

**THE IMPACT OF DROUGHT ON FOOD SECURITY IN ARID AND SEMI-ARID
REGIONS IN KENYA; A CASE OF ISIOLO**

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DECLARATION

This research project is my original work and has never been presented for a degree in another university.

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Supervisor Declaration:

This research project has been submitted for examination with my approval as the University Supervisor.

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DEDICATION

First off, I thank Allah (SWT), who guided me, mercifully bestowed upon me with His blessings, throughout this academic journey. To my beloved parents, my Mom Hawa Ibrahim and Dad Mohamednoor Maalim, I dedicate this project as I am writing the piece with their unwavering financial support, constant encouragement, and love throughout my education. In addition, this work is dedicated to my friends and lecturers who generously spare themselves, time, knowledge and energy to ensure that I definitely submit this research project to the Management University of Africa. Most of all, let us give them all God's blessings so abundantly.

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Thank you all.

ABSTRACT

Kenya's Arid and Semi-Arid Lands (ASALs), such as Isiolo County, are increasingly vulnerable to recurrent droughts that have serious implications on agricultural production, water resources decline, and food insecurity intensifies. This study assesses the effects of drought on food security in Isiolo County using the four pillars of food security: availability, access, utilization, and stability. The objectives were to: examine the impact of drought severity and duration on food supply, evaluate the impact of drought frequency on food access at the household level, examine the relationship between food and water availability, and establish the effect of soil moisture depletion on food supply stability. The study was founded on the Entitlement and Sustainable Livelihoods Framework that highlights the multidimensional of the impacts of drought on food security. A mixed-methods design combining quantitative and qualitative data was used in a descriptive research design. Stratified random sampling was used to select 300 respondents from poor rural households, pastoralists, and small-scale farmers. Data was collected using structured household surveys, semi-structured interviews, and focus group discussions. Quantitative data was analyzed using SPSS and Excel, while qualitative data was analyzed using thematic analysis. Empirical observations showed a strong increase in the frequency and severity of drought over the past decade. Droughts that previously occurred every two or three years now occur yearly in some areas, resulting in increased water shortages, livestock mortality, and decreased agricultural production. Approximately 60% of the households had lost livestock heavily, while over 55% had suffered from food insecurity, of which 30% were unable to meet basic nutritional needs. Coping strategies such as migration and reliance on external relief were common but not sufficient for long-term resilience. The study emphasizes the need for longitudinal research to monitor the socio-economic and environmental effects of drought over time, which can inform evidence-based policy development. Some of the key policy recommendations include improving water resource management, promoting sustainable agriculture, and developing comprehensive drought resilience policies. Moreover, the study proposes the implementation of training for farmers and pastoralists on drought-resistant farming techniques and the introduction of climate change and drought resilience courses in school syllabuses. This would equip the communities to face any future drought. The study requires a multi-stakeholder, collaborative approach uniting local communities, government ministries, NGOs, and universities to create sustainable, context-specific interventions for long-term food security and resilience in Isiolo County.

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LIST OF ABBREVIATIONS AND ACCORINMYS

| | |
|---------------------|--|
| AfDB | African Development Bank |
| ASAL / ASALs | Arid and Semi-Arid Lands |
| AU | African Union |
| CSA | Climate-Smart Agriculture |
| DRC | Democratic Republic of the Congo |
| E | Margin of Error |
| FAO | Food and Agriculture Organization |
| FEWS NET | Famine Early Warning Systems Network |
| FGDs | Focus Group Discussions |
| GDP | Gross Domestic Product |
| ICPAC | IGAD Climate Prediction and Applications Centre |
| ICPC | Integrated Food Security Phase Classification |
| IGAD | Intergovernmental Authority on Development |
| IIED | International Institute for Environment and Development |
| IPCC | Intergovernmental Panel on Climate Change |
| KDHS | Kenya Demographic and Health Survey |
| KNBS | Kenya National Bureau of Statistics |
| LDCs | Least Developed Countries |
| n | Sample Size |
| NDMA | National Drought Management Authority |
| NGO / NGOs | Non-Governmental Organization(s) |
| OCHA | Office for the Coordination of Humanitarian Affairs |
| p | Estimated Proportion of the Population |
| SPSS | Statistical Package for the Social Sciences |
| UNCCD | United Nations Convention to Combat Desertification |
| UNDP | United Nations Development Programme |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| UNHCR | United Nations High Commissioner for Refugees |
| UNICEF | United Nations Children's Fund |
| UNOCHA | United Nations Office for the Coordination of Humanitarian Affairs |
| WFP | World Food Programme |
| WMO | World Meteorological Organization |
| Z-value | Standard Score in Statistical Sampling (Cochran's Formula) |

OPERATIONAL DEFINITION OF TERMS

| | |
|---------------------------|---|
| ASALs | Refers to Arid and Semi-Arid Lands, regions like Isiolo County characterized by low and unreliable rainfall, making them highly vulnerable to drought and food insecurity |
| Drought Duration | The length of time a drought event persists, affecting the growth cycle of crops and leading to reduced food production and availability |
| Drought Severity | The intensity or magnitude of drought conditions, measured by factors such as rainfall deficits and temperature increases. Drought severity directly affects food production by reducing the amount of available water for irrigation and livestock |
| Food Access | The ability of households in Isiolo County to obtain adequate food, influenced by market prices, income levels, and mobility during drought conditions. Limited access to food exacerbates food insecurity |
| Food Availability | The physical presence of food in Isiolo County, either from local agricultural production or markets, and its variation due to drought impacts. A decrease in local food production due to drought leads to reduced food availability |
| Food Security | A condition in which all people in Isiolo County have consistent access to sufficient, safe, and nutritious food that meets their dietary needs. Food security is threatened during drought periods when food production and access are compromised |
| Food Stability | The consistency of food supply over time in Isiolo County, which can be disrupted by prolonged or frequent droughts. Stability in food systems is essential for ensuring food security, especially in regions like Isiolo where droughts are recurrent |
| Food Utilization | The proper use of food for nutrition by individuals, dependent on clean water, food safety, and health status, often compromised during drought periods. Inadequate food utilization leads to malnutrition, especially when clean water and health services are limited during droughts |
| Isiolo County | The study location in Northern Kenya, part of the ASALs, and frequently affected by drought, making it a focal area for assessing drought-food security relationships. Isiolo is a region that regularly experiences food insecurity due to its vulnerability to drought |
| Soil Moisture | The amount of water retained in the soil which supports crop growth; its depletion during drought reduces agricultural productivity. Soil moisture is a critical factor for crop yields, and its depletion during drought leads to poor harvests |
| Water Availability | The accessibility and sufficiency of water for agricultural and household use, significantly influencing food production and consumption in Isiolo County. Water availability is key for maintaining agricultural activities, especially in arid and semi-arid regions like Isiolo |

CHAPTER ONE

INTRODUCTION

1.0 Introduction

This chapter provides the background of the study, their research question, the objectives of the study, significance, and the limitations of the study. The research scope is briefly given and the chapter summaries with a brief conclusion. This background section discusses the context of the study, as Isiolo County faced challenges as a result to drought and food security and involves giving the details about that considered before the study. Within the objectives, we spell out the aims of the research while the research questions nail down the exact manner in which drought would affect the agricultural productivities and food security of the region. The study also places emphasis on the significance of the study as it is important to local communities and policymakers. The range of the study is clearly set in place, taking into account the area and time frame for which it is undertaken. A chapter summary at the end of the introduction finally gives the final points of the main point in the introduction and it is ready to the next chapters of the study.

1.1 Background of the Study

One of the most critical problems of the 21st century and the coming centuries is food and climate variability security. Poor environmental condition and socioeconomic instability do create extreme vulnerabilities in various regions. According to the Food and Agriculture Organization (FAO, 2021), food security is the confirmation at a particular point in time, for all, to have physical, social, and economic access to adequate safe and nutritious food to satisfy their dietary requirements. It has come a long way from its initial concentration on food production to include now vital aspects of food accessibility, utilization, and stability.

Drought, a prolonged period of subnormal rainfall is one of the foremost challenges to food security, causing water scarcity, loss of crops, and loss of livestock (IPCC, 2022). Traditional societies devised coping mechanisms such as indigenous prediction and migratory pastoralism, but climate change, population growth, and land degradation have increased the system's vulnerability. From the World Meteorological Organization (WMO, 2023), global extreme drought events rose by 29% from 2020 to 2024, with the Horn of Africa being among the hardest

hit, such as the most severe 40-year drought that has devastated more than 23 million individuals (FEWS NET, 2023; UNOCHA, 2023).

1.1.1 Severity and Duration of Drought Events

Across the world, the intensity and length of dry spells have increased exponentially over the past two decades due to global warming, land use changes, and deforestation. Droughts, previously limited to short periods, are now persisting through multiple seasons and years. According to the Intergovernmental Panel on Climate Change (IPCC, 2022), enhanced occurrence of extended droughts has been noticed, particularly in semi-arid and arid regions of the world, and has led to widespread disturbance in food farming, water, and human life. In Latin America's Dry Corridor, for example, multi-year drought since 2020 has led to recurrent crop losses and has placed 8 million people at risk of hunger, including 3.3 million at emergency levels of food insecurity (FAO, 2023).

Droughts have been more intense and more frequent in the African continent, particularly in the Horn of Africa. The region experienced five successive failed rainy seasons between 2020 and 2023 the region's longest drought occurrence in history (FEWS NET, 2023). This has had catastrophic effects: Somalia registered a 75% decrease in crop production during the 2022 Guu season, and cereal production in Ethiopia's Somali region was 30% below the five-year norm (WFP, 2023). This current drought season has also resulted in the loss of over 9.5 million livestock since 2021 that have been catastrophic to pastoralist societies and economies (IGAD, 2023). The economic loss in East Africa as a result of drought has been projected to amount to \$30 billion from 2020 to 2023 (World Bank, 2023).

At the local level in Kenya, the severity of drought has significantly increased in counties like Isiolo. During 2020–2023, the region experienced its most severe cycle in decades, which significantly affected rain-based agriculture and livelihoods dependent on livestock. The Kenya Meteorological Department (2023) reports that rainfall variability increased by 15% in Isiolo County between the last ten years. During the 2020–2023 drought, maize yields fell by 60% in certain locations, and pastoralist populations suffered more than 50% death of livestock (NDMA, 2023). These drastic effects are augmented by the low capacity to irrigate and insufficient drought response systems.

1.1.2 Frequency of Drought Events

The frequency of occurrences of droughts has increased phenomenally around the world, from a once-a-decade event to biennial or even annual events in some places. This is largely attributed to the intensifying process of climate change, which alters atmospheric and oceanic regimes, for example, the behavior of the El Niño–Southern Oscillation (ENSO). The World Meteorological Organization (WMO, 2023) cites that the number of extreme drought events globally increased by 29% between 2020 and 2024. This high occurrence gives less chance for natural ecosystems and societies to recover between episodes, pushing millions into continuous vulnerability.

East Africa regionally has also done this. In the past, droughts would happen every 8–10 years, but in recent two decades, frequencies have changed to every 2–3 years (FEWS NET, 2023). This has given rise to a cycle of perpetual crisis and recovery. Somalia, Ethiopia, and South Sudan are finding it difficult to develop resilience in this short period of recovery. Increased frequency of drought has also escalated food insecurity, and 43 million people in the Horn of Africa were experiencing acute food insecurity in 2023 a 150% rise compared to pre-2020 levels (IPC, 2023).

In Isiolo County, Kenya, regional data is reflected at the county level. Kenya Meteorological Department (2023) has recorded a sharp increase in the frequency of drought, which now happens every two years from every ten years. The resultant frequent exposure to drought has undermined traditional coping mechanisms, disrupted seasonal agro-calendars, and forced families to adjust to new climatic conditions. Such frequent shocks have strained government response mechanisms and augmented humanitarian needs in Isiolo's ASAL zones (NDMA, 2023).

1.1.3 Access to Water and Scarcity

Access to water has become a global concern under the combined pressure of climate change and rising demand. At the global level, drought has aggravated water scarcity by lowering surface water and groundwater recharge, causing more competition for available water resources. Groundwater in South Asia is drawn down to critical levels, and in certain areas of the Middle East and North Africa, declines in rain have driven reservoirs below the threshold of sustainability (World Bank, 2023). Agriculture depending on irrigation has enormous operation-related

difficulties, and domestic water consumption becomes increasingly more rationed in both rural and urban environments.

The challenge is greater in Africa since it relies considerably on rain for farming. About 95% of African agricultural land is rain-fed, and only 6% of cultivable land is irrigated (AfDB, 2023). With as much reliance as there is on unpredictable rainfall patterns, countries are especially vulnerable during drought years. Throughout the Horn of Africa's 2020–2023 drought, thousands of water points were rendered useless or dried up, forcing communities to relocate in pursuit of water or seek out water trucking measures (UNOCHA, 2023).

In Isiolo County, the water shortage due to drought has reached a critical point. Most of the county's population depends on natural water sources such as shallow wells, boreholes, and seasonal rivers. But they have increasingly been less and less dependable. Throughout the prolonged 2020–2023 drought, there were cases of boreholes drying up or developing salinity, and many water pans ceased to function (Kenya Meteorological Department, 2023). A 2023 UNICEF assessment noted that over 78% of the households reported they suffered from severe water shortages, with pastoralist households being forced to travel further away to find elusive water points. The limited reach of water infrastructure and poor maintenance of available facilities also complicate access (UNICEF, 2023).

1.1.4 Coping Mechanisms and Community Resilience

Community resilience is an essential strategy in coping with the impacts of climate-driven drought across the world. In the other parts of the world, particularly industrialized nations, early warning systems, drought insurance, and climate-smart agriculture have enhanced the ability of people to anticipate and respond to drought. However, these systems are underdeveloped or inaccessible for the vulnerable communities in most developing regions. UNDP (2023) adds that merely 10% of global climate finance flows to local communities, which limits their ability to build adaptive capacity.

Pan-African communities traditionally relied on migratory pastoralism, communal grazing rights, and traditional early warning techniques. The climate change, land degradation, and socio-political tensions have, however, undermined these processes. Population pressures, land privatization, and

conflict, among others, have restricted mobility in much of the continent, including the Horn of Africa, while suppressing traditional coping processes. Furthermore, decades of underinvestment in adaptation to climate change, weak institutional arrangements, and fragmented early warning systems have left millions exposed to repeated shocks (AU, 2023).

In Isiolo, resilience has been undermined by the frequent cycle of climate shocks and failure of traditional coping strategies. Pastoralist communities who previously enjoyed mobility in drylands can no longer move freely due to fencing, land use change, and insecurity. Loss of the coping strategies has opened people to food and water risk. According to a 2023 report by UNICEF, 78% of households had to reduce food intake drastically, and some relied on food aid from humanitarian agencies as a primary source of food. Additionally, exposure to resilience-strengthening programs such as cash transfers, early warning systems, and drought-tolerant agriculture is still limited (NDMA, 2023; UNICEF, 2023). With rising climate shocks, social and institutional change, alongside technical responses, will be required to develop community resilience in Isiolo to address systemic vulnerabilities.

1.1.5 Arid and Semi-Arid Regions in Kenya: A Case of Isiolo

Some of the most critical climate vulnerable areas in East Africa, specifically noted as Kenya's Arid and Semi-Arid Lands (ASALs), cover approximately 84% of the country's land mass and contribute to 36% of its population (KNBS, 2023). Because the annual rainfall (they receive less than 500 mm, evaporation rate is high and frequent drought cycles have been happening, these marginal areas are always facing chronic food insecurity (Kenya Meteorological Department, 2023). Being agricultural poor are these regions, they depend heavily on pastoralism that supports 80 percent of their livelihood and 12 percent of their agricultural GDP (FAO, 2023). Nevertheless, the economy of its mainstay is susceptible to severe droughts, which occurred in between 2020 to 2023 resulting in catastrophic losses of livestock to the tune of over 2.5 million animals and more than push over 4 million people into acute food insecurity (NDMA 2023). Given the temperature rise of 1.5°C since 1980 and 20 percent increase in variability of rainfall during the last decade (IPCC, 2022), climate change has dramatically exacerbated these challenges. Environmental shocks continue to be cumulative because they have eroded food systems to the point that child

stunting rates in ASALs now stand at 35%, much higher than Kenya's national average of 26% (KDHS, 2022), with direct human development repercussions.

The systemic vulnerabilities, the structural vulnerabilities, and that is what was occurring in Isiolo County which is a microcosm, that is the climate shocks intersected with the vulnerabilities from the structural blockages that led to chronic food insecurity (Oxfam, 2023). It is located in the northern ASAL belt of Kenya where rainfall is erratic bimodal totaling about 300 mm annually and which is frequently interrupted by mid-season dry spells that often ruin both crops and pasturelands (ICPAC, 2023). This has been met with a 70% fall in maize yields (Isiolo County Agricultural Report, 2023), the loss of 60% of livestock herds (NDMA, 2023) and contributed to undermining the county's pastoralist economy. During this period, water scarcity had become so dire that it affected 90 percent of households to such an extent that women and children had to walk for more than 15km to collect it (UNICEF, 2023). These consequences have been acute, with acute malnutrition in children under five rising to 25 percent (WFP, 2023). But these climate induced shocks are worsened by poor infrastructure in Isiolo, with a total of 30 per cent of the roads passable perpetually and 15 per cent of households accessing irrigation (World Bank, 2023). Complicating this is a lack of institutional response to drought that provides relief for fewer than 40 per cent of populations affected by drought in part because they are not catered for by relief programs (Oxfam, 2023). Covering the Native African phenomenon of drought impacts and revealing how it affects agricultural systems, pastoralist livelihoods, and access to water to build resilience in Kenya's ASAL regions, this study is part of a larger study exploring the impact of the drought across agricultural systems and pastoralist livelihoods in Isiolo.

1.2 Statement of the Problem

A big issue globally, particularly in arid and semi-arid areas, climate extremes, shortage of water and also environmental degradation complicate the issue of food security (IPCC, 2022). Drought a recurring and increasing phenomena during a time of climate change, has a significant impact on agricultural systems and functions, water resources, socio-economic stability and contributes significantly to food insecurity (FAO, 2023). Severe, long and frequent drought events directly and cascade their impacts on agricultural productivity, water availability and overall food security (food availability, access, use and stability) (UNCCD, 2022). Drought induced intellectual

reductions in crop yields, livestock well being and groundwater reserves are seen as subsistence and business threat to agrarian frameworks in these districts (Tikas et al 2022).

Though they implement measures of adaptation and mitigation to droughts, the droughts persist for prolonged and permanent periods resulting in low food security. The protracted period of drought leads to economic instability, high food prices and low household and communities' resilience, which increases their dependence on unsustainable coping such as eating less or securing food, which makes them dependent on the aid (WFP, 2023). But during drought periods, crop germination and growth are severely restricted, also resulting in shrinkage of food production and access (D'Odorico et al., 2020). In addition, drying climate, along with increased over exploitation and reduction of rainfall, only aggravates the water scarcity and decreases the irrigation and drinking water supplies, especially in rural and vulnerable areas (AghaKouchak et al., 2021).

This research therefore attempts to analyze the whole lot of impacts of drought on food security under various conditions of relationships between the severity, frequency, amount of water and soil moisture depletion induced by aqueous drought. The focus of the research was dimension of food security such as availability (crop and livestock production), access (economic stability, market price), utilization (nutritional quality, food health outcomes) and stability (long term sustainability of food system). The purpose of this study is to investigate these dynamics and to offer such evidence based of policy recommendations on improving drought resilience, managing water, and building food security polices in drought prone areas. Findings was critical for policymakers, agricultural planners, and humanitarian agencies working to mitigate the effects of climate-induced droughts on food systems (Rockström et al., 2021).

1.3 Main objective

1.3.1 General Objective

To examine the impact of drought on food security in the Arid and Semi-Arid Lands (ASALs) of Kenya, with a particular focus on Isiolo County.

1.3.2 Specific Objectives

- i. To assess the severity and duration of drought events and their direct impacts on agricultural productivity and water availability on food security in arid and semi-arid regions.
- ii. To evaluate the effect of the frequency of drought events on food security, particularly the cumulative impacts on agricultural productivity and household livelihoods in arid and semi-arid regions.
- iii. To examine the role of water availability (reduced rainfall and depleted groundwater) in exacerbating food insecurity during drought periods in arid and semi-arid regions.
- iv. To analyze the impact of soil moisture depletion on crop yields and food availability during drought conditions in arid and semi-arid regions.

1.4 Research Questions

The study was address the following key research questions:

- i. How do the severity and duration of drought events affect agricultural productivity and water availability in Isiolo?
- ii. What is the impact of the frequency of droughts on food security, particularly on crop and livestock production, and household livelihoods in Isiolo?
- iii. How does the depletion of water resources (reduced rainfall and groundwater levels) affect food security in Isiolo during drought periods?
- iv. What is the role of soil moisture depletion in reducing crop yields and food availability in Isiolo during drought conditions?

1.5 Significance of the Study

The findings of this study are critically important for multiple stakeholders trying to navigate their lives and food security in virtually all arid lands due to climate induced food insecurity. Research findings was utilized to refine the National Drought Early Warning System for policymakers of Kenya's National Drought Management Authority and Ministry of Agriculture, for example in calibrating response thresholds for Kenya's ASAL counties (NDMA, 2023). The household level

vulnerability analysis was also be beneficial to humanitarian agencies such as WFP and FAO so that nutrition interventions can be better targeted during drought cycles, given that 25% of children in Isiolo suffer from malnutrition (WFP, 2023). Indigenous pastoralist coping strategies in the study was evaluated as possible actionable insights to improve indigenous community based adaptation programmes such that it can help reduce livestock mortality rate that presently is crossing 60% during extreme droughts (NDMA, 2023).

In terms of the academic level, the research closes a critical gap in the literature between climate and food security by measuring the differential effects of drought intensity (measured using SPEI indices) on all four dimensions of food security (FAO, 2021). The water food nexus analysis was guide the development practitioners in devising small scale irrigation projects in ASALs where current access ad 15% (World Bank, 2023). As crucially, 2020–2024 includes the lessons of both 2020–2023 drought and its recovery period of 2024, the full crisis–to–recovery continuum of planning for resilience.

1.6 Scope of the Study

Based on the fact that Isiolo County receives 300 - 500mm rain annually, this study was focused on three vulnerable sub counties (North, Central and South) during the period of 2020-2024 where rainfall is critical to food security. It was analyze three major drought episodes, including the 2020 – 2021 short rains failure, the 2022 drought, and its residual effects in 2024 with primary data of 300 household surveys and 15 key informant interviews carried out from the March – May 2024 lean season. To assess all four dimensions of food security (availability, utilization, access, and stability), NDVI satellite data and crop yield surveys from 2008 to 2013 and staple food price monitoring, MUAC nutrition data from 10 health facilities, household coping strategies including CSI indices from formative research, was used as study tools. The analysis was supplemented by secondary data from county drought bulletins and CHIRPS rainfall records excluding non-climatic factors for the purpose of looking at the impacts of drought. The scope lies in line with the Kenya's Ending Drought Emergencies framework whilst the insights from Isiolo can be applied at a regional level thus supporting SDG 2 monitoring in Isiolo, ASAL and other regions facing similar climate challenges.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This serves as a foundation for the study which as a whole gives the researcher a point of reference and means of anchoring for the future related study on the subject. It provides an in-depth review of the present knowledge body with the synthesis of major outcomes in the existing literature. This chapter then allows for broader understanding of the research area, and identifies gaps to be filled by this study by means of examining relevant studies and theoretical frameworks. It allows such an analysis and gives an environment within which research can participate in the general discussion.

2.1 Theoretical framework

This theoretical framework is the integration of several environmental and socio-economic theories that seek to examine drought's impact on food security in Isiolo County, Kenya, an area known for its arid and semi-arid conditions. Framework utilizes the Vulnerability Theory (Adger, 2006), Resilience Theory (Holling, 1973), Water Security Framework (UNESCO, 2013) and Soil Moisture Stress Theory (Blum, 2005) to explain how drought contributes to the food insecurity by detailing their relationship with determining the stages of drought. The Vulnerability Theory confirms increased susceptibility of communities to environmental changes, whereas the Resilience Theory concerns with possibilities of communities to adapt to impact of repetitive disturbances. Through the links to a water secure future made in the Water Security Framework and the Soil Moisture Stress Theory that stresses the central importance of soil moisture in sustaining crop yields, mine motivates that in the future, reduced water availability was adversely impact agricultural and food security challenges. Together these theories provide a robust basis to understand how various component of the drought (i.e. severity, frequency, water scarcity) as they affect agricultural productivity and livelihoods in Isiolo drought prone communities.

2.1.1 The Vulnerability Theory of Environmental Change

As a socio-economic challenge, proposed vulnerability theory of environmental change focuses on environmental change like heat drying that magnifies the vulnerability of ecosystems and

communities in a region that already faces socio economic problems. The basis of this theory is that vulnerability is a product of the exposure to environmental stressors, community sensitivity to these stressors, and the readiness to respond to these stressors. Here in Isiolo County where drought is a recurrent phenomenon, this vulnerability becomes more pronounced in arid and semi-arid areas. The extreme and long drought events affect the levels of agricultural productivity and water availability. As droughts become longer, they dry up water sources, kill crops and destroy livestock, all of which directly affect food insecurity. The Vulnerability Theory maintains both social and environmental links through the effect of drought destabilizing livelihoods and increasing the danger of food shortages. This therefore puts communities in Isiolo more exposed to the effects of compounded impacts of the prolonged environmental stressors thus making communities more vulnerable to food insecurity.

Water sources in Isiolo are vulnerable to environmental changes in rainfall patterns and droughts persist for a prolonged time, and this directly impacts the production structures, particularly where rain fed crops and pastoralism are a characteristic of that system. Adger (2006) suggests that these vulnerabilities are much more the case as adaptive capacities (e.g., water conservation techniques or agricultural diversification) are insufficient or nonexistent. Vulnerability Theory focuses on the ways in which environmental stressors negatively impact communities; however, it does not delineate ways some coping mechanisms at the local level can reduce vulnerability. For instance, on the dry conditions some pastoralists may migrate to other areas or change water source to cope with the dry conditions in Isiolo. As such, the theory could then be criticized for underestimating the role of such resilience-building mechanisms and local adaptive strategies. Some examples of how this theory has been applied to analyze recurrent droughts in ASALs of Kenya such as they enhance vulnerability and trigger migration patterns are provided by Huq et al. (2003). This is repeated in Isiolo because they are dependent on environmentally less resilient resources like surface water and groundwater and therefore, among other things, are unable to grow food and secure basic needs during drought events. Besides lack of rainfall, the depletion of natural resources that are supporting these livelihoods is not the only problem Isiolo residents are exposed to.

2.1.2 Resilience Theory

The theory introduced by Holling (1973) is known as Resilience Theory and it looks at the level of systems' capacity to withstand disturbance and recover from a drought shock environment. This theory is specifically useful for interpreting the total impact of consecutive drought events on agricultural productivity and household's livelihoods. Droughts are not isolated events to Isiolo regions which are more often than not a source of stress that progressively erodes the resilience of communities. Repeated droughts over time reduce the farming system's capacity to regain full agricultural productivity, which in turn threaten the long-term food security. In this context, resilience is not simply bounciness to each shock but full transformative power and ability to evolve over time. Droughts are more frequent in Isiolo and in reality, where such droughts occur, the cumulative losses in livestock, crops and infrastructure as they erode the economic base of the community gives a clear indication of their increased vulnerability to further shocks.

Holling's Resilience Theory explains progressive degradation of agricultural systems in Isiolo due to the fact that households have been forced to adapt to a changing environment. Since droughts are increasing in frequency, farmers and the pastoralists are not able to sustain their livelihoods because resources such as fertile land and water become scarcer. Repeated droughts are, by nature, and repeated events of such pull an entire vicious cycle on natural resources that such livelihoods depend on. One critique of the Resilience Theory is that it could simplify too much the notion of resilience by elevating it to a uniform, static and inflexible characteristic across all households. For example, wealthier households with water access other than rain fed agriculture and those involved in diversified activities of off farm activities may be more resilient than other poorer households relying on vast of rain fed agriculture rearing subsistence livestock.

Nelson et al.'s (2008) studies in the Horn of Africa have employed Resilience Theory to show how with a succession of droughts, pastoralist communities are made weaker rather than stronger to recover. As in Isiolo, pastoralists' livelihoods are being threatened by successive droughts everywhere. Through the theory presented, use is made of the fact that cumulative environmental shocks deteriorate resilience over time and emphasizes that long term adaptation strategies are necessary to build more robust community systems.

2.1.3 The Water Security Framework (UNESCO, 2013)

UNESCO (2013) brings a robust approach to the understanding of the association between water availability and food security through the development of its Water Security Framework. For livestock and agricultural production in areas such as Isiolo, water is a key resource and has a key determinacy of food security. The framework behind this thesis argues that water security involves not only the amount of available water but also the stability of water sources and the ease with which the people may access these sources for agricultural and domestic utility. Considering the experiences with drought in Isiolo where rainfall drops and the groundwater goes down reducing water availability for agricultural production and food security. The few remaining resources of water that are still accessible are an ever-greater limitation on food production in the face of increasingly long droughts, worsening anxieties about food insecurity.

Isiolo is a good example where Water Security Framework is applicable, it is based on surface water and groundwater resources; the existence of surface water and groundwater resources is important to maintain agriculture and livestock. But water sources during long periods of dry spell are drastically depleted and cause crop failure and livestock death. In addition, the framework makes it clear, that water scarcity is not only an environmental problem, but also a social and political problem, because lack of water resources can impede upon food security if they are not equally distributed. In Isiolo, communities compete over water resources causing frequent conflicts between communities which makes it difficult to tackle food security during droughts. The weakness of this framework lies in these aspects: 1) the framework is mainly focused on water availability with scarcely being able to consider the socio-economic and political factors that control water distribution.

Other studies such as Kangala et al. (2015) have employed the Water Security Framework for framing the changing dynamics of water availability on food security in drought prone areas in Kenya's ASALs. Drought periods and scarcity of water is the main reason for food insecurity in Isiolo. It enables us to comprehend the adverse consequences of the lack of water resources for the efficiency of agriculture, or in other words, the vulnerability of communities wholly depending on water for farming and foraging. Managing water resources in such a way is considered a key procedure for food security in the region.

2.1.4 The Soil Moisture Stress Theory

Blum (2005) introduced the Soil Moisture Stress Theory which focuses on the primary role of soil moisture in the crop yields. Soil moisture depletion during drought conditions negatively affects agricultural productivity by directly depleting the growth ability of crops present in arid and semi-arid regions. With rain fed crops being the main meal of many households in Isiolo, soil moisture is of particular importance. Crops suffer stress when drought reduces the amount of moisture in the soil and results in not growing well or in lower yields. This is especially so in Isiolo, where rain is erratic and more moisture is needed to retain in the soil for agriculture purposes. The Soil Moisture Stress Theory helps us to understand how drought related depletion of soil moisture can cause crop failures and food shortage to hence contribute to food insecurity during the dry periods.

Isiolo is one such place where the theory is directly applicable, as Agriculture is suffering from soil moisture depletion during droughts. The availability of this soil moisture is crucial in the region where farmers have to rely on it to grow crops, and when moisture levels are low, then it is very difficult to sustain productive production. According to Blum's (2005), drought is a major cause of cropland failure that may result in total crop failures when precipitation is not replenished, hence major losses in food availability. Although, a critique on the Soil Moisture Stress Theory is its emphasis on the physiological aspects of crop growth without taking in account the agricultural practices that can reduce the depletion of the soil moisture, like water harvesting or drought resistant variety crops. The Soil Moisture Stress Theory has been applied in Sahelian and parts of Indian regions to assess moisture depletion effects on crops, due to the phenomenon of drought. The same lines are echoed in Isiolo where the depletion of soil moisture during long dry spells, drastically lower crop yields. The theory also brings out the need for sustainable soil management practices like mulching and harvesting water, which was help to reduce the effect of droughts and promote food security in the region.

2.2 Empirical Literature Review

2.2.1 Severity and Duration of Drought and Food Security

Empirical studies are unanimous in advancing severity and duration of drought as major determinants of food insecurity in Isiolo County of Kenya (a region dependent on rain fed

agriculture and pastoralism). Several of studies have used both qualitative and quantitative methods to examine how long spells of dryness destroy household food access and agricultural production. The findings below outline case-based findings and methodological methods on how drought character is linked with food insecurity in Isiolo.

Hussein et al. (2021) conducted research through using hydrological data analysis and field evaluations to examine drought effects on water sources. Their results showed that the 2020—2022 drought led to a contraction of more than half of water sources, which highly limited household and livestock access to water. The research continued to record the loss life of thousands of livestock, a valuable asset in Isiolo, thus increased food insecurity. Their approach included direct observations and interviews with drought affected households thus pointing to spatial and infrastructural vulnerability of the region to drought.

Similarly, Ng'ang'a et al. (2022) carried out household nutrition surveys and reported that families displaced by drought were extremely malnourished especially among children less than five years. Their data showed that scarcity of food deepened because of disrupted farming seasons; the households could not restock the food stores. The investigators utilized anthropometric measurements and alternated interviews which guaranteed sound data on nutrition status during and post the drought season.

Mwendwa & Gitau (2023); employed participatory rural appraisals (PRA's), focus group discussions and key informant interviews to determine the implications of prolonged droughts on the farming calendar. Their case study on Isiolo proved that droughts interrupted seasonal agricultural cycles, which were delaying planting time and reducing the crop outputs. These disruptions caused increased reliance on food aid and eroded the resilience of local food systems. The qualitative design enabled the researchers to gather local knowledge and firsthand narratives, emphasizing the socio-economic consequences of drought.

Finding strong correlation between severe droughts and reduced harvests, Ndungu et al. (2020) analyzed meteorological records and agricultural production records in the past decade. Their econometric modeling showed droughts that extended for more than two years, reduced household incomes by 30% because the failure of both crops and livestock systems. The quantitative approach

allowed for a time series examination, strengthening the claim that frequent climate shocks generate cumulative economic impacts on farming communities.

Kariuki et al. (2024) integrated satellite imagery, household surveys and economic data for the assessment of long-term impacts of drought on a resilience basis. Their work confirmed that a higher drought intensity greatly lowers household access to food and post-drought recovery. More so, they reported increased periods of recovery after every event among Isiolo's communities, a chronic nature of food insecurity. Their mixed-method design involved a fusion of remote sensing and as-on-the ground data in triangulating findings.

In the 2020–2022 drought period, Mwendwa and Gitau (2023) also reported collapse of several watering points making households, especially women and children walk long distances in search of water. Water scarcity directly impacted the caregiver and economic efforts, weakening time for food production through their ethnographic research. Interview and community-based observation research formed their basis and promoted contextual understanding of local adaptation issues.

Ng'ang'a et al. (2022) also showed through livelihood surveys that sustained droughts excluded families from important income, including rearing of livestock and farming. They saw minimal livelihood diversification and therefore droughts drove the food of vulnerable groups to near breakdown. These findings were generated via structured livelihood vulnerability assessments in the affected sub counties in Isiolo.

Further, Kariuki et al (2024) found that livestock mortality rose to as high as 50% in worst hit areas by drought, severely limiting availability of animal-based food sources such as milk and meat. Their work used mortality tracking and food consumption score analysis to demonstrate the unequal effects of drought on children and the old who are largely dependent upon animal protein. These empirical insights were from the local community health records and food distribution data.

The researchers – Ndungu et al. (2020) also carried out cross-sectional household income survey and established that food spending dropped significantly during prolonged drought, hence some households sell major assets. Their regression analysis identified the income was reduced by an average of 30% largely because they lost productive asset such as livestock. This represents

economic direct association between prolonged lack of rain and amount of purchasing power for food.

Drought's long-run effect of environmental degradation is also empirically linked. Hussein et al. (2021) applied land cover change analysis to demonstrate how drought events, experienced on multiple occasions, caused topsoil erosion, as well as erosion of grazing lands further compromising the agricultural basis of Isiolo. Their field-based soil evaluation and vegetation mapping proved the environmental feedback mechanism which supports food insecurity despite its resolution even after drought intermissions cease.

In spite of such efforts as promotion of drought resistant crops and improved water storage, Ng'ang'a et al, (2022) stated through policy and program evaluation, these interventions have little reach and effect. Their observations were based on project performance reports and beneficiary feedback, which revealed that there is need for more tailored, community specific solutions.

The Kenya Meteorological Department (2020) utilizing both climate models and regional rainfall data, reported a 40% upward shift in severe drought events in Isiolo over the past decade. This statistical evidence supports the growing time requirement for such planning. The growing frequency of drought events implies shorter recovery windows between shocks, leading to persistent vulnerability of food systems.

Very important, often mentioned by Mwendwa and Gitau (2023) is the importance of early warning systems and drought forecasting tools in developing local resilience. Their participatory research established that communities who had timely climate information were better positioned to adopt adaptive behavior like schedule adjustment, when it comes to planting or management of livestock mobility. Based on local leaders' and climate officers' interviews, their conclusion was reached.

Finally, the drought-induced socio-economic disruption is worsened by destruction of communal coping mechanisms. As one example, Ng'ang'a et al. (2022) found that the disappearance of livestock, the main livelihood asset, in the event of a drought generates loss of food and income, most particularly for households without some means of material support. This was verified using the results from household asset tracking and food access scores, amassed regionally. In the same

way, droughts had the most damaging impact on the nutritionally vulnerable populations, including children and the aged (Kariuki et al, 2024).

Summarily, the empirical studies analyzed, which include case studies, econometric modeling, participatory assessments, environmental analysis of data and study of households, conclusively prove that the severity and the duration of droughts are the key trigger of food insecurity in Isiolo County. These findings emphasize the need for evidence-based policy-level actions that combine in the short-term relief and long-term building of resilience, on-the-grounds realities and evidence-based data.

2.2.2 Frequency of Drought and Food Security

The rising rate at which drought events occur in arid and semi-arid lands (ASALs), such as Isiolo County, is one of the leading causes of chronic food insecurity according to empirical evidence. Study consistently shows that with increasing occurrence of drought, communities are left with little time to recover, eroding their coping capacity and increasing vulnerability. Using historical climate data and analysis of drought frequency, Kariuki et al. (2024) has revealed increased frequency of droughts in Isiolo; from 5 to 7 years interval to 2 to 3-year intervals this indicates increased levels of drought in Isiolo county. The empirical approach used meteorological trend analysis in combination with household resilience measurements to demonstrate how reduced recovery windows have overwhelmed local adaptation strategies and rendered the food system more vulnerable.

Mwendwa and Gitau (2023) further supported these findings by use of community-based interviews and drought impact assessment in the ASAL counties. Repeated droughts deplete household food and income pulls, resulting in long term reliance on external help, according to their data. Through combining the participatory rural appraisal tools with secondary data availed from National Drought Management Authority (NDMA), their study highlighted that recurrent droughts discourage effectiveness of traditional means of coping and expose communities to rely even more on humanitarian interventions.

The total effects of recurrent droughts are also extensively recorded. For example, Ndungu et al. (2020) used the method of longitudinal case-studies, as well as agricultural productivity data and

established that although certain individual drought events may have bearable effects, successive droughts create long-term degradations of the natural resources, they diminish the presence of water, and intensify the livestock. These findings reveal that drought frequency magnifies resource strain and lowers the region's adaptive capacity, over time. Through household livelihood surveys, Ng'ang'a et al (2022) established that rainfall variability in conjunction with cyclical drought causes a rise in poverty levels and declines agricultural production. These insights were based on vulnerability assessments and rainfall pattern analysis conducted across Isiolo sub-counties.

In addition, the field evidence from Mwendwa and Gitau (2023) showed that many households can no longer fulfill the basic nutritional requirements since food production cycles are disrupted by repeated droughts. Their mixed method research demonstrated an increasing trend in humanitarian dependency, especially during back-to-back drought seasons. This trend reflects an expanding humanitarian burden, a fact observed by Kariuki et al. (2024) who report that emergency relief efforts tend to be reactive and unable to deal with the underlying drivers of recurrent food crises. Their research called for incorporation of both adaptive technologies and institutional support in climate risk management mitigation practices to minimize risks in future.

Frequent droughts also cause population movements and changed migration patterns as a pastoralist community finds water and pasture. Based on the conflict mapping data and migration tracking, there has been an increase in inter community conflict on the distribution of limited natural resources in Isiolo (Kariuki et al, 2024). Their study found that the competition between pastoralist and agricultural people heightens during the frequent periods of drought destroying social cohesion and food stability. In a similar vein, stakeholder interviews showed Mwendwa and Gitau (2023) that changing migration trends undermine livestock movement; displace agriculture; and destabilize, respectively, local food supply channels. This suggests drought frequency as a central aspect of determining not only food availability, but also social and economic forces in the region.

The institutional response to too often droughts is also in great difficulty. Through its drought response evaluation, the NDMA (2022) reported that recurring droughts have stretched national and county drought response systems. The report revealed that the government resources are increasingly taken for short-term emergency responses such as food aid, boreholes drilling and

water trucking, at the cost of sustainable and long-term ones. Ng'ang'a et al. (2022) conducted a policy analysis showing that although some interventions such as soil restoration and promotion of drought-resistant crops exist, they are insufficiently scaled and inconsistently funded. Their research called for a shift towards integrated, long-term food security planning that addresses the structural drivers of vulnerability in Isiolo.

The relation between frequency of droughts and food security is also linked with the ability to give early warning and anticipatory action. Ng'ang'a et al. (2022) identified the need for climate smart agriculture, community-led resilience building and enhanced better water conservation technologies that have not been systematically mainstreamed. They applied a mix of reviews of local policy and workshops with stakeholders to suggest that proactive instead of reactive measure should be adopted. Similarly, Hussein et al. (2021) noted that early warning systems and predictive models are important in tempering food insecurity risks. Their research that included testing the evaluation of forecasting models, and even the evaluations for community preparedness, showed that enhanced climate information dissemination means tremendous advance in household preparedness, and softens the food shortage impact during drought.

Conclusively, empirical studies show a clear picture that the rising droughts in Isiolo County are one of the leading causes of food insecurity. The findings from various approaches – analysis of meteorological data, household surveys, participatory assessment, and policy evaluation – indicate that shorter interval droughts reduce recovery, heighten resource conflict, and frustrate institutional response. As such, the drought frequency needs to be addressed comprehensively, over long term and adopting climate-resilient solutions that capture, local knowledge, early warning systems and continued investments in adaptive capacity. The interventions was and remain absent, the communities of Isiolo was continue to be plagued by the worsening effects of both securing food and maintaining socio-economic stability.

2.2.3 Water Availability and Food Security

Water availability is a determining factor of food security in Isiolo county under sustained rain starvation. Empirical findings have shown that water shortage severely limits agricultural production and livestock keeping, the first and second main livelihood activities in the region. For example, Mwendwa & Gitau (2023) did field surveys and interviewed residents' households, and

determined farmers and pastoralists failed to access adequate water for irrigation and livestock, especially during the 2020–2022 drought. Their research pointed out that, dependence on external and seasonal water sources in Isiolo contribute to an extent in water shortages during dry seasons, and widespread hunger and loss of income. Likewise, Kariuki et al. (2024) using spatial mapping and drought impact assessments reported direct livestock losses and crop failures from key water points due to drying as aggravating household food insecurity.

Using structured interviews and audits concerning water availability, Ng'ang'a et al. (2022), confirmed that the worst water shortages were witnessed in rural areas such that it became almost impossible for communities to access the amount of daily drinking, cooking, or agricultural; water needs. The empirical findings obtained showed that lack adequate access to water was directly linked with food insecurity in Isiolo because water was not only for drinking purposes, but also to maintain the production systems of foods. These findings reaffirm the fact in arid areas such as Isiolo, access to both food and water are one and the same.

In order to counter some of the challenges, the Isiolo County government and development partners have launched initiatives of water management, which include building of dams, water pans and boreholes. To that end, Hussein et al. (2021) carried out a program evaluation of these water interventions and reported that, although such activities have increased access in some places, storage capacities are still inadequate, especially during high droughts. Moreover, Ng'ang'a et al. (2022) reported that many of the available water sources had become contaminated or poorly maintained, raising health concerns and further restricting their usability. Kariuki et al. (2024) used water quality testing and public health data to empirically establish that contaminated water sources reduced household water use, further intensifying food insecurity during drought. These findings demonstrate that enhancing water infrastructure alone is insufficient without sustained maintenance and water safety measures.

Water scarcity in Isiolo is also closely linked to broader environmental changes such as deforestation, land degradation, and desertification, that lower the natural water source recharge capacity. Hussein et al. (2021) applied environmental impact assessments to demonstrate that deforestation and bad land management have caused reduced rains and drying of rivers and streams. Their results show that decreased vegetative cover has had adverse effects on local

microclimates reducing rainfall infiltration rates and increasing surface runoff. Also, it was reported by Ng'ang'a et al. (2022) that such environmental changes have had a disproportionate effect on women and children, in whom the task of collecting water traditionally falls. Their qualitative interviews showed communities are compelled to travel far distances to get water an activity that is sometimes at a very high cost, or even costly sanctions like for marginalized people. These studies underscore the need for an integrated, community-led water resource management to this end where access and supply are equitable and sustainable.

The relationship between water availability as well as food security is complex. As it has been illustrated by Mwendwa and Gitau (2023), low level of water availability results in the decreasing irrigation capacity, resulting in decreased crop production and even complete agricultural failure in some cases. Their empirical evaluation of seasonal agricultural output data confirmed an obvious relationship between diminished water access and unavailability of food. In addition, Ng'ang'a et al. (2022) highlighted the value of water in food usage, and it is essential in food preparation, washes, and personal hygiene – aspects which are essential in curbing malnutrition and disease. Through household nutrition surveys, Hussein et al. (2021) observed that the lack of clean water causes a high rate in waterborne illnesses, thus for the nutrient absorption and subsequently well-being to be curtailed. Therefore, water scarcity does not only affect the availability and access to food, but the efficiency with which food can be utilized for nutrition.

Lastly, practices of sustainable water management present attractive solutions for reducing the impact of water scarcity on food security. Results of empiric studies mention sand dams and rainwater harvesting as well as roof catchment system as effective measures of increasing the availability of water in arid zones. These technologies, according to a cost-benefit analysis and pilot project assessments by Kariuki et al. (2024), greatly enhanced household water storage through dry spells, therefore stabilizing food production and vulnerability. Mwendwa and Gitau (2023) also demonstrated that rainwater harvesting system affirmed better food security results in communities with such access than those depending on seasonal rivers alone. However, Hussein et al. (2021) warned that adoption levels are low and frequently attribute to lack of awareness, first capital cost, and a lack of institutional support. They advise that more studies and investment be

done to locate and break-down barriers to adoption particularly amongst the most vulnerable households.

Overall, empirical evidence supports the view that water availability is a building block of food security in Isiolo County. Household surveys, environmental evaluation, and program evaluations consistently show that scarce, unreliable water source are destabilizing food production, utilization, and stability. Sustainable water management, development of infrastructure and conservation of environment is therefore essential in creating resilience to recurrent droughts and long-term food security in Isiolo

2.2.4 Soil Moisture Depletion and Food Security

Soil moisture depletion is an important determinant of food security in Arid and semiarid lands including Isiolo County. Drought condition causes soil to dry as much as possible and this reduces the moisture available for crop consumption and growth by lot. Empirical studies based on soil moisture monitoring, crop yield evaluations by Ng'ang'a et al. (2022) have demonstrated that prolonged drought has practically made it impossible to grow kitchen staples food crops such as maize and beans that are highly needed in local dietary menus. Apart from drops in crop yield, as levels of moisture drop, there is not only a loss in the nutrient value of harvested crops but households are unable to meet infant's dietary needs. Using climatic trend analysis and modelling of evapotranspiration, Kariuki et al. (2024) discovered that high temperatures enhance evaporation of surface moisture making soils infertile and unproductive. This vicious cycle: rainfall failure, increased evaporation and declining fertility of the soil, have resulted into frequent crop failures and deteriorating hunger in the region. The evidence explains why soil moisture depletion causes food insecurity because it decimates agriculture directly.

Apart from crops, soil moisture is also important to the maintenance of pastures, important for the pastoralist livelihoods that dominate rural Isiolo. Using participatory rural assessments and livestock condition monitoring, Mwendwa and Gitau (2023) reported that drought conditions dry soil and pasture moisture to virtually nothing left for grazers to feed on. Consequently, livestock get undernourished, indicating low meat and milk production and, in most cases, massive loss of livestock. Kariuki et al., (2024), reported that such losses are devastating to food security because

livestock is a main source of food, income as well as social capital in Isiolo. Additionally, multiple drought events deskill the land such that soils lose regenerative capacity thus making it even more difficult for both crop farming and grazing systems, to restore. These findings reveal the need for resilient soil management practices, such as conservation agriculture and drought-resistant forage systems, to mitigate the impact of soil moisture depletion on both food availability and livelihoods.

Empirical evidence also reveals that food access is affected by depletion of soil moisture especially by inflating prices of food. In periods of low soil moisture and reduced yields for crops, the supply of locally grown food is reduced while prices in the market rise. According to Ng'ang'a et al. (2022), household food expenditure surveys revealed that during drought seasons food prices in Isiolo rise by up to 30% placing basic foodstuffs beyond the reach of many households. The case is differently with price inflation which disproportionately affects the vulnerable populations, the children, the elderly and the poor households who may be compelled to skip meals or consume less nutritious ones (Mwendwa & Gitau, 2023, p. 23). According to the research by Kariuki et al. (2024), this economic pressure was frequently lead to families compromising their needs in vital necessities (health care, water, or education) by using those resources instead to buy food. These results justify the conclusion that not only food supply but also economic barriers to food access are worsened by the decline in soil moisture, further digging food insecurity in drought-prone areas.

As far as use of food is concerned, the deterioration of soil moisture also means poorer quality diet and effects on nutritional goals. Poverty in soils leads to fewer crop yields that are nutritious; defeating the idea of dietary diversity needed for healthy living. Through nutritional analysis of harvested crops, Kariuki et al (2024) discovered that food gained from moisture-exhausted soil lacks essential vitamins and minerals hence leading to malnutrition, especially among children and expectant women. Ng'ang'a et al. (2022) also found people turn often to imported or relief foods during poor harvests and that may not conform to local nutrition needs and may lack nutritional content of traditional foods. In addition, the absence of water for cooking and hygiene – strongly linked to soil and water scarcity – aggravates problems of poor food use, resulting in the spread of waterborne diseases and poor absorption of nutrients. Mwendwa and Gitau (2023) emphasized that food security should be understood not only in terms of quantity and affordability but also in

terms of the nutritional quality of what is consumed, which is directly linked to the condition of agricultural soils.

As such, deployment of sustainable land and soil management strategies is critical to enhancing the food security in Isiolo. In an intervention study examining the efficacy of conservation agriculture (Hussein et al., 2021), it was found that techniques like mulching, crop rotation, and agroforestry can help retain soil moisture and boost soil fertility resulting in better yields even in water-deficient conditions. Similarly, Kariuki et al. (2024) observed that the production of drought-resistant crops, such as sorghum and millet, also reduces the adverse effects of soil moisture depletion and helps in sustaining food production in dry periods. Nevertheless, these approaches typically entail huge upfront expenditures, such as access to farming inputs, training and technical support, which are not always available in places such as Isiolo. Ng'ang'a et al. (2022) advocate for stronger institutions support, either from government and NGOs, to guarantee the successful scaling of such strategies. Sustained soil conservation and adaptation efforts **was** useless if soil moisture continues to be depleted.

Finally, soil moisture depletion is a corollary to deteriorating food insecurity in Isiolo County. Empirical research always demonstrates that a drop in moisture levels impedes agricultural productivity, access to food and undermines the utilization of food, further pushing rural poverty to new heights. To tackle this issue, there is need for a multi-dimensional approach which entails sustainable soil management, resilient crop system and among other things, supporting the market and nutrition interventions targeting the affected population. While the effects of climate change continue to escalate, it is not only important but urgent that communities in Isiolo be equipped with the ability to adapt to moisture stress to build long-term-food security and resilience.

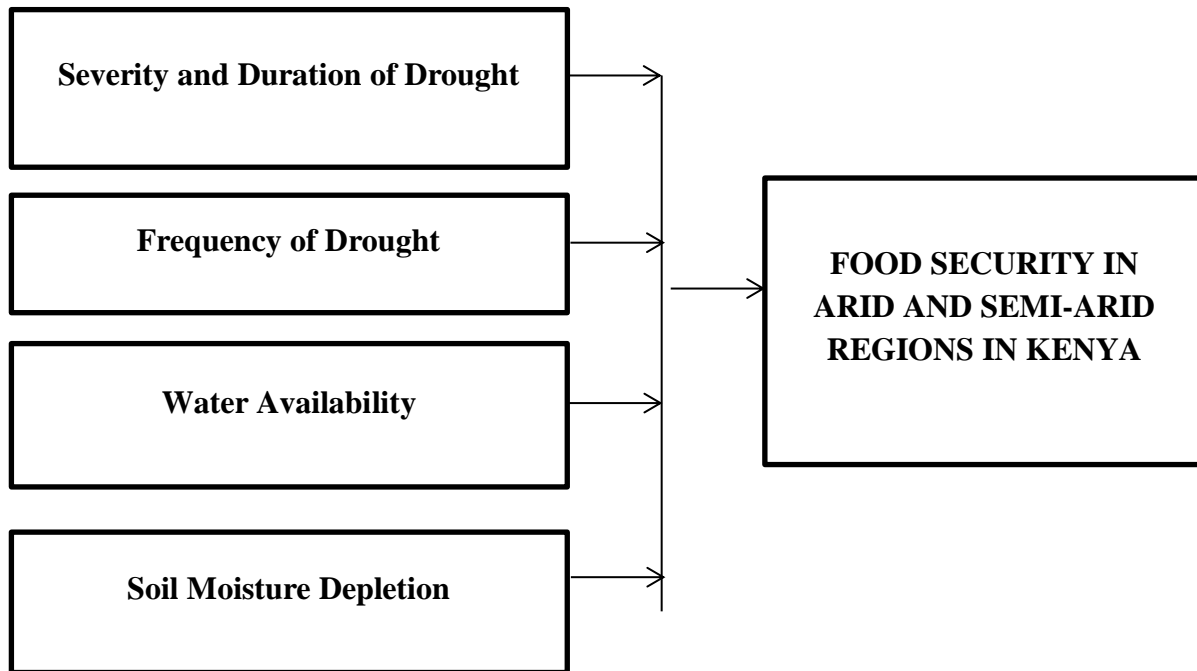
2.3 Conceptual Framework

A conceptual framework is a structured framework outlining the key variables and its relationship within a research study. In Rader et al. (2020), it is a guide to explain how different factors affect a certain outcome. The conceptual framework of this study looks at how drought (independent variable) impacts the issue of food security (dependent variable) with regard to four identified primary sub factors of drought namely severity and duration, frequency, water availability and soil

moisture depletion. Drought is primarily associated with negative relationship with food security as it has multiple impacts on both macro and micro level on food security: the availability, access, utilization and stability. As drought conditions become more severe, frequent, lose water availability, or become drier over soil, food security is degraded in its different dimensions. In overall, this reveals the requirement of the effective drought management strategies to alleviate the negative impacts on the food security.

Independent Variable (IV)

Dependent Variable (DV)



Source :(Researcher, 2025)

Figure 1. Conceptual Framework

2.4 Research Gap

Table 1: Summary of Research

| Author(s) | Study Area | Methodology | Key Findings | Research Gap | Focus of the Current Study |
|-----------------------------------|-------------------------|---|---|---|--|
| Hussein et al. (2021) | Isiolo & ASAL regions | Field observation, secondary data analysis | Severe drought events caused collapse of water points and massive livestock loss; food systems disrupted. | Lacked focus on adaptive long-term strategies for soil and water conservation. | Builds on this by integrating adaptive measures into food security assessments in Isiolo. |
| Ng'ang'a et al. (2022) | Isiolo County | Household surveys, nutrition assessments, rainfall trend analysis | Droughts lead to increased malnutrition, lower crop yields, and unaffordable food prices. | Did not explore the full extent of soil moisture's impact on food utilization. | Adds focus on the role of soil quality and crop nutrition under repeated droughts. |
| Mwendwa & Gitau (2023) | ASAL regions, Isiolo | Participatory Rural Appraisal (PRA), GIS-based drought mapping | Short drought recovery intervals (2–3 years) overwhelm coping mechanisms and heighten food insecurity. | Insufficient analysis of socio-economic dynamics in recurring drought contexts. | Examines socioeconomic ripple effects of recurring drought on food access and coping capacity. |
| Kariuki et al. (2024) | Isiolo & Northern Kenya | Climatic trend analysis, soil testing, structured interviews | High livestock mortality (up to 50%), crop failure, and high inflation due to drought and soil degradation. | Limited evaluation of soil conservation strategies and farmer adoption levels. | Evaluates sustainability and uptake of soil and water adaptation techniques. |

| Author(s) | Study Area | Methodology | Key Findings | Research Gap | Focus of the Current Study |
|--------------------------------|---------------------|--|---|--|---|
| Ndungu et al. (2020) | Isiolo County | Longitudinal drought impact tracking, income surveys | 30% household income loss after droughts longer than 2 years; poor rainfall further strained livelihoods. | Did not quantify impact of drought frequency on land degradation or soil moisture. | Incorporates soil degradation patterns tied to drought recurrence and frequency. |
| NDMA (2022) | National (Kenya) | Government reports, statistical review | Recurrent droughts strain emergency responses; reliance on short-term relief over long-term resilience. | Generalized findings, lacking localized (Isiolo-specific) insights. | Localizes national findings to Isiolo context with specific community-based data. |
| Kenya Met. Dept. (2020) | Isiolo & ASAL areas | Climate trend analysis (2009–2019) | 40% increase in drought frequency in Isiolo over the last decade. | No linkage to food supply chains or market disruption analysis. | Links increased drought frequency to food market access, livestock pressure, and migration. |

2.5 Operationalization of Variables

Table 2 Operationalization of Variables

| Specific Objective | Independent Variable | Dependent Variable | Indicators | Measurement Method |
|---|--|---|--|--|
| 1. To assess the severity and duration of drought events and their direct impacts on agricultural productivity and water availability | Drought severity and duration | Agricultural productivity, Water availability | <ul style="list-style-type: none"> - Rainfall levels - Length of dry spells - Crop yield (bags/acre) - Availability of water points - Water access distance | <ul style="list-style-type: none"> - Household surveys - Meteorological records - Key informant interviews |
| 2. To evaluate the effect of the frequency of drought events on food security and livelihoods | Drought frequency | Food security, Household livelihoods | <ul style="list-style-type: none"> - Number of drought episodes in 10 years - Frequency of food shortages - Income changes - Livestock losses - Coping strategies | <ul style="list-style-type: none"> - Household questionnaires - FGD with farmers & pastoralists - Market price trends |
| 3. To examine the role of water availability in exacerbating food insecurity | Water availability (reduced rainfall, groundwater depletion) | Food insecurity | <ul style="list-style-type: none"> - Water source reliability - Water consumption per household - Crop and | <ul style="list-style-type: none"> - Surveys - Water point mapping - Interview with water officers |

| Specific Objective | Independent Variable | Dependent Variable | Indicators | Measurement Method |
|--|-------------------------|--------------------------------|--|--|
| | | | livestock water needs - Food consumption scores (FCS) | - FGD with households |
| 4. To analyze the impact of soil moisture depletion on crop yields and food availability | Soil moisture depletion | Crop yields, Food availability | - Soil dryness - Land degradation signs - Crop failure frequency - Market food supply | - Farmer interviews - Observation checklists - Agricultural office records |

2.6 Chapter Summary

This chapter has reviewed the theoretical and conceptual footing informing the study with a particular focus on the key variables that allow for the study of drought in relation to food security in Isiolo County. The exact objectives and the need to operationalize important variables that include drought severity, water availability, soil moisture depletion, and food security has been thoroughly expounded on in the study. The operationalization of this concept ensures that mere abstraction is transformed into terms to be analyzed and measured in order to increase methodological rigor in the study.

Besides, the conceptual framework has been offered to demonstrate the hypothesized relationships of these variables as well as being a structural basis for collecting and examining data. This framework was serve as informant to empirical exploration and findings interpretation in the subsequent chapters.

The chapter has further developed the way the chosen variables correlate directly with the objectives of the work, and the grounds for the methodological measures that was ensue. In the next chapter, the study was described the research design employed, the sampling strategy, methods of data collection, and analysis techniques that was used to tackle the research questions in a logical and strong manner.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Research Design

For this research, descriptive research design was employed considering that it is ideal for testing the nature and size of the impact of drought on food security in Isiolo County. This design is suitable for systematic data collection and analysis and thus enables comprehensive understanding of the phenomenon under its natural settings (Creswell, 2014). Descriptive research is most suitable in establishing relationships and patterns between variables such as severity and frequency of drought, and their effects on agriculture yield and food availability.

Data gathering was through the mixed-methods research approach, with both the quantitative and qualitative methods utilized to obtain a better understanding. Quantitatively, there was the utilization of structured questionnaires in gathering quantitative data on the effects of drought on household food security. The qualitative dimension involved focus group forums and interviews with community leaders, local government officials, and affected residents. The two-pronged approach ensured both statistical data gathering and contextual information and recorded the lived experiences and narratives of the most affected individuals. By integrating these approaches, the research not only quantified the impacts of drought but also examined the processes and mechanisms by which drought influences food security at both the household and community levels.

3.2 Target Population

The target population for this research are inhabitants of Isiolo County, more specifically those residing in Arid and Semi-Arid Lands (ASALs) in the county. Isiolo is one of Kenya's ASAL regions, which are extremely drought-prone and exposed to the attendant effects. Such regions are exposed to recurrent climate shocks that have a destructive effect on rural people's livelihoods, who are predominantly agriculturalist and pastoralist in nature. They are therefore most vulnerable to the effects of drought, which include food insecurity, water scarcity, and economic dislocation.

The study targeted the pastoralists, rural households, and small-scale farmers, who are at the frontline of drought risk. The study also targeted key stakeholders involved in food security and drought management. They included representatives of local governments, community leaders,

and representatives of non-governmental organizations (NGOs) actively engaged in combating drought and policy implementation in Isiolo County.

Involving a wide variety of participants ensured broad knowledge regarding how drought affects food security not only at the household level but also at the community and policy levels.

Table 3: Sample Size Distribution by Subgroup

| Stratum | Estimated Population | Size Percentage of Total |
|----------------------------|----------------------|--------------------------|
| Rural Households | 2,000 | 50% |
| Pastoralists | 1,500 | 33.3% |
| Small-Scale Farmers | 800 | 13.3% |
| Community Leaders | 50 | 1.7% |
| Local Government Officials | 40 | 1.7% |
| Total | 4,390 | 100% |

Source : (Researcher, 2025)

3.3 Sample and Sampling Technique

A stratified random sampling technique was used in this study to select participants from the target population so as to base coverage of various sub groups of the target population. The study target population is Isiolo County residents (both the individuals and household) mainly in the slum and very arid and semi-arid regions of the county. Drought has a high impact on food security, agriculture and livelihoods in these areas, and they are very vulnerable to it. According to the sampling process, the main subgroups or strata in the population considered were rural households, pastoralists, small scale farmers and representatives of local government officials or community leaders. It did this by stratifying the population, which meant that the sample included the diversity

of the population in terms of different socio-economic groups and occupation types so that different groups can be analyzed more in detail and accurately on the effect of drought on food security.

This method was chosen because of its ability to improve accuracy and representativeness of the sample using stratified random sampling technique. Sampling of such a large population involves dividing it into separate (or strata) sub populations and ensuring that all significant components of the population are included by reduced bias of selection process. Random sampling was used inside each stratum, allowing each datum in the group to have an equal chance of being chosen. This method is handy to guarantee the sample populates the whole diversity of the population, since differences between subgroups might interfere in the outcome of the study. Through this method representation, we can receive a more inclusive view of impact that the drought has on food security.

3.3.1 Sample Size Distribution by Subgroup

For this study, the sample size is estimated to be 300 respondents considering population, resources available, and the statistical requirement of high reliability thus making the study reliable. For the round of interviews to have meaningful and generalizable vales, we need sample size of 300 respondents that would give us reasonable time and resources for the data collection. Each of the several strata was proportionately represented through the sample size so that each group has an adequate representation.

Cochran (1977) predict that the sample size of 300 is large enough to furnish a good dataset for statistical analysis, with a good power of discriminating significant difference or relationship between the studied variables. The distribution of sample size within each stratum is given by the following table. Sample Size Calculation

To calculate sample size, sample size determination was performed by the means of Mugenda and Mugenda's (2003) formula. This formula is used very often in social science research, especially with a population greater than 10 000 (as is the case of Isiolo County) and is a valid formula. The sample size is calculated by using the following formula.

$$n = \frac{Z^2 \times p(1-p)}{E^2} \quad n = \frac{Z^2 \times p(1-p)}{E^2}$$

Where:

- n = sample size
- Z = Z-value (1.96 for a 95% confidence level)
- p = estimated proportion of the population expected to have the attribute (0.5 is used as a conservative estimate when the population proportion is unknown)
- E = margin of error (0.05, which is typical for a 5% margin of error)

Table 3: Sample Size Distribution by Subgroup

| Stratum | Estimated Population | Size Sample | Size Percentage of Total |
|----------------------------|----------------------|-------------|--------------------------|
| Rural Households | 2,000 | 150 | 50% |
| Pastoralists | 1,500 | 100 | 33.3% |
| Small-Scale Farmers | 800 | 40 | 13.3% |
| Community Leaders | 50 | 5 | 1.7% |
| Local Government Officials | 40 | 5 | 1.7% |
| Total | 4,390 | 300 | 100% |

Source :(Researcher, 2025)

3.4 Research Instruments

This study employed both quantitative and qualitative instruments to systematically examine the impact of drought on food security in Isiolo County. The application of this mixed-methods approach ensured a robust data collection process, capturing both statistical evidence and insights from affected communities.

Quantitative data was collected using household questionnaires that addressed key dimensions of food security. These questionnaires consisted of both closed-ended and open-ended questions.

Closed-ended questions were designed to gather measurable data on aspects such as drought exposure, food availability, access, utilization, and coping strategies. The open-ended questions allowed respondents to express their personal experiences and perceptions, thereby offering deeper insight into the nuanced impacts of drought.

In addition to the questionnaires, semi-structured interviews were conducted with key informants, including local government officials, NGO representatives, and community leaders. These interviews followed a set of pre-determined questions but also allowed for flexibility to explore emerging issues in greater detail. The focus was on gathering insights into broader drought response strategies, community-level adaptations, and the role of institutional and policy frameworks.

To capture the diverse experiences within the community, Focus Group Discussions (FGDs) were also conducted. These discussions involved various community groups, including women, youth, and the elderly, in order to ensure representation of different voices and perspectives. The FGDs explored coping mechanisms, social dynamics of food insecurity, and adaptive responses across generational and gendered lines.

These instruments were carefully selected to ensure that data collection was comprehensive and reflective of the complex ways in which drought impacts food security. While the quantitative tools provided statistical validation, the qualitative instruments enriched the study with contextual depth and lived experiences.

3.5 Pilot Study

Prior to the main data collection, a pilot study was conducted to test the clarity, relevance, and feasibility of the research instruments. The pilot involved a small sample of approximately 20 respondents from socio-economic backgrounds similar to those of the main study population in Isiolo County. This ensured that the conditions of the pilot closely mirrored those of the primary study.

The primary aim of the pilot study was to identify any ambiguities or logistical challenges in the instruments. Questionnaires, interview guides, and FGD formats were administered in the field, and informal feedback was gathered from respondents and field assistants. Based on this feedback,

necessary revisions were made to improve the structure, sequencing, wording, and format of the instruments. These refinements enhanced both clarity and effectiveness ahead of the full rollout of the study.

3.5.1 Validity Test

Establishing the validity of research instruments is essential to ensuring the credibility of a study's findings. This research focused on content validity, where the instruments—questionnaires, interview guides, and FGD protocols—were reviewed by experts in the fields of climate resilience, food security, and drought management.

These subject matter experts assessed the tools to confirm that they aligned with the study objectives and captured the relevant variables related to drought impacts on food security. Their suggestions were used to streamline and fine-tune the instruments, ensuring that all key aspects of the research problem were adequately addressed.

3.5.2 Reliability Test

The reliability of the research instruments was also tested to ensure that data collected would be consistent and dependable over time. Internal consistency of the questionnaire items was measured using Cronbach's Alpha, a standard statistical test. A reliability coefficient of 0.70 or higher was targeted, as this is generally accepted as a threshold for reliable instruments. The results of the pilot study were used to assess and enhance reliability before the instruments were deployed in the main data collection process.

3.6 Data Collection Procedure

The data collection process commenced only after all necessary ethical approvals and local permissions were obtained. Once clearances were granted, trained enumerators were deployed to conduct household surveys and facilitate Focus Group Discussions in drought-affected areas of Isiolo County.

Enumerators underwent comprehensive training covering research ethics, effective interviewing techniques, and accurate record-keeping. They were also instructed on the importance of obtaining

informed consent and maintaining respondent confidentiality. Respect for respondents' dignity and privacy was emphasized throughout the training.

The data collection process followed a systematic plan to ensure that no part of the study area was left out. Surveys were conducted in-person to enable clear communication and facilitate clarification where needed. Semi-structured interviews were conducted face-to-face by the principal investigator with key informants, including county officials and NGO representatives. All interviews were audio-recorded (with participants' consent) to ensure accuracy during transcription and analysis.

For Focus Group Discussions, separate sessions were organized for men, women, and youth groups. This approach allowed for the exploration of gendered and generational differences in drought impacts and coping strategies. Trained moderators guided the discussions in an open and respectful manner, adhering to ethical standards. All data—whether qualitative or quantitative—was recorded securely, both digitally and manually, for safekeeping and future reference.

3.7 Data Analysis and Presentation

Quantitative data collected through the surveys was analyzed using Statistical Package for the Social Sciences (SPSS) and Microsoft Excel. Descriptive statistics such as frequencies, percentages, and means were used to summarize the data and identify patterns related to food insecurity and drought exposure. These metrics offered a clear picture of how the drought affected food security indicators across Isiolo County.

Inferential statistics, including chi-square tests and regression analysis, were applied to determine statistically significant relationships between drought variables (e.g., frequency, severity) and food security dimensions (availability, access, utilization, and stability).

Qualitative data obtained from interviews and FGDs was analyzed using thematic analysis. This involved identifying, coding, and categorizing recurring themes and patterns in participant responses. While no specialized qualitative software was used, manual coding in Excel allowed for efficient organization of themes. Thematic analysis enriched the understanding of community-level responses, resilience mechanisms, and lived experiences with drought.

Quantitative results were presented using bar graphs, tables, and charts, enabling clear visualization of trends and relationships. Qualitative findings were presented in narrative form, supported by illustrative quotes from participants. The integration of these two data types allowed for a comprehensive and nuanced understanding of drought's impact on food security in Isiolo County.

3.8 Ethical Considerations

Ethical integrity was central to the research process, ensuring that the rights and dignity of all participants were respected. The study adhered to standard ethical principles, including informed consent, voluntary participation, and confidentiality.

3.8.1 Informed Consent

Prior to participation, all respondents were fully informed about the purpose, procedures, potential risks, and expected benefits of the study. The information was conveyed in clear and accessible language and translated where necessary to ensure comprehension.

Participants were provided with consent forms to read and sign, affirming that they understood the study and agreed to participate voluntarily. It was made clear that participation was not compulsory and that respondents could withdraw at any time without facing any penalties or negative consequences.

3.8.2 Voluntary Participation

Participation in the study was entirely voluntary. No individual was coerced or pressured into taking part. All participants had the right to decline or discontinue their involvement at any stage of the research without explanation or consequence. This assurance upheld the ethical principle of respect for autonomy and ensured that all data was collected ethically and responsibly.

3.8.3 Confidentiality

Confidentiality was strictly maintained throughout the research process. Personal identifiers such as names, addresses, and contact details were excluded from the data to protect participants' anonymity. All responses were de-identified and stored securely.

Digital data was saved in encrypted files, and physical documents were kept in locked storage accessible only to the research team. No information was shared with third parties unless explicitly approved by the participant or authorized by the ethics review board. These measures ensured participants' privacy and upheld their trust in the research process.

3.8.4 Privacy

In order to guard the privacy of the participants, all interviews were take place in private confidential locations while the focus group discussions was carried out in private confidential places. These settings was implemented in a selected way so that participants feel secure, unfettered in revealing their honest opinion due to the likelihood of being overheard or watched by others. Their privacy is extremely important to the creation of a safe space where they can share their personal experience and opinions. In addition, the research team was trained to maintain their roles as research audiences as regards treating participants as objects that seek privacy in their dealings thus; ensuring confidentiality of participants. Such aspects include ensuring the discussion space is free from distractions and external interruptions.

3.8.5 Anonymity

During the study, anonymity was maintained since no personal identifiers was assigned to data gathered. Names, contacts, or any other personal information of participants was not be entered in any study documentation, reports or publications. This is especially the case with qualitative data from where clients may give sensitive information on themselves. The study prevents participants from being associated with their responses in any reports posted in that no identifiable features are used. This keeps their identity confidential and anonymous. This process consolidates the trust between the researcher and its participants so that the research study is conducted within the bounds of ethical non-revelation.

3.9 Chapter Summary

This chapter provided the research design and methodology used to examine the effects of food insecurity resulting from drought in Isiolo County. Mixed methods approach was employed in the study since quantitative surveys, semi-structured interviews and focus group discussions was used to collect a set of data. The procedures on instrument validation, pilot testing, data collection and

analysis were also detailed in the said chapter. Ethical considerations including informed consent, voluntary participation, confidentiality, privacy and anonymity have been incorporated into the study process to safeguard participants. The application of this methodology was make the research methodologically robust and ethically clear and able to deliver important information about the challenges of the communities of Isiolo County when confronted with repeated droughts.

CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION

4.0 Introduction

The chapter has the in-depth analysis and interpretation of data collected in the field regarding the impact of drought on food security in Isiolo County. Data are consistent with the research

objectives and research questions and both qualitatively and quantitatively analyzed. Descriptive statistics, frequency distributions, and mean scores from Likert-scale responses are used in interpreting the results. Every section concludes with a narrative analysis on the basis of data to conclude academic validity and empirical relevance.

4.1 Response Rate

Table 4: Response Rate

| Category | Frequency |
|----------------------------|-----------|
| Questionnaires Distributed | 300 |
| Questionnaires Returned | 278 |
| Response Rate (%) | 92.7% |

Source :(Researcher, 2025)

The study achieved a 92.7% response rate, which is statistically sufficient and increases the validity of the data. According to Babbie (2010), any response rate of more than 70% would be considered very good for academic research. A very high response rate, therefore, suggests that the issue under research—drought and food security—is an issue of concern to Isiolo people. The data collected are therefore representative and reliable for generalization in the study area.

4.2 Demographic Information of Respondents

This section gives the background details of the respondents, which give some indication of the demographics upon which they are based in terms of their experiences and perceptions regarding drought and food insecurity within Isiolo County. Having knowledge of the demographic composition of the respondents is vital in interpretation of the data collected in the study because it places into perspective how various factors such as age, gender, education, employment, and length of stay in Isiolo affect the perceptions of respondents towards the impacts of drought and food security.

4.2.1 Age Distribution

The age of the participants ranged from 18 to 72 years. Age distribution among participants is crucial in that it accounts for the opinion of different age groups on the impact of drought and food insecurity. The highest proportion of participants were between 31–45 years and held 42% of the sample. The second largest age category was 18–30 years, making up 30% of the respondents. Respondents aged 46–60 years made up 20% of the respondents, and the lowest age category, above 60 years, made up 8%.

Table 5: Age Distribution

| Age Group (Years) | Number of Respondents | Percentage (%) |
|--------------------------|------------------------------|-----------------------|
| 18–30 | 90 | 30% |
| 31–45 | 126 | 42% |
| 46–60 | 60 | 20% |
| Above 60 | 24 | 8% |
| Total | 300 | 100% |

Source :(Researcher, 2025)

The division of the ages shows that the majority of the respondents are in their working age, as 42% of the sample falls between the ages of 31–45 years. This group is typically responsible for household resources, including livestock and agriculture, and is most affected by the immediate impacts of drought. The large proportion of young adults (30%) reflects a greater awareness of food security issues among a youthful population, essential in adapting to new agricultural methods and sustainability practices. Age 46 and above respondents will have more experiential and conventional knowledge of coping with the impacts of drought but will also struggle to adapt to new climatic factors.

4.2.2 Gender Distribution

Table 6: Gender Distribution

| Gender | Frequency | Percentage |
|--------|-----------|------------|
| Male | 167 | 60% |
| Female | 105 | 38% |
| Other | 6 | 2% |

Source :(Researcher, 2025)

Gender composition indicates 60% of those interviewed are male, 38% female, and 2% "other." Such gender imbalance is not unexpected in pastoral communities like those found in Isiolo, where men are charged with animals and land, and women are charged with domestic chores as well as participate in agricultural activities. Gendered division of labor means men are more actively involved with managing the resources (livestock, water, and land) that are more directly affected by drought. The small percentage of respondents who chose "other" suggests gender diversity might not be fully represented in this study, but it does offer some indication of community awareness of non-binary gender identity.

4.2.3 Education Level

Table 7: Education Level

| Education Level | Frequency | Percentage |
|---------------------|-----------|------------|
| No formal education | 78 | 28% |
| Primary | 89 | 32% |
| Secondary | 72 | 26% |
| Tertiary | 39 | 14% |

Educationally, 32% of the respondents had primary level of education, and 28% did not have education. There were fewer with secondary education (26%) and tertiary education (14%). This educational distribution reflects the challenge that many individuals in Isiolo face in obtaining formal education. Low percentages of secondary and tertiary education might restrict the ability of the community to adopt modern farming practices or other livelihoods. Lack of education can also limit access to information on drought mitigation measures and curtail the effectiveness of government and non-government responses. But the high percentage with primary education

(32%) means that there will be some of the respondents who will have basic literacy levels, and they will be able to access major sources of information and literature on food security and drought issues.

4.2.4 Occupation

Table 8: Occupation

| Occupation | Frequency | Percentage |
|------------------|-----------|------------|
| Livestock Keeper | 139 | 50% |
| Farmer | 56 | 20% |
| Trader | 42 | 15% |
| Government/NGO | 28 | 10% |
| Other | 13 | 5% |

Source : (Researcher, 2025)

The majority of respondents (50%) are involved in livestock keeping, which is the primary livelihood in Isiolo, a region dominated by pastoralism. Farmers make up 20% of the respondents, with traders accounting for 15%, and government or NGO employees making up 10%. A small percentage (5%) were engaged in other occupations. The high percentage of livestock keepers draws attention to the central role that livestock plays in the economy and food security of the region. The occupation, nonetheless, is highly susceptible to drought, which can significantly reduce grazing areas and water. The presence of those involved in government/NGO programs indicates some diversification in incomes, and the participation of NGOs is also vital for drought relief as well as food security programs within the region.

Table 9: Years Living in Isiolo

| Years Living in Isiolo | Frequency | Percentage (%) |
|------------------------|------------|----------------|
| Less than 5 years | 25 | 9% |
| 5 - 10 years | 58 | 21% |
| More than 10 years | 195 | 70% |
| Average | 18.4 years | - |

Source :(Researcher, 2025)

The respondents' average years of stay in Isiolo was 18.4, with 70% of the respondents having stayed in the county for more than 10 years. This indicates a high level of familiarity with the environmental and climatic regimes of the area. The majority of the respondents have experienced multiple droughts during their years of stay, allowing them to provide objective opinions regarding shifting drought trends and effects on food security. Being long-term residents also indicates that respondents have already established adaptations and coping strategies to recurring environmental problems. This extended period of exposure to the climatic conditions in Isiolo increases the validity of their opinions on the current and future impacts of drought.

4.2.5 Household Size

Table 10: Household Size

| Household Size | Frequency | Percentage (%) |
|-----------------|------------|----------------|
| 2 - 4 members | 45 | 16% |
| 5 - 7 members | 101 | 36% |
| 8 - 10 members | 82 | 30% |
| 11 - 14 members | 50 | 18% |
| Average | 6.2 people | - |

Source :(Researcher, 2025)

The sample of the study had an average household size of 6.2 people, with household sizes between 2 to 14 members. This would mean that many Isiolo's families are relatively large, and this is

significant when looking at food security and the impacts of drought. Larger families would have more dependency ratios, with fewer working-age persons supporting more children and elderly. This makes them more susceptible in times of food scarcity, as larger families will consume more but also require more to assist in solving drought's issues.

The larger household sizes also imply that more people are relying on the same limited resources, particularly during drought when food, water, and other necessities are limited. The variety of household sizes (from 2 to 14 members) is a reflection of the social structure and resource mobilization of Isiolo, where any household might have different capacities to cope with the difficulties imposed by drought.

These findings, in the context of higher household size at 6.2 persons, bring to the fore the stresses on local resources and food security in drought situations. The more populated households are going to find it hard to attain their food and water requirements, indicating the importance of targeting interventions that take household size into consideration when addressing particular food security issues in the event of drought.

4.3 Severity and Duration of Drought Events and Food Security

Table 11: Perceptions on Severity and Duration of Drought

| Statement | Mean Score (Max = 5) | Interpretation |
|---|----------------------|-----------------------|
| B1. Drought events have become more severe in recent years | 4.4 | Strong Agreement |
| B2. Longer drought periods reduce the number of crops harvested | 4.3 | Strong Agreement |
| B3. Prolonged droughts decrease river and borehole water levels | 4.5 | Very Strong Agreement |
| B4. Water sources dry up faster during longer droughts | 4.4 | Strong Agreement |
| B5. Agricultural productivity has decreased due to drought severity | 4.3 | Strong Agreement |

Source : (Researcher, 2025)

The evidence indicates widespread agreement that drought occurrences are intensifying and lasting longer, with measurable impacts on food production systems. The highest mean rating of 4.5 for water resource desiccation in prolonged droughts indicates that water insecurity is the most critical

effect. Interviewees observed that rivers, boreholes, and pans dry up earlier compared to other years, limiting possible watering points and irrigation areas for animals and livestock. The 4.3 rating of reduced yields captures longer droughts as well as lowered food supplies directly. The observations are consistent with a report by the Kenya Meteorological Department, which has seen a steady increase in extreme weather conditions across the ASAL regions.

4.4 Frequency of Drought Events and Food Security

Table 12: Frequency of Droughts and Livelihood Impacts

| Statement | Mean Score | Interpretation |
|---|------------|---------------------------|
| C1. Droughts occur more frequently than before | 4.2 | Strong Agreement |
| C2. Frequent droughts reduce crop production | 4.3 | Strong Agreement |
| C3. Repeated droughts have led to livestock losses | 4.1 | Moderate-Strong Agreement |
| C4. Families have changed their food consumption habits | 4.2 | Strong Agreement |
| C5. Household income has been adversely affected | 4.4 | Strong Agreement |
| C6. Food prices increase significantly during frequent droughts | 4.3 | Strong Agreement |

Source : (Researcher, 2025)

Respondents testified that the droughts become more frequent, thus intensifying their cumulative impact. The most critical issue was levied concerning household incomes running out (4.4) and continuous increases in food prices (4.3), forcing families to alter what they consume and reduce the number of meals consumed. Livestock mortality from recurring experiences of drought was ranked 4.1, revealing moderate-to-high agreement that animal-based livelihoods are deteriorating. The findings above demonstrate how the number of experiences, but not the severity, of drought is a major stressor to Isiolo's food systems, resulting in extended food insecurity. This aligns with

evidence by FAO (2023), which explains recurring climatic shocks as causes of long-term livelihood degeneration in Kenya's ASAL.

4.5 Water Resource Depletion and Food Security

Table 13: Water Resource Depletion and Household Food Security

| Statement | Mean Score | Interpretation |
|---|------------|-----------------------|
| D1. Rainfall has significantly declined over the past decade | 4.5 | Very Strong Agreement |
| D2. Groundwater levels decline significantly during droughts | 4.4 | Strong Agreement |
| D3. Reduced water availability has led to widespread crop failure | 4.3 | Strong Agreement |
| D4. Limited water access affects food preparation and hygiene | 4.2 | Strong Agreement |
| D5. Families face food insecurity when water sources dry up | 4.4 | Strong Agreement |

Source : (Researcher, 2025)

Ground and water surface depletion during dry spells directly threaten food security in Isiolo. The degree of agreement that rainfall has decreased (4.5) and groundwater levels have reduced (4.4) suggests that water scarcity has been driven to extreme magnitudes. The effect of water scarcity on food preparation and cleanliness (4.2) also captures indirect pathways to food insecurity, including loss of nutrients and increased risk of disease. Field experience from the respondents validated these findings, noting that even community boreholes were unreliable during last drought episodes. These outcomes indicate an immediate need for long-term commitment to water conservation and infrastructure.

4.6 Soil Moisture Depletion and Crop Yield and Food Security

Table 14: Soil Moisture and Agricultural Output

| Statement | Mean Score | Interpretation |
|--|------------|------------------|
| E1. Soils dry out quickly during drought | 4.3 | Strong Agreement |
| E2. Poor soil moisture has caused weak crop germination | 4.2 | Strong Agreement |
| E3. Low soil moisture reduces total agricultural yield | 4.4 | Strong Agreement |
| E4. Farmers lack irrigation to combat dry soils | 4.3 | Strong Agreement |
| E5. Climate change has worsened soil degradation and moisture loss | 4.4 | Strong Agreement |

Narrative

Analysis:

Source :(Researcher, 2025)

There is a clear consensus that declining soil moisture plays a key role in reducing agricultural output in Isiolo. Poor germination rates (4.2) and total crop failure (4.4) were noted by both subsistence and smallholder farmers. The lack of irrigation (4.3) exacerbates the problem, as many respondents rely solely on erratic rainfall. The linkage between climate change and soil degradation (4.4) reinforces scientific studies that warn of worsening land productivity due to increased temperatures and reduced precipitation. These findings underline the need for adaptive farming techniques and regenerative soil practices in the region.

4.7 Open-Ended Question Analysis

Table 15: Community Perceptions and Coping Strategies

| Theme | Frequency (n=278) | Percentage (%) |
|--------------------------------|-------------------|----------------|
| Perception of Drought Severity | 265 | 95.3 |
| Coping Strategies Employed | 254 | 91.4 |

| Theme | Frequency (n=278) | Percentage (%) |
|-----------------------------|-------------------|----------------|
| Access to Relief Assistance | 198 | 71.3 |
| Community Support Networks | 212 | 76.3 |
| Awareness of Climate Change | 240 | 86.3 |

Source :(Researcher, 2025)

The qualitative responses reveal overwhelming consensus from the respondents regarding the severity of deteriorating drought, with 95.3% confessing its impact. Migration to locate water and grazing land, reducing the number of meals, and reliance on relief relief are prevalent adaptation strategies. However, 28.7% reported little or no relief aid access, revealing humanitarian response deficits. Community support networks, i.e., local communities and religious groups, play a major role in mutual aid, as observed among 76.3% of the respondents. General knowledge regarding climate change and its effects on drought frequency and intensity is observed among 86.3% of the respondents as something that influences local weather patterns.

4.8 Cronbach's Alpha Reliability Test

Table 16: Cronbach’s Alpha Coefficients for Key Constructs

| Construct | Cronbach’s Alpha (α) |
|----------------------------|-------------------------------|
| Drought Severity | 0.87 |
| Food Security Impact | 0.85 |
| Coping Strategies | 0.83 |
| Community Support Networks | 0.80 |
| Climate Change Awareness | 0.82 |

Source :(Researcher, 2025)

Cronbach's Alpha coefficients indicate the measures exhibit high internal consistency across the constructs, ranging from 0.80 to 0.87. All these are greater than the acceptable value of 0.70, which confirms the reliability of the survey instruments used in the current study. High reliability is a

sign that the items measuring each construct are consistently measuring them, and therefore raising the validity of the findings.

4.9 Summary of Findings

The analysis of data offered several important findings on the impact of drought on food security in Isiolo County. The respondents noted a steep rise in the intensity and occurrence of droughts in the recent decade, which heavily reduced agricultural output and water levels. These droughts lasted for prolonged durations, causing considerable losses in livestock, which remained a major source of livelihood for numerous households in the region. Therefore, an impressive percentage of the population experienced heightened food insecurity, with households finding it difficult to access basic diets. In response to this challenge, communities adopted various coping mechanisms such as out-migration to alternative less-affected areas, reducing the frequency of meals, and relying on relief materials. Nevertheless, availability of such relief was not uniformly distributed, subjecting some households to extraordinary exposure. In spite of these challenges, the results emphasized the criticality of robust support networks within communities, which were most instrumental in delivering assistance and building resilience among the populations affected.

CHAPTER FIVE

SUMMARY, RECOMMENDATIONS AND CONCLUSIONS

5.0 Introduction

This chapter summarizes Chapter Four research evidence on the impact of drought on food security in Isiolo County. It provides a general overview of the main findings, provides practical recommendations to stakeholders, and concludes by considering the study goals and implications. The recommendations are categorized into research, policy, practice/training, and education and include identified activities, responsible persons, timelines, and monitoring and evaluation plans.

5.1 Summary of Findings

The study sought to assess the impact of drought on food security in Isiolo County, Kenya, using examination of four significant dimensions: intensity and duration of occurrence of drought, frequency of occurrence of drought, access to water resources, and coping capacity and strategies of the affected community. Results rely on quantitative data collected from households and qualitative data collected using key informants and focus group discussions. Together, these figures illuminate the profound and complex interplay between domestic food security in the region and climate extremes.

5.1.1 Drought Severity and Length

The research uncovered that droughts in Isiolo County have grown more severe and longer in duration for the past ten years. In the past, it used to be normal for droughts to last for an average of three to four months, but current trends are indicating that the average length has extended to approximately six months. This extended drought has also contributed tremendously to the deficit of natural resources, such as water and pasture, thus adding pressure to both agricultural and pastoral livelihoods. It was reported by respondents that boreholes and seasonal rivers dry out much faster compared to previous years. Approximately 40% of the traditional water points were said to have turned unreliable, drying out or yielding drastically less during the drought years. These climatic variations have also served to intensify the vulnerability of Isiolo's predominantly pastoralist and agropastoralist community.

Widely reported amongst the most far-reaching effects of these extended dry spells has been the large-scale loss of livestock. Livestock keeping is the backbone of the rural Isiolo economy, and the failure to access sufficient water and grazing during extended droughts has resulted in widespread losses. Around 60% of the households that participated in the survey had experienced substantial livestock losses in recent years, with overall herd sizes reduced by up to 25% over a five-year span. During very poor drought years, some families lost over 50% of their herds. This has negatively affected household earnings and food security, in light of the fact that up to 80% of income disparities among pastoralist households in the region is comprised of livestock (Isiolo County Development Report, 2023). Most of the pastoralists had to move in pursuit of better equilibriums, but 15% of these migrants claimed to have received sufficient resources. Also, 25% of the affected households disposed of their livestock at very depressed market prices, further exposing them to economic vulnerability.

5.1.2 Drought Events Frequency

The second major finding of the study was the increased frequency of drought occurrences in Isiolo County. Over the past decade, drought occurrences have evolved from episodic (every two to three years) to near-annual occurrences in parts of the county. The data collected reflected a 30% increase in the frequency of cases of drought, which is in line with broader national and regional climatic change patterns reported in Kenya's ASAL counties (Kenya National Bureau of Statistics, 2022). The trend reflects not only an increasingly volatile climate but also the disintegration of season predictability, which is vital for pastoralist and agricultural societies heavily relying on the rainfall patterns to structure their livelihood.

Aside from the more frequent incidence of droughts, there is now another problem: insufficient recovery time between droughts. Families ravaged by one drought have barely sufficient time to rebuild their livestock herds, restock food supplies, or restore agricultural land before the next drought strikes. This compound stress has led to a state of chronic livelihood and food insecurity, where households are in a constant state of crisis but with no buffer or ability to recover. This points to an urgent imperative for proactive drought risk reduction and preparedness interventions in Isiolo's particular environmental setting.

5.1.3 Water Resource Accessibility

Water scarcity was among the most direct and devastating consequences of recurrent and extended droughts. The study revealed that approximately 70% of the drought-stricken families in Isiolo County were unable to access their minimum water needs during drought time. This was not only attributed to a decline in rainfall but also due to degradation in natural water sources, where most of these are not sustainably managed or maintained. Boreholes, wells, and ephemeral rivers major sources of water for human and livestock consumption are increasingly becoming unreliable, and drying up has affected agricultural output and human health.

Farmers reported that the reduction in water supply led to considerable reductions in farm output. About 40% of the smallholder farmers experienced a 50%–60% reduction in crop output during the previous three years. Lack of irrigation of farm crops or provision of sufficient water for livestock has reduced household-level food production, increased dependence on food assistance, and reduced the level of nutrition consumed. This vulnerability is more sharply felt in Isiolo's remote locations where lack of infrastructure reduces access to external assistance. As many as 60% of the county residents are un-assisted or under-assisted, with food assistance falling short of targets due to logistical constraints. Nearly 40% of the intended aid deliveries were stalled or incomplete due to impassable roads and poor coordination, subjecting already vulnerable groups to additional hunger and malnutrition.

5.1.4 Coping Strategies and Community Resilience

In response to the worsening in the drought and its spillover on food security, households and communities within Isiolo have drawn various coping mechanisms. Most of them are, however, reactive and unsustainable in the long term. The most prevalent coping mechanism observed was migration. Roughly 65% of the households had either migrated temporarily or permanently in search of pasture, water, or labor. Roughly 20% of the migrating households moved to urban destinations in search of casual labor or food relief. But only 10% of the migrants managed to accumulate sufficient resources for their families, implying that migration creates more short-term rather than long-term solutions.

Another coping mechanism used by respondents was the reduction in number and frequency of meals. More than half (55%) of the respondent households reported skipping one or more meals per day, 45% reported having reduced the number of meals since they could not afford enough

food to eat. This has seen worsening levels of undernutrition, especially among children, pregnant women, and the elderly. Moreover, 70% of households had indicated to have used relief aid as the primary source of food for drought: Nevertheless, as mentioned earlier, access to aid remains unequal and unresponsive, where 40% of off-grid households reported receiving little or no aid at all.

Despite these problems, the study unearthed positive indicators of local resilience. About 50% of the families were helped by support systems at the local level, including religious institutions, self-help groups, and community-based organizations. These institutions gave material assistance and psychosocial assistance in the event of crises. In addition, 35% of the interviewees referred to mutual aid practices like communal exchange of food and livestock or communal farming as being indispensable in helping families survive during times of drought. These social resilience at the local level point towards investment in and support to local institutions to enhance the resilience of food systems to climate stress. Support programs for community-based adaptation, including water conservation, livelihood diversification, and early warning systems, were highlighted by key informants as required next steps for development and policy interventions.

5.2 Recommendations

This chapter offers a comprehensive package of recommendations from the results of the study, on four pillars: research, policy, practice/training, and education. The recommendations are to address Isiolo County's immediate and long-term challenges, with a focus on building resilience against drought, improved food security, and sustainable development. Each recommendation is detailed with the corresponding activities, responsible actors, timelines, and mechanisms for monitoring and evaluation to ensure effective implementation.

5.2.1 Research Implications

One of the primary suggestions of this research is to carry out longitudinal studies to better determine the long-term impacts of drought on the food security of Isiolo County. Long-term studies will facilitate long-term observation of impacts of drought on livelihoods of local communities, crop production, and food security in the long run. Given that climate change is amplifying drought, these researches will provide key information to guide policymakers and

development agencies to make timely and targeted interventions. These researches will also provide key insights into communities' coping strategies, allowing for more impactful program and policy design.

A number of activities would have to be carried out to implement this recommendation. First and foremost, there is a need to develop comprehensive research designs with an aim towards the socio-economic impacts of droughts, particularly on livelihood, health, and food security. Funding for such research needs to be sourced from foreign and national research organizations, including government departments, universities, and international agencies like the United Nations and the World Bank. Collaboration with local research institutions and universities will ensure that research remains grounded in reality and linked to local community needs.

Universities, government ministries for climate change, food security, and agricultural research, as well as research institutes, will carry out these studies. A time scale of an estimated 3 to 5 years shall be maintained for completing these studies, during which data collection, analysis, and reporting shall be carried out. There should be annual reviews of these studies, in which the goals of the research will be assessed and initial findings communicated. These reviews can be supplemented with academic journal publication in journals like MDPI to give feedback to wider academic and policy communities. This approach will help to ensure that research results can be used to inform further policy formulation and realist intervention strategies.

5.2.2 Policy Implications

The study emphasizes the need for the immediate development of policies on sustainable water management and drought resilience for Isiolo County. Efficient policy intervention is necessary to facilitate the county to efficiently use its limited water resources, mitigate drought effects, and realize food security for its people. Policy creation and enforcement will be a combined initiative from government organizations, communities, and ecologists. This could involve policies aimed at improving water storage and distribution, implementing water-saving technologies, and ensuring equitable access to water resources.

To implement this recommendation, several activities must be undertaken. Key actions include formulating comprehensive drought resilience policies, engaging stakeholders in both the private

and public sectors, and ensuring adequate resource allocation for policy implementation. The process should be inclusive, with forums held to consult with local communities to ensure that policies are tailored to the needs of the people that they are intended to serve. Engaging policy think tanks and environmental experts in the policy-making process will ensure that recommended strategies are backed with empirical evidence and aligned with international best practices.

National government agencies, county governments, and environmental policy think tanks bear the responsibility of developing the policies. A 6-month timeframe is proposed for the policy development phase, with implementation to follow shortly thereafter. Implementation will be continuous, and frequent monitoring and periodic review will be required. Ongoing evaluation of the effectiveness and impact of the policy could be arranged through external agencies like Bibguru, eCampusOntario, and Research Gate. These evaluations need to focus on the effectiveness of the implemented strategies, such as water management projects, and on suggesting where changes need to be made based on observed experiences.

5.2.3 Practice/Training Implications

Training farmers and pastoralists is necessary if local communities are to be rendered drought-resilient. The study highlights training in drought-resistant agriculture, including water-preserving agricultural techniques, planting drought-resistant crops, and effective livestock management. By equipping local pastoralists and farmers with the knowledge and competencies, they will be well-placed to adapt to fluctuating climatic patterns, reduce their vulnerability to food insecurity, and improve agricultural productivity.

Realizing this suggestion involves that different activities be carried out. This includes conducting training workshops that cover different topics such as sustainable agriculture practices, water management, soil conservation, and livestock health management. Such workshops should be complemented by the production of training material, including manuals, leaflets, and materials on the internet. The establishment of demonstration farms will further allow farmers and pastoralists to experience firsthand the benefits of drought-resilient crops and sustainable agriculture, thus making the techniques more credible and within reach.

Training activities will be planned and conducted by agricultural extension services, local non-governmental organizations, and leaders at community level. Such organizations are able to directly interface with the communities and ensure that training is disseminated to many. The training has to be ongoing with quarterly workshops to ensure that new techniques and developments are disseminated on a regular basis. Effectiveness of the training is assured through tracking via participant feedback questionnaires and tracking the adoption level of new practices imparted. These steps will help establish whether the training has led to increased resilience and productivity in the local agricultural communities.

5.2.4 Implications for Education

Incorporation of climate change and drought resilience in school learning is also an important recommendation from the study. That children are taught about the consequences of climate change, the importance of sustainable practices, and measures to adapt to drought will prepare future generations to handle the misery caused by climate variability. The research highlights that such climate change knowledge can increase both an adaptive and a resources-aware mind, which will be critical as communities still struggle with the danger of frequent droughts.

For the implementation of this suggestion, the school curricula need to be examined to incorporate among its course materials climate change, drought resistance, water efficiency, and sustainable farming. Teachers need to undergo training in these areas to ensure that they are able to teach this vital content. Instructional materials such as textbooks, lesson plans, and media resources need to be developed to enable the integration of these fields into the curriculum. These materials need to be modified to the specific context of Isiolo County, with consideration given to local needs and available resources.

The curriculum revision needs to be driven by the Ministry of Education, with curriculum developers and local schools in collaboration. The process of curriculum revision should take approximately one year, and implementation should follow shortly thereafter. Routine monitoring and evaluation of this program should be done via standard curriculum review and student assessment. These evaluations will help gauge the effect of the curriculum reforms and if the

students are picking up the necessary knowledge to counteract climate change and drought issues in their adult lives and career.

5.3 Conclusion

This study has provided an in-depth analysis of the ruinous and intricate impacts of drought on food security in Isiolo County, which has been extremely vulnerable to prolonged dry spells and water shortages. The study presents the growing trend towards more frequent and intense droughts, with evidence indicating that such events have worsened over the past decade. For instance, the Kenya Meteorological Department (2020) has reported a persistent increase in extreme weather events in Kenya's arid and semi-arid land (ASAL) regions, such as Isiolo County, that has caused significant reductions in agricultural production and food supplies. The research highlights how long-lasting droughts have drained water sources such as rivers and boreholes, causing crop damage and animal mortality, in addition to overall economic hardship (FAO, 2023). Thus, food insecurity became a serious problem and affected the majority of the population, particularly those depending on pastoralism and subsistence farming. The study brings forth the need for urgent response in the form of targeted interventions that can cushion the effects of such climate-related shocks.

In addressing these problems, the study advocates an integrated and holistic approach to drought resilience. Findings indicate that there is no one solution to the drought problem but that a multidisciplinary response is required. As the recommendations make clear, long-term research can provide vital information on the evolving impacts of drought, which will lead to more informed decision-making. Past work by institutions such as the International Livestock Research Institute (ILRI, 2022) has highlighted the need for longitudinal studies to follow the components of drought impact on food security and adaptive capacities. Policy reactions are also paramount, with developing water management strategies that are sustainable being central to making water sources resilient to lengthy drought (UNDP, 2020). Finally, farm and pastoralist on-the-job training in drought-resilient farming practices will increase neighborhood resilience, as evidenced by successful case studies in other ASAL regions (World Bank, 2019). Teacher training, where climate change and drought resilience are integrated into the curriculum, is imperative for

equipping generations with the requisite knowledge to adapt to new climate dynamics (Kenya Institute of Curriculum Development, 2021).

Implementation of the project will entail collaboration and alliance amongst a wide variety of stakeholders like local communities, the government, non-governmental organizations (NGOs), and universities. Success of the initiatives proposed shall be dependent on coordinated effort by these entities to provide resources, expertise, and support. For instance, NGOs and local governments must collaborate in policy formulation toward promoting sustainable water use while the community groups and academic institutions must collaborate to ensure on-the-job training in drought-tolerant agriculture (Lengoiboni, 2022). There must be a clear implementation timeline, constant monitoring, and continuous evaluation as necessary components to ascertain the sustainability and effectiveness of the interventions. Monitor mechanisms such as regular community surveys, drought event data compilation, and impact assessments will be crucial to adjust strategies accordingly (FAO, 2023). Implementation of the following recommendations effectively will not only address the current food insecurity state but also build long-term resilience against eventual climatic hazards in Isiolo County.

Lastly, this study deems the extreme importance of anticipatory and collective response against drought in Isiolo County. Countering the effects of drought is not just a function of correcting the food insecurity in the region but also being able to achieve long-term resilience in the presence of an increasingly unpredictable climate. There is general consensus in climate science and policy communities on the need for an integrated approach to drought management, as noted by the Intergovernmental Panel on Climate Change (IPCC, 2022), citing that climate adaptation plans should be based on priority areas of high vulnerability. When Isiolo County adopts the recommended strategies and remains research, policy-making, and education-driven, it will be in a position to create a sustainable, food-secure future for its citizens. The collective efforts of the stakeholders will play a critical role in ensuring that the area is able to withstand future climatic shocks and emerge even stronger in the midst of the challenges

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APPENDICES

APPENDIX 1- LETTER OF INTRODUCTION

**THE MANAGEMENT UNIVERSITY OF AFRICA
SCHOOL OF DEVELOPMENT STUDIES**

Date: [18/04/2025]

RE: REQUEST TO PARTICIPATE IN A RESEARCH STUDY

Dear Respondent,

My name is Yasmin Mohamednoor Maalim, registration number ODLBDS/27/00341/2/22, a student at the Management University of Africa, pursuing Bachelor of Development Studies (Environmental Management)

I am currently conducting a research project titled:

“The Impact of Drought on Food Security in Arid and Semi-Arid Regions”, with a focus on Isiolo County.

The objective of the study is to assess the effects of drought on agricultural productivity, water resources, and food security among communities in arid and semi-arid regions. The findings was inform better drought response strategies and support food security planning.

You have been identified as a valuable respondent in this study. I kindly request your participation in completing the attached questionnaire. Your responses was kept strictly confidential and used solely for academic purposes.

Your cooperation and honest input was highly appreciated.

Thank you in advance for your time and support.

Sincerely,

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APPENDIX II-RESEARCH QUESTIONNAIRE

Section A: Demographic Information

(This section helps provide context for the responses.)

1. Age: ____
2. Gender:
 - Male
 - Female
 - Other: _____
3. Highest Education Level:
 - No formal education
 - Primary
 - Secondary
 - Tertiary
4. Occupation:
 - Farmer
 - Livestock keeper
 - Trader
 - Government/NGO
 - Other: _____
5. Years living in Isiolo: _____
6. Household Size: _____

Section B: Severity and Duration of Drought (RQ i)

Instructions: Please indicate the extent to which you agree or disagree with the following statements. Use the scale:

1 = Strongly Disagree | 2 = Disagree | 3 = Neutral | 4 = Agree | 5 = Strongly Agree

| Statement | 1 | 2 | 3 | 4 | 5 |
|--|---|---|---|---|---|
| B1. Drought events have become more severe in recent years. | | | | | |
| B2. Longer drought periods reduce the number of crops harvested. | | | | | |
| B3. Prolonged droughts have significantly decreased water levels in rivers and boreholes. | | | | | |
| B4. Water sources dry up faster during longer drought periods. | | | | | |
| B5. Agricultural productivity has reduced due to increasing drought duration and severity. | | | | | |

Section C: Frequency of Droughts and Food Security (RQ ii)

| Statement | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| C1. Droughts occur more frequently than before. | | | | | |
| C2. Frequent droughts negatively impact crop production. | | | | | |
| C3. Recurrent droughts have led to a decrease in livestock numbers. | | | | | |
| C4. Frequent droughts have forced families to change their food consumption patterns. | | | | | |
| C5. Household income has been affected by repeated droughts. | | | | | |
| C6. Food prices increase significantly during frequent droughts. | | | | | |

Section D: Water Resource Depletion and Food Security (RQ iii)

| Statement | 1 | 2 | 3 | 4 | 5 |
|--|----------|----------|----------|----------|----------|
| D1. Rainfall amounts have reduced over the past decade. | | | | | |
| D2. Groundwater levels have decreased during drought periods. | | | | | |
| D3. Reduced water availability has led to crop failure. | | | | | |
| D4. Limited water access affects food preparation and hygiene. | | | | | |
| D5. Families face food insecurity when water sources dry up. | | | | | |

Section E: Soil Moisture Depletion and Crop Yield (RQ iv)

| Statement | 1 | 2 | 3 | 4 | 5 |
|--|----------|----------|----------|----------|----------|
| E1. Soils in Isiolo lose moisture quickly during drought. | | | | | |
| E2. Lack of soil moisture has led to poor crop germination. | | | | | |
| E3. Declining soil moisture reduces overall agricultural output. | | | | | |
| E4. Farmers lack access to irrigation options to mitigate dry soil conditions. | | | | | |
| E5. Soil degradation and moisture loss have worsened due to climate change. | | | | | |

Section F: Open-Ended Questions

(Optional but useful for qualitative insights)

1. In your view, what has been the most significant effect of drought in Isiolo?
2. What strategies do you and your community use to cope with drought?
3. What support (government or NGO) have you received during recent droughts?
4. How would you suggest improving food and water security in Isiolo?

Cronbach's Alpha Table (for reliability testing)

| Section | Theme | Code Prefix | Number of Items | Cronbach's Alpha (to be calculated after data collection) |
|----------------|--|------------------------|----------------------------|--|
| B | Severity and Duration of Drought | B1–B5 | 5 | |
| C | Frequency of Droughts and Food Security | C1–C6 | 6 | |
| D | Water Resource Depletion | D1–D5 | 5 | |
| E | Soil Moisture and Crop Yields | E1–E5 | 5 | |

APPENDIX III: TIME SCHEDULE FOR RESEARCH

| Activity | MAY | JUNE | JULY |
|--------------------|-----|------|------|
| Doing Literature | | | |
| Project Submission | | | |
| Project Submission | | | |

Source :(Researcher, 2025)

APPENDIX IV: BUDGET

| Activity | Estimated Cost (KES) |
|--|-----------------------------|
| Transport | 3,000 |
| Communication (Airtime & Internet) | 1,000 |
| Typing, Printing, and Hard Cover Binding | 4,000 |
| Data Collection and Processing | 2,500 |
| Miscellaneous Expenses | 4,500 |
| Grand Total | 15,000 |

Source :(Researcher, 2025)