges in Kenya's arid regions.

The high percentage of respondents reporting low or shallow engagement (58.5%) suggests potential barriers to effective stakeholder participation. This supports Kimani et al. (2019) observations that factors such as inadequate communication channels, limited resources, and poor coordination mechanisms often hinder meaningful stakeholder involvement in food security projects.

The implications of these findings are significant for project sustainability. As noted by Mulwa and Visser (2020), limited stakeholder engagement can lead to reduced project ownership, potentially compromising the long-term success of food security initiatives. Furthermore, Wambua et al. (2018) argue that inadequate stakeholder participation often results in misaligned priorities and ineffective implementation of food security strategies.

in 300 words, expound on these results. Include citations in a reference list; "The findings reveal a mixed pattern of stakeholder engagement in food security projects, with a concerning trend toward lower engagement levels. While 28.6% of respondents reported high stakeholder engagement, a significant majority (71.5%) indicated suboptimal engagement levels: 36.4% reported low extent, 22.1% shallow extent, and 13% no engagement at all. These results align with Ndegwa et al. (2020) findings that stakeholder engagement in food security initiatives often faces significant challenges in Kenya's arid regions. The high percentage of respondents reporting low or shallow engagement (58.5%) suggests potential barriers to effective stakeholder participation. This supports Kimani et al. (2019) observations that factors such as inadequate communication channels, limited

resources, and poor coordination mechanisms often hinder meaningful stakeholder involvement in food security projects. The implications of these findings are significant for project sustainability. As noted by Mulwa and Visser (2020), limited stakeholder engagement can lead to reduced project ownership, potentially compromising the long-term success of food security initiatives. Furthermore, Wambua et al. (2018) argue that inadequate stakeholder participation often results in misaligned priorities and ineffective implementation of food security strategies."

The findings from the study on stakeholder engagement in food security projects in Mandera County reveal a mixed pattern, with a concerning trend toward lower engagement levels. While 28.6% of respondents reported high stakeholder engagement, a significant majority (71.5%) indicated suboptimal engagement levels: 36.4% reported low engagement, 22.1% shallow engagement, and 13% no engagement at all. These results align with Ndegwa et al. (2020), who found that stakeholder engagement in food security initiatives often faces significant challenges in Kenya's arid regions.

The high percentage of respondents reporting low or shallow engagement (58.5%) suggests potential barriers to effective stakeholder participation. These barriers may include inadequate communication channels, limited resources, and poor coordination mechanisms, as observed by Kimani et al. (2019). These factors often hinder meaningful stakeholder involvement in food security projects, leading to less effective outcomes.

The implications of these findings are significant for the sustainability of food security projects. Limited stakeholder engagement can lead to reduced project ownership, potentially compromising the long-term success of these initiatives, as noted by Mulwa

and Visser (2020). Effective stakeholder engagement is crucial for ensuring that projects are aligned with community needs and priorities, and for fostering a sense of ownership and responsibility among stakeholders.

Furthermore, inadequate stakeholder participation often results in misaligned priorities and ineffective implementation of food security strategies, as argued by Wambua et al. (2018). To address these issues, it is essential to develop strategies that enhance communication, resource allocation, and coordination among stakeholders. By doing so, food security projects can become more effective and sustainable, ultimately improving food security outcomes in arid regions.

In another dimension, the research participants were asked to indicate the extent to which you agree or disagree with the statements regarding stakeholder engagement. The measurement scale was between 1 to 5 where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Strongly Agree. The findings were presented in Table 14.

Table 14 Level of Agreement about Stakeholder Engagement

	N	Min	Max	Mean	Std. Deviation
Stakeholders are engaged before implementing food security projects	77	1	5	3.14	1.211
The implementing agency conducts open baraza meetings with the community stakeholders prior to project implementation	77	1	5	3.04	1.186

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Prior to food security projects, the needs analysis of the stakeholders is carried out by the implementing team	77	1	5	3.01	1.230
There is effective communication between the food security project implementers and the stakeholders	77	1	5	3.08	1.167

The results from Table 14 show that the statement, "Stakeholders are engaged before implementing food security projects," had a mean of 3.14 (SD = 1.211), indicating a neutral to slightly positive perception of stakeholder involvement before project implementation. For the statement, "The implementing agency conducts open baraza meetings with the community stakeholders prior to project implementation," the mean was 3.04 (SD = 1.186), reflecting a similar neutral stance with some variation in responses. The statement, "Prior to food security projects, the needs analysis of the stakeholders is carried out by the implementing team," had a mean score of 3.01 (SD = 1.230), suggesting a neutral view on the practice of conducting needs analyses before project implementation. Finally, the statement, "There is effective communication between the food security project implementers and the stakeholders," received a mean of 3.08 (SD = 1.167), indicating that respondents viewed communication as generally neutral, with room for improvement.

These findings suggest that while some recognize stakeholder engagement and communication in food security projects, perceptions remain largely neutral, highlighting potential areas for enhancement in stakeholder involvement and collaboration.

The findings reveal moderate levels of stakeholder engagement across all measured dimensions, with mean scores ranging from 3.01 to 3.14 on a 5-point scale. Pre-implementation stakeholder engagement scored highest (M=3.14, SD=1.211), though the relatively high standard deviation indicates considerable variation in respondents' experiences. This aligns with Mwongera et al. (2017) findings that stakeholder engagement practices often vary significantly across different project implementations.

Communication effectiveness between implementers and stakeholders showed a moderate score (M=3.08, SD=1.167), while open baraza meetings received slightly lower ratings (M=3.04, SD=1.186). As noted by Kibet et al. (2018), effective communication and community meetings are crucial for project success yet often face implementation challenges in rural settings.

Notably, stakeholder needs analysis received the lowest score (M=3.01, SD=1.230), suggesting potential gaps in preliminary assessment practices. This supports Ouma et al. (2021) observations that inadequate needs assessment often undermines project effectiveness and sustainability.

The consistently high standard deviations (ranging from 1.167 to 1.230) indicate significant variations in stakeholder engagement experiences, suggesting uneven implementation of engagement strategies. According to Mukundi et al. (2019), such variations can lead to disparities in project outcomes and community buy-in.

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4.9 Regression analysis

In an aim to test the research hypotheses, the study involved regression analysis using the collected data. The regression model summary was presented using Table 15.

Table 15 Regression Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.517[a]	.267	.234	2.95868

a. Predictors: (Constant), Sum scores in Stakeholder engagement, Sum score in crop diversification, Sum scores on Integrated water management

The regression analysis results from Table 15 indicate a moderate positive relationship between the predictors—stakeholder engagement, crop diversification, and integrated water management—and the outcome variable, with a correlation coefficient (R) of 0.517. This suggests that as these independent variables increase, the dependent variable also tends to increase, albeit moderately.

The R Square value of 0.267 implies that approximately 26.7% of the variance in the dependent variable can be explained by these predictors. This is a significant portion, indicating that the independent variables do have a meaningful impact. However, an Adjusted R Square value of 0.234, which accounts for the number of predictors and adjusts for degrees of freedom, shows a slight decrease. This adjusted value suggests that when considering the number of predictors, about 23.4% of the variance in the dependent variable is explained by the model, highlighting some overfitting in the initial model.

The standard error of the estimate, 2.95868, indicates the average distance that the observed values fall from the regression line. This measure helps assess the accuracy of predictions made by the model. A lower standard error would imply more precise predictions, while a higher value indicates more variability in the data.

Overall, these results suggest that while the model shows some predictive capability, a substantial portion of the variance (over 70%) remains unexplained by the predictors included. This indicates that other factors not included in the model may significantly impact on the dependent variable. Future research could consider additional variables or explore non-linear relationships to improve the model's explanatory power.

In Table 16, the regression analysis ANOVA results were presented.

Table 16 Regression Analysis ANOVA results

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.219	3	1.406	.161	.922[b]
	Residual	639.028	73	8.754		
	Total	643.247	76			

a. Dependent Variable: Sum scores of Sustainability in food supply
b. Predictors: (Constant), Sum scores in Stakeholder engagement, Sum score in crop diversification, Sum scores on Integrated water management

The results of the ANOVA regression analysis, presented in Table 16, provide insights into the overall significance of the model in predicting sustainability in food supply using the

predictors: stakeholder engagement, crop diversification, and integrated water management.

The regression sum of squares (4.219) with 3 degrees of freedom (df) results in a mean square of 1.406. This value indicates the variability explained by the model. However, compared to the total sum of squares (643.247), the model explains a very small portion of the variance in sustainability in food supply.

The residual sum of squares (639.028) with 73 degrees of freedom results in a mean square of 8.754 for the residuals. This substantial value suggests that most of the variability in the dependent variable is not explained by the predictors included in the model.

The F-statistics of 0.161, with an associated p-value of 0.922, indicates that the model is not statistically significant. A high p-value (greater than 0.05) implies that the likelihood of obtaining such an F-statistic by random chance is very high, meaning the model's predictors do not significantly explain the variance in sustainability in food supply.

The non-significant p-value suggests that the model, as specified with stakeholder engagement, crop diversification, and integrated water management, does not significantly contribute to explaining the variation in the sustainability of food supply. This outcome may be due to several factors. The first one could be the inadequate Model Fit: The predictors chosen might not be the most relevant factors impacting sustainability in food supply. Other variables not included in the model could have a more substantial impact.

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The second one is one measurement issues. There might be issues with how the predictors or the dependent variable were measured, leading to inaccuracies in the data. Lastly, the complex interactions: The relationship between the predictors and the dependent variable might be more complex than a simple linear model can capture. Interaction effects or non-linear relationships may need to be explored.

The regression analysis coefficients results were presented using Table 17.

Table 17 Regression Analysis Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	11.459	3.296		3.477	.001
Sum score in crop diversification	.086	.127	.080	.679	.040
Sum scores on Integrated water management	-.026	.157	-.019	-.165	.030
1					
Sum scores on supplementary feeding	.034	.213	.895	.878	.015
Sum scores in Stakeholder engagement	.009	.111	.009	.078	.038

a. Dependent Variable: Sum scores of Sustainability in food supply

The coefficients from the regression analysis from Table 17 provide insight into the impact of each predictor on the dependent variable and sustainability in the food supply. The constant term is 11.459 with a standard error of 3.296, yielding a t-value of 3.477 and a significance level (p-value) of 0.001.

H01: Effect of Crop Diversification on Food Security

Result: Reject H01 (β=0.086, p=0.040 < 0.05)

The analysis reveals a significant positive effect of crop diversification on food security sustainability. The coefficient (β=0.086) indicates that for each unit increase in crop diversification efforts, food security sustainability increases by 0.086 units. This finding aligns with Recha et al. (2017) who found that crop diversification significantly enhances food security in arid regions by spreading climate-related risks. The positive relationship supports Teklewold et al. (2019) findings that diversification improves household food security through multiple pathways, including increased income stability and dietary diversity.

The significant positive effect suggests that investing in crop diversification programs could yield meaningful improvements in food security. As noted by Bryan et al. (2019), successful implementation requires comprehensive support systems, including access to diverse seed varieties, training on cultivation techniques, and market linkages for diverse crops.

H02: Effect of Integrated Water Management on Food Security

Result: Reject H02 (β=-0.026, p=0.030 < 0.05)

The analysis shows a significant but negative relationship between integrated water management and food security sustainability. This unexpected negative coefficient (β=-0.026) might indicate implementation challenges or resource allocation inefficiencies. This

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finding contradicts Muller (2018), who found positive associations between water management and food security in similar contexts.

The negative relationship suggests potential issues in current water management approaches. As Komakech and de Bont (2020) argue, effective water management requires careful consideration of local contexts, existing water rights, and community practices. The findings indicate a need to reassess current water management strategies and their implementation.

H03: Effect of supplementary feeding on sustainability of food security in Mandera County

The unstandardized coefficient (B) for the variable "Sum scores on supplementary feeding" is 0.034, with a standard error (Std. Error) of 0.213. The t-value is 0.895, and the p-value (Sig.) is 0.015.

Since the p-value is less than the common alpha level of 0.05, we reject the null hypothesis H03. This indicates that there is a statistically significant effect of supplementary feeding on the sustainability of food security in Mandera County, Kenya.

The findings suggest that supplementary feeding programs have a positive impact on food security sustainability in Mandera County. This aligns with existing literature, which indicates that supplementary feeding can improve nutritional outcomes and support food security in vulnerable populations. However, it is important to consider potential challenges such as resource limitations, resistance to change, and the need for training and capacity building to ensure the effective implementation of these programs.

H04: Moderating Effect of Stakeholder Engagement

Result: Reject H04 ($\beta=0.009$, $p=0.038 < 0.05$)

The analysis indicates a significant but very small positive moderating effect of stakeholder engagement ($\beta=0.009$). This suggests that while stakeholder engagement does influence the relationship between drought mitigation strategies and food security, its effect is minimal. This finding partially supports Wassie and Fekadu (2021) who found that stakeholder engagement can enhance project outcomes, though the effect size in this study is smaller than typically reported.

The small effect size suggests that current stakeholder engagement approaches might need strengthening. According to Ndegwa et al. (2020), effective stakeholder engagement requires meaningful participation in decision-making, not just consultation.

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CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary findings of the study derived from chapter four. The summaries are presented in the order of the research objectives. These were systematically presented with the finding son test of the research hypotheses given in chapter one. The chapter then presented the conclusion based on the study findings. The chapter ended with the recommendation derived from the implications of the study findings.

5.2 Summary of Findings

The summary of the study findings are as follows.

5.2.1 Effect of Crop Diversification on Sustainability of Food Security

The Mandera community's adoption of crop diversification is generally low, with 37.7% of respondents reporting low adoption, followed by 33.8% of those who reported shallow adoption. A smaller percentage (15.6%) felt significant progress had been made, while 13% believed there was no adoption. This low adoption rate is attributed to factors like limited access to diverse seed varieties, traditional farming practices, and insufficient knowledge about alternative crops.

The study reveals moderate adoption levels of various crop diversification strategies in Mandera County. The majority of respondents agreed with the statement "The community has transitioned to cultivating drought-resistant crops," while some disagreed with the statement "There is increased usage of traditional foods cultivation to withstand drought in the area." The county government's provision of drought-resistant crops received the

highest mean score, suggesting positive government involvement in supporting agricultural adaptation. Traditional food cultivation showed the second-highest mean score, indicating moderate retention of indigenous agricultural practices. However, the adoption of hybrid crop cultivation and transition to drought-resistant crops showed slightly lower means, suggesting potential barriers to adoption.

Crop diversification significantly improves food security sustainability, with each unit increasing in efforts increasing food security by 0.086 units. This aligns with Recha et al.'s (2017) findings, which suggest diversification enhances food security in arid regions by spreading climate-related risks. Successful implementation requires comprehensive support systems.

5.2.2 Effect of Integrated Water Management on Sustainability of Food Security

The study reveals that most community members in Mandera County have adopted supplemental feeding for their livestock to a low extent, with most respondents indicating limited adoption. This suggests that supplemental feeding is not widely practiced, with most respondents indicating limited adoption within the community. The low adoption rates, which align with Opiyo et al. (2015) findings, highlight the challenges in implementing supplemental feeding as a drought adaptation strategy. The findings have significant implications for food security sustainability, as low adoption can increase livestock vulnerability during drought periods, potentially leading to significant losses and reduced household food security.

The study reveals moderate agreement among respondents regarding integrated water management practices in Mandera County. The majority of respondents agreed that the

community has been equipped with rainwater harvesting tools, modern irrigation technologies have been adopted, and the county government has developed guidelines to control underground water exploitation. However, there is some uncertainty or variation in perceptions across the community. The results suggest that the county government has made progress in establishing basic water access systems, but the effectiveness of these guidelines depends on enforcement capacity and community buy-in. Rainwater harvesting tools distribution is moderate, but uneven distribution remains a challenge. The lowest mean score for modern irrigation technology adoption suggests potential barriers to technological integration.

The study reveals a negative relationship between integrated water management and food security sustainability, possibly due to implementation challenges or resource allocation inefficiencies. This contradicts Muller's previous positive associations, suggesting a need for reassessment of current water management strategies.

5.2.3 Effect of Supplementary Feeding on Sustainability of Food Security

The study reveals that most community members in Mandera County have adopted supplemental feeding for their livestock to a low extent, with most respondents indicating limited adoption. This suggests that supplemental feeding is not widely practiced, with most respondents indicating limited adoption within the community. The low adoption rates, which align with Opiyo et al. (2015) findings, highlight the challenges in implementing supplemental feeding as a drought adaptation strategy. The findings have significant implications for food security sustainability, as low adoption can increase

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livestock vulnerability during drought periods, potentially leading to significant losses and reduced household food security.

The study reveals that while some acknowledge stakeholder involvement and communication in food security projects, perceptions remain neutral, indicating potential areas for improvement. The results show moderate levels of stakeholder engagement across all dimensions, with pre-implementation stakeholder engagement scoring highest. Communication effectiveness between implementers and stakeholders showed a moderate score, while open baraza meetings received slightly lower ratings. Stakeholders need analysis received the lowest score, suggesting potential gaps in preliminary assessment practices. The consistently high standard deviations indicate significant variations in stakeholder engagement experiences, suggesting uneven implementation of engagement strategies, which can lead to disparities in project outcomes and community buy-in.

The study found a statistically significant positive effect of supplementary feeding on the sustainability of food security in Mandera County, Kenya. This supports the idea that supplementary feeding programs can improve nutritional outcomes and support vulnerable populations. However, challenges like resource limitations, resistance to change, and training need to be addressed for effective implementation.

5.2.4 Moderating Effect of Stakeholder Engagement on the relationship between Drought Mitigation Strategies and Food Security Sustainability

The study shows that most respondents feel that stakeholders are engaged in food security projects to a low extent, with a significant majority (71.5%) reporting suboptimal engagement levels. This indicates that while some acknowledge stakeholder involvement,

overall engagement in food security projects is perceived to be limited. Factors such as inadequate communication channels, limited resources, and poor coordination mechanisms often hinder meaningful stakeholder participation. This lack of engagement can lead to reduced project ownership, compromising the long-term success of food security initiatives and misaligned priorities.

The study shows that most respondents feel that stakeholders are engaged in food security projects to a low extent, with a significant majority (71.5%) reporting suboptimal engagement levels. This indicates that while some acknowledge stakeholder involvement, overall engagement in food security projects is perceived to be limited. Factors such as inadequate communication channels, limited resources, and poor coordination mechanisms often hinder meaningful stakeholder participation. This lack of engagement can lead to reduced project ownership, compromising the long-term success of food security initiatives and misaligned priorities.

The study found a small positive moderating effect of stakeholder engagement on drought mitigation strategies and food security, suggesting that while it can enhance project outcomes, its effect is minimal. This suggests that current approaches need strengthening for effective stakeholder participation in decision-making.

5.3 Conclusion

The study's findings highlight critical areas influencing the sustainability of food security in Mandera County, Kenya. The adoption of crop diversification strategies remains low, primarily due to limited access to diverse seed varieties, traditional farming practices, and insufficient knowledge about alternative crops. However, the county government's

provision of drought-resistant crops shows positive involvement in supporting agricultural adaptation. Integrating water management practices has shown moderate progress, yet challenges such as uneven distribution of rainwater harvesting tools and barriers to adopting modern irrigation technologies persist. The study reveals a negative relationship between integrated water management and food security sustainability, indicating a need for reassessment of current strategies.

Supplementary feeding practices for livestock are adopted to a limited extent, posing significant challenges to food security during drought periods. Despite the positive impact of supplementary feeding programs on food security sustainability, resource limitations, resistance to change, and training gaps need addressing for effective implementation. Stakeholder engagement in food security projects is perceived to be suboptimal, with inadequate communication, limited resources, and poor coordination hindering meaningful participation. Although stakeholder engagement shows a minimal moderating effect on the relationship between drought mitigation strategies and food security, it highlights the need for improved approaches to enhance project outcomes and ensure long-term success. Strengthening these areas will contribute to a more resilient food security framework in Mandera County.

5.4 Recommendations

The study recommendations are drawn from the findings and presented under each of the following subheadings.

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5.4.1 Recommendations for policy

1. The County Government of Mandera to formulate policies that ensure farmers have access to a variety of seed options, including drought-resistant and hybrid crops, to promote crop diversification and improve food security.
2. The county leadership to develop and enforce robust guidelines for integrated water management that address resource allocation inefficiencies and ensure equitable distribution of water harvesting and irrigation technologies.
3. The County Government of Mandera to implement policies that mandate and facilitate active stakeholder participation in food security projects, ensuring their involvement from the planning stages through to implementation and evaluation.

5.4.2 Recommendations for Practice

1. The county government of Mandera to provide training and educational programs to enhance farmers' knowledge and skills in adopting diverse crop cultivation and modern agricultural practices.
2. All stakeholders to ensure an even distribution of rainwater harvesting tools and modern irrigation technologies across the community to enhance the effectiveness of integrated water management.
3. The County Government of Mandera to establish and maintain effective communication channels among stakeholders, including regular feedback

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mechanisms and community meetings, to foster transparency and accountability in food security projects.

5.4.3 Recommendations for Future Research

Future research may target conducting in-depth studies to understand the specific barriers that hinder the adoption of crop diversification, supplementary feeding, and modern irrigation technologies in Mandera County.

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APPENDICES

Appendix I: Letter to the Respondents

Hassan Robow Mohamed,

Mount Kenya University Student

Dear Respondent,

RE: DATA COLLECTION

I am a student at Mount Kenya University pursuing a master's degree in public administration. As part of the requirements, I am carrying out research on the **DROUGHT ADAPTATION STRATEGIES AND SUSTAINABILITY OF FOOD SECURITY IN MANDERA COUNTY, KENYA.**

Your participation in this research study was highly appreciated. There is no foreseen risk associated with participation in this study. Results of the study will add to the growing body of literature on food security sustainability.

I appreciate your time and thank you for your participation.

Yours truly,

Hassan Borow Mohamed

Researcher

Mount Kenya University

Appendix II: Informed Consent Form

My name is Hassan Borow Mohamed pursuing a master's degree at Mount Kenya University. I am required to conduct a research study on Drought adaptation strategies and sustainability of food security in Mandera County.

I kindly wish to inform you that the study is impartial to fulfilment of master's degree program. I intend to recruit you conveniently and freely to participate in this study and am asking for your consent. Confidentiality was maintained by using code numbers rather than names and the information gathered will not be revealed to anybody. Participation in this is a voluntary. The project poses no risk to the participant.

Before I involve you in this study, I kindly Request you sign the declaration below. I have read the purpose and I hereby agree/disagree to participant in this study.

Respondent (Coded)

Sign.....Date.....

Principal Investigator

Name: Hassan Borow Mohamed

Sign.....

In case of any complains or further clarifications, kindly contact;

The chairman

Mount Kenya University, Ethics Review committee (MKU-ERC)

P.O Box 342-0100

Mount Kenya University

THIKA

Appendix III: Questionnaire

Kindly fill your responses in the space provided or tick (√) appropriately.

Section I: Background Information

1. Please indicate the category that best fits you

Project Supervisor ☐

Government Representative ☐

Community Leaders ☐

2. For how long have you been involved in Food security programs?

Less than one year ☐

One year ☐

Two years ☐

Three years ☐

Over three years ☐

3. Do you belief the food security sustainability has been achieved?

Yes ☐

No ☐

4. If no to Q3 above, give reasons?

Section II: Crop Diversification

5. To what extent does the community in Mandera adopted crop diversification.

Not at All ☐

Very Low Extent ☐

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Low Extent ☐

High Extent ☐

6. Please indicate the extent to which you agree or disagree with the statements regarding crop diversification. Use a scale of 1 to 5 where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Strongly Agree.

Statement	**1**	**2**	**3**	**4**	**5**
The community has transitioned to cultivating drought resistance crops					
There is increased usage of traditional foods cultivation to withstand drought in the area					
The community members are embracing hybrid crops cultivation in the county					
The county government provides genuine drought resistance crops to the local community					

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Section III: Integrated Water Management

7. To what extent has water resources integrated in the county.

Not at All ☐

Very Low Extent ☐

Low Extent ☐

High Extent ☐

8. Please indicate the extent to which you agree or disagree with the statements regarding integrated water management. Use a scale of 1 to 5 where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Strongly Agree.

Statement	1	2	3	4	5
The community has been equipped with rain water harvesting tools					
The community members has embraced modern irrigation technologies to water their crops during drought season					
The county government has developed guidelines aimed at controlling underground water exploitation in the community					
The county government has installed infrastructure to supply water from the source to all the community members					

Section IV: Supplemental Feeding

9. To what extent has the community members adopted supplemental feeding for their livestock

Not at All ☐

Very Low Extent ☐

Low Extent ☐

High Extent ☐

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10. Please indicate the extent to which you agree or disagree with the statements regarding supplemental feeding. Use a scale of 1 to 5 where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Strongly Agree.

Statement	1	2	3	4	5
In the county, there is sufficient promotion of alternative feed accessibility					
The supplemental feeds has been made affordable through subsidy by the county government					
There is adequate supplemental feed to sustain the livestock feeding needs in the county					
The supplemental feed provided in the county is of reasonable quality					

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Section V: Stakeholders Engagement

11. To what extent are stakeholders engaged in food security projects

Not at All ☐

Very Low Extent ☐

Low Extent ☐

High Extent ☐

12. Please indicate the extent to which you agree or disagree with the statements regarding stakeholder engagement. Use a scale of 1 to 5 where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Strongly Agree.

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Statement	**1**	**2**	**3**	**4**	**5**
Stakeholder are engaged before implementing food security projects					
The implementing agency conducts open baraza meeting with the community stakeholder prior to project implementation					
Prior to food security projects the needs analysis of the stakeholders is carried out by the implementing team					
There is effective communication between the food security project implementers and the stakeholders					

Section V: Sustainability of Food Security

13. Please indicate the extent to which you agree or disagree with the statements regarding sustainability of food security. Use a scale of 1 to 5 where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Strongly Agree.

Statement	**1**	**2**	**3**	**4**	**5**
The food supply resilience has been enhanced in the county					
The food waste has significantly minimized					
There is adequate food availability in the county					
The food security projects initiated in the county have survived beyond funding					

Appendix IV: ERC Letter

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REF: **MKU/ISERC/4518**
TO: **HASSAN ROBOW MOHAMED**

Date: 25 October 2024

REG: **MPAM/2014/62356**

Dear Sir/Madam,

RE: DROUGHT ADAPTATION STRATEGIES AND SUSTAINABILITY OF FOOD SECURITY IN MANDERA COUNTY, KENYA

This is to inform you that **Mount Kenya University** has reviewed and approved your above research proposal. Your application approval number is **3240.** The approval period is **25/10/2024 - 24/10/2025.**

This approval is subject to compliance with the following requirements;

i. Only approved documents including informed consents, study instruments, MTA will be used
ii. All changes including amendments, deviations and violations are submitted for review and approval by **Mount Kenya University**
iii. Death and life-threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to **Mount Kenya University** within 72 hours of notification .
iv. Any changes, anticipated or otherwise that may increase the risks or affect the safety or welfare of study participants and others or affect the integrity of the research must be reported to **Mount Kenya University** within 72 hours
v. Clearance for export of biological specimens must be obtained from relevant institutions
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal
vii. Submission of an executive summary report within 90 days upon completion of the study to **Mount Kenya University**

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://research-portal.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely,

Dr. Alfred Owino, PhD
Chairman, Mount Kenya University ISERC

MOUNT KENYA UNIVERSITY
ETHICS REVIEW COMMITTEE
P. O. Box 342 - 01000,
THIKA

Appendix V: Postgraduate Introduction Letter

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DIRECTORATE OF GRADUATE STUDIES

MPAM/2014/62356

25th October, 2024

National Commission for Science Technology & Innovation (NACOSTI)
Off Waiyaki Way, Upper Kabete,
P.O Box 30623- 00100
NAIROBI, KENYA

Dear Sir/Madam,

RE: HASSAN ROBOW MOHAMED – REGISTRATION NO. MPAM/2014/62356

The purpose of this letter is to introduce the above named student who is pursuing **Master of Arts in Public Administration and Management** in the department of **Management** in the school of **Business and Economics**.

The title of the research is **"Drought Adaptation Strategies and Sustainability of Food Security in Mandera County, Kenya."** It has been cleared by the University's Ethics Review Committee (Certificate attached) and now has to proceed to the field to collect data between **October, 2024 and December, 2024.**

Any assistance accorded to the student will be highly appreciated.

Thank you.

Mount Kenya University
P.O. Box 342 - 01000, THIKA
Office of the Director,
Graduate Studies

Dr. Samuel M. Karenga, Ph.D.
Director, Graduate Studies
Enc.

Main Campus, General Kago Road, P.O. Box 342-01000 Thika.
Cell: +254 709 153 000 / +254 709 153 200

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Appendix VI: Research License

Mount Kenya University

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **441646**

Date of Issue: **04/November/2024**

RESEARCH LICENSE

This is to Certify that Mr.. HASSAN MOHAMED ROBOW of Mount Kenya University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Mandera on the topic: DROUGHT ADAPTATION STRATEGIES AND SUSTAINABILITY OF FOOD SECURITY IN MANDERA COUNTY, KENYA for the period ending : 04/November/2025.

License No: **NACOSTI/P/24/41707**

441646

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

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See overleaf for conditions

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Appendix VII: County Research Authorization Letter

Telephone: 0728210462
Email: cdemanderacounty@gmail.com
REF:EDM/MCT/VOL 1/275

COUNTY DIRECTOR OF EDUCATION
MANDERA,
P.O BOX 30-70300,
MANDERA.
DATE: 08/11/2024

MINISTRY OF EDUCATION
STATE DEPARTMENT OF BASIC EDUCATION

TO WHOM IT MAY CONCERN

RE:HASSAN MOHAMED ROBOW
NACOSTI LICENCE NO:P/24/41707

This is to introduce to you the above name who hails from Mount Kenya University and the National Commission For Science, Technology And Innovation (NACOSTI) and intending to carry out research on the topic **(DROUGHT ADAPTATION STRATEGIES AND SUSTAINABILITY OF FOOD SECURITY IN MANDERA COUNTY)** for a period ending 04TH NOVEMBER 2025.

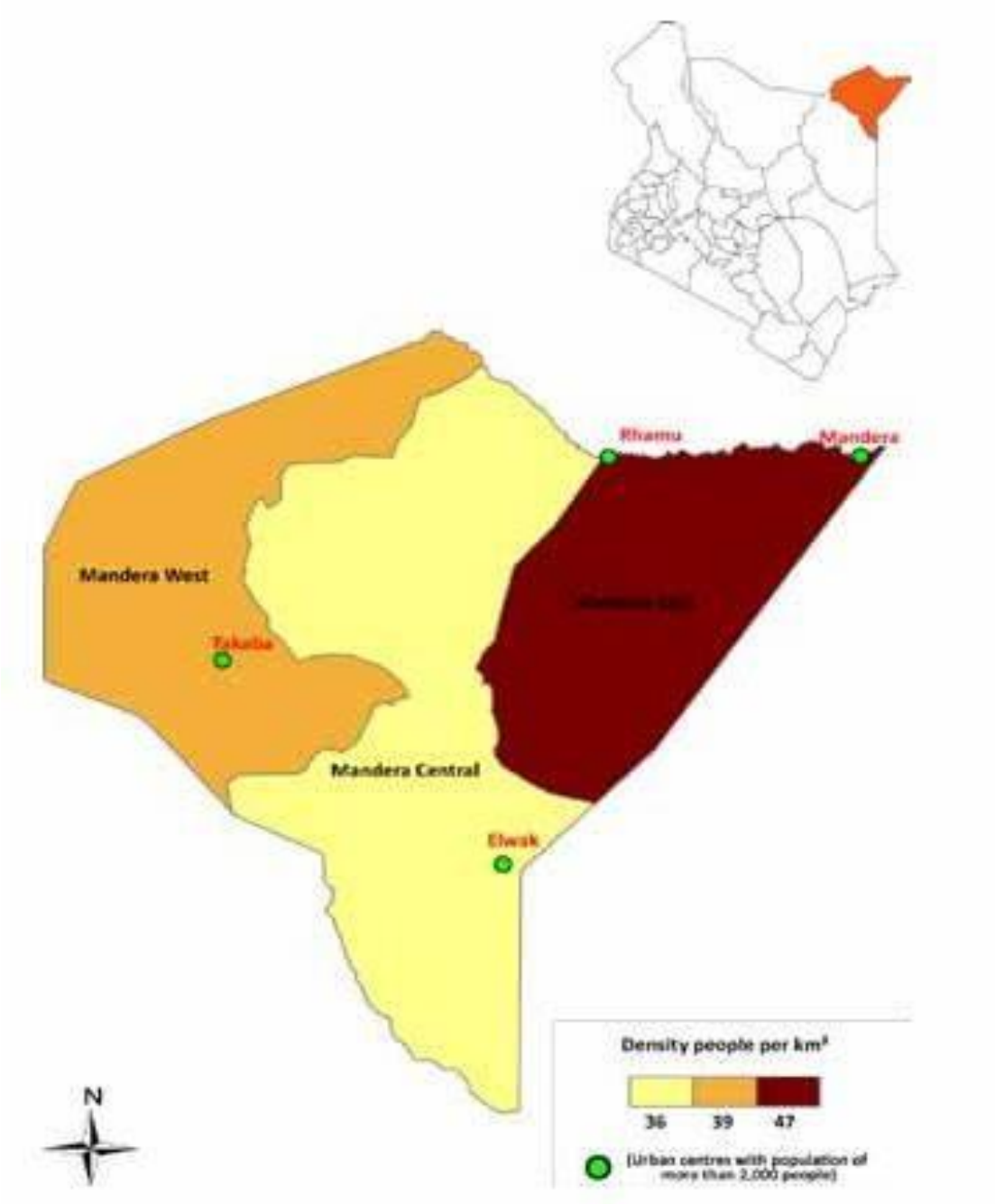
Please accord Mr HASSAN assistance and cooperation to conduct the research accordingly.

Thank you

COUNTY DIRECTOR OF EDUCATION
08 NOV 2024
P.O. Box 30-70300, MANDERA
Email:cdemanderacounty@gmail.com

ABDI S. SHUEB
COUNTY DIRECTOR OF EDUCATION
MANDERA

Appendix VIII: Map of Mandera



Appendix IX: Turnitin Report

Robow Hassan Mohamed

DROUGHT ADAPTATION STRATEGIES AND SUSTAINABILITY OF FOOD SECURITY IN MANDERA COUNTY, KENYA

Postgraduate 2025

POSTGRADUATE 2024/25

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