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# Examine the effect of desert locust invasion on the availability and accessibility of food due to climatic conditions within households in Loima Sub-County, Turkana County, Kenya.

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***ABSTRACT***
*The purpose of this study is to Examine the effect of desert locust invasion on the availability and accessibility of food due to climatic conditions within households in Loima Sub-County, Turkana County, Kenya. The study employed the Phase theory and Systems theory and adopted a descriptive research design, allowing for the explanation, description, and validation of findings. A sample size of 400 respondents was selected from a target population of 19,599 households using basic random and systematic sampling methods. Data collection methods included questionnaires, interview guides, and focus group discussions. Qualitative data analysis involved identifying recurring themes and patterns linked to the research objectives, while quantitative data analysis provided both descriptive and inferential statistics. Descriptive data were presented through percentages, frequency tables, arithmetic means, and standard deviations, and inferential statistics were derived using Pearson's Product Moment correlation, simple and multiple regressions, and the F-test. The study's results offer valuable insights that can inform policy development and guide the implementation of effective measures to enhance food security and resilience against future locust invasions. The findings reveal that desert locust invasions significantly impacted food security in Loima Sub-County, with severe crop and vegetation destruction leading to a marked decrease in food availability. This highlights the urgent need for effective interventions. The study concludes that desert locust invasions have severely compromised food security in the region, necessitating robust interventions to mitigate the crisis and ensure sustained food security. The study recommends proactive measures for the prompt detection of locust swarms and the deployment of effective control strategies. Comprehensive support programs should assist affected households in economic recovery, and efforts to diversify income sources and strengthen resilience are crucial. Supporting community-based initiatives to enhance local resilience is also essential.*

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## LIST OF ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| **AUC** | Area under the Curve |
| **FAO** | Food and Agriculture Organisation |
| **FCC** | False Colour Composite |
| **FGD** | Focus Group Discussion |
| **FSOM** | Food Security Outcome Monitoring |
| **GBIF** | Global Biodiversity Information Facility |
| **GIS** | Geographic Information System |
| **GPS** | Global Positioning System |
| **MT** | Metric Tonnes |
| **OCHA** | Office for the Coordination of Humanitarian Affairs |
| **rOSI** | relative Operating Severity Index |

**SDM** Species Distribution Modelling
**UN** United Nations
**WFP** World Food Programme
**NDU-K** National Defence University-Kenya
**NACOSTI** National Commission for Science, Technology & Innovation

## OPERATIONAL DEFINITION OF TERMS

**Coping strategies:** The actions and measures taken by households in Loima Sub-County, Turkana County, in response to the challenges posed by desert locust invasions and their impact on food security. These strategies may include changes in agricultural practices, reliance on alternative food sources, migration, or seeking external assistance.

**Crisis:** The state of acute food insecurity and disruption of livelihoods within households in Loima Sub-County caused by the desert locust invasion. It encompasses a significant decline in food availability, access, and utilisation, leading to a severe and immediate threat to the well-being of the affected population.

**Dietary Diversity:** The range and variety of different foods and food groups consumed by individuals or households within a specified period, typically measured over a given timeframe, such as a week or a month. It encompasses the inclusion of various food items from different food groups, such as grains, vegetables, fruits, protein sources (e.g., meat, fish, and legumes), dairy products, and other nutrient-rich foods.

**Food Security:** The condition in which all individuals within households in Loima Sub-County, Turkana County, have consistent access to sufficient, safe, and nutritious food to meet their dietary needs and preferences for an active and healthy life. It includes the availability, accessibility, utilisation, and stability of food sources.

**Household head**: The person responsible for making key decisions and managing the overall well-being of the household. This individual is often the primary breadwinner and decision-maker.

**Household**: A group of individuals living together in a common dwelling in Loima Sub-County, Turkana County, sharing economic and social resources and typically headed by a single individual.

**Locust Invasion:** The sudden and significant influx of desert locust swarms into the agricultural and pastoral areas of Loima Sub-County, resulting in the infestation of crops and grazing lands.

## I. Background of the Study

The migration of desert locusts (*Schistocerca gregaria*) presents a threat to ecosystems worldwide that sustain agriculture and vegetation. Throughout time, desert locusts have been widely regarded as a significant nuisance (Sánchez-Zapata et al., 2007; Githae & Kuria, 2021). In periods of economic downturn, desert locusts have the ability to shift from a benign solitary stage to large groups of social individuals that disperse over vast areas (Meynard *et al.*, 2020).

The desert locust *(Schistocerca gregaria*) is a very perilous migratory pest that poses a significant threat to agricultural and rangeland productivity (Lecoq, 2003). Consequently, controlling this pest is of utmost importance for ensuring food security in many locations (Retkute et al., 2021). From 2019 to 2021, there was a significant increase in desert locust activity, one of the highest in the past twenty years. This resulted in a desert locust invasion that spread from Kenya to India (Salih et al., 2020; Lecoq & Cease, 2022).

The health of the plants, winds, type of soil and amount of precipitation are all factors that affect desert locust outbreaks (Jhiknaria, 2021). They can reproduce rapidly, travel freely and have favoured eating habits due to these circumstances. The ever-grazing pests that live near the habitats gorge on grass, tree leaves and stems and crop leaves and shoots. Food security is under jeopardy due of the harm that hopper bands and adult swarms produce (Cressman, 2013).

According to Upton et al. (2016), food security refers to the condition in which individuals consistently have the necessary economic, social, and physical resources to obtain an adequate and safe supply of nourishing food that meets their dietary needs and promotes a healthy and thriving lifestyle. Conversely, food insecurity is characterized as a circumstance where individuals face insufficiency in attaining enough, safe and nutritious sustenance to support typical growth and development, along with sustaining a healthy and active existence (Burchi & De Muro, 2016). Food insecurity is triggered by factors such as the desert locust invasions, encompassing uneven distribution of food within household members and insufficient food access (Kimanthi *et al*, 2020).

Mullié *et al*, (2023) notes that swarm of desert locusts can consume roughly 80,000 metric tons of vegetation in a day. This amount of vegetation can feed about 35,000 people for a year. It is important to remember that desert locust invasions not only create catastrophic losses and damages but are also extremely unpredictable. Therefore, desert locust outbreaks pose a serious danger to achieving the priorities set out in the Sendai Framework for Disaster Risk Reduction 2015-2030, especially priorities 1 through 4. In addition to assisting in the eradication of poverty, research on the interactions between humans and their environment and desert locusts benefits sustainable agriculture, food security and biodiversity preservation (Murali-Sankar & Shreedevasena, 2020).

Due the condition of food insecurity, FAO and UN Office for the Coordination of Humanitarian Affairs (OCHA) 2020 reported that desert locusts are the most devastating migratory pests in the world. It is necessary to undertake the study to find a solution since hundreds of thousands of hectares, including farmland and pasture, have already been impacted. Over the past decades, the management of desert locust invasions have been inadequate to reduce the risks associated with the invasions, primarily due to limited surveillance systems, absence of coordination structures as well as inadequate manpower and equipment (Showler *et al.,* 2022). Further, the supply of reliable, affordable pesticides and spraying equipment has been insufficient (Sultana *et al*., 2021). Under these conditions, the initiatives deployed such as spraying of insecticides are effective but inadequate to counteract the reproduction cycles of desert locusts because of inadequate measures to estimate the spatial extent of the risk (Showler, 2019).

Desert locust swarms have decimated pastures and crops in over 60 nations from Africa to western Asia, leaving around 10% of the world's population food insecure (Renier *et al.,* 2015). Further, desert locust swarms may be extremely destructive, especially in nations where agriculture accounts for 20% of the GDP (Sultana *et al.,* 2021).

In Kenya, desert locusts have had a detrimental impact on crop production and threatened food security (FAO, 2020). The pest caused widespread crop damage in Kenya during the 2019/2020 cropping season and continued to spread and cause damage to crops, threating the food security in the subsequent seasons (Kassegn, & Endris, (2021), Odhiambo *et al*, (2021). The effects of desert locust invasion on food security crisis have been evident in all of the Arid and Semi-Aril Lands (ASAL) counties from 2019.

A Food Security Outcome Monitoring (FSOM) conducted by the World Food Programme (WFP) in 2020 identified distinct patterns in household food consumption. Within the marginal agricultural livelihood zones along the coast, a significant proportion, amounting to 25.3%, experienced poor food consumption. In other areas, such as the southern marginal and the northeast pastoral zones, 78% and 89% respectively, achieved recommended food consumption scores. A separate SMART survey undertaken in Turkana County in 2021, after the outbreak of desert locust, highlighted that nearly 24% of the population encountered inadequate food consumption due to crop destruction caused by desert locust invasions. Notably, sub-counties in Marsabit, specifically North Horr and Laisamis neighbouring Turkana County, exhibited a lower percentage of 21.5%. This survey also delved into the relative Operating Severity Index (rOSI) across various zones, with Marsabit County reporting the highest value of 20% (Gok, 2021).

In view of the widespread infestation of desert locusts, a small but growing number of studies have sought to provide evidence on its impacts. The existing literature has largely focused on estimation of crop losses due to locust damage, which was either based on farmers' estimates, without accounting for confounding factors (Chatterjee, 2022), impacts of desert locusts on crops and vegetation (Sultana *et al.,* 2021), effective mitigation measures in desert locust management (Samejo *et al*., 2021); the influence of climate on the distribution of locusts (Bag & Bhoi, 2020), locusts as an alternative protein source (Peng *et al*., 2020) and how vegetation influences gregarisation (Despland *et al.,* 2000).

The study aims to analyse the effect of desert locust invasions on food security in Loima Sub County, Turkana County, Kenya. The study will also examine whether and to what extent the adoption of control strategies helped to attenuate any observed effect of desert locust invasions. Such information can help policymakers in developing appropriate strategies to mitigate the economic impact of this highly destructive pest.

## 1.2 Statement of the Problem

The Loima Sub-County, located in Turkana County, Kenya, has been facing a severe crisis in recent years due to recurrent desert locust invasions. These invasions have posed significant threats to the agricultural sector, which forms the backbone of the local economy and plays a vital role in ensuring food security for the community. The desert locusts, known for their voracious appetite and ability to devastate crops, have resulted in substantial losses of agricultural produce, leading to increased vulnerability and food insecurity among the population.

Few studies have been conducted locally that particularly address how invasions of desert locusts affect food security in Loima Sub-County, Turkana County, Kenya (Ekesi et al., 2020). Most current studies typically offer a more comprehensive geographical viewpoint. Many of the research that are now available are usually short-term evaluations of the direct effects of locust infestations (World Bank, 2020). Regarding the long-term effects of recurring locust outbreaks on food security and community resilience in Loima Sub-County, there is a gap in the literature.

Although there is a dearth of thorough study on the particular adaptation techniques used by local communities in Loima Sub-County, some studies (UN OCHA, 2020) address coping mechanisms in reaction to invasions by desert locusts. Targeted intervention development requires a thorough understanding of these tactics and their efficacy. Few studies have looked closely at the economic effects of desert locust infestations in the context of Loima Sub-County, including how they affect local markets, livelihoods, and sources of income (FAO,

2020). One significant area of unmet research need is the measurement of the monetary losses suffered by impacted families and communities.

Although the varying effects of locust invasions on various demographic groups are becoming more widely recognized (UN OCHA, 2020), there is still a lack of knowledge regarding the risks and difficulties that women in the Loima Sub-County face because of their gender. Research on local populations' traditional knowledge and methods for managing desert locusts is scarce (Sivanandam & Muralidharan, 2018). Research is required to determine how traditional methods might be used with contemporary therapies. Further investigation is needed into the effects of locust invasions on local and regional food markets, including changes in prices, market accessibility, and trade and food distribution implications.

The ability of regional food and agricultural systems to withstand the combined effects of desert locust invasions and climate change has not received much attention. An expanding field of study looks into how communities can adjust to these two issues. Invasion of desert locusts affects not just crops but also grazing areas and animal welfare (FAO, 2020). There are research gaps in our knowledge of these effects of livestock and how they affect the region's food security.

This study aims to explore the impact of the crisis caused by desert locust invasions on food security in the Loima Sub-County. The degree of crop damage, the loss of cattle feed, the disruption of traditional livelihoods, and the ensuing socioeconomic effects on the local populace are among the crucial elements that need to be looked at.

## 1.3 Justification for the Research Study

The desert locust, widely recognised as a very destructive insect, with the ability to inflict substantial harm upon agricultural crops and pastures in a relatively brief timeframe. The dry climate and low resources of Loima Sub-County, Turkana County, have rendered it particularly susceptible to desert locust infestations in comparison to other sub-counties within the same region. In May 2019, the sub-counties of Loima, Turkana East, Turkana Central, and Turkana West had varying degrees of vegetation damage, ranging from mild to high. The decrease in vegetation seen in the aforementioned sub-counties was hypothesized to be attributed to the presence of desert locust infestations, as documented in these specific regions. The sub-county of Loima saw the most significant level of devastation as a consequence of the desert locust invasion. Nevertheless, the northern regions exhibited substantial levels of vegetative degradation, despite the little historical documentation of desert locust sightings in those areas (Mongare et al., 2023).

Food security is a fundamental concern for the local population. Overall, Turkana County faces chronic food insecurity, exacerbated by factors such as unreliable rainfall patterns, limited access to markets and high levels of poverty. The desert locust invasions are an additional layer of vulnerability that further threatens the availability and access to food for the community. Examining the relationship between desert locusts and food security will help identify the specific challenges faced by the local population and guide interventions to mitigate the crisis.

The research study will contribute to the scientific understanding of the ecological and socio-economic effects of desert locusts on food systems. By investigating the direct and indirect effects of the invasion on crop production, agriculture and livestock rearing, the study will generate valuable data and insights. This knowledge will be used to inform policymaking, resource allocation and preparedness measures at the local, regional and national levels.

The study holds practical implications for disaster management and disaster risk reduction efforts. Turkana County and other regions affected by desert locusts require timely and effective responses to mitigate the damage caused by these pests. By examining the consequences of the desert locust invasion on food security, the research study can inform the development of early warning systems, surveillance strategies among other response mechanisms. This information can aid in building resilient communities and enhancing the adaptive capacity of the affected regions.

This research study is justifiable due to its relevance in addressing the pressing challenges faced by the local population. The findings of the study can contribute to improved understanding, policy formulation and practical interventions to enhance food security and resilience in the face of future desert locust invasions.

## 1.4 Significance of the Study

The study on the desert locust invasions crisis on the food security in Loima Sub-County, Turkana County, holds substantial significance in shedding light on a critical issue with profound implications for both the local community and the broader region. Turkana County, known for its vulnerability to environmental challenges, faces the escalating threat of desert locust invasions, which have the potential to disrupt the delicate balance of food security and livelihoods. This study will seek to comprehend the intricate interplay between desert locust invasions and their cascading effects on food security.

By dissecting the multifaceted dimensions of this crisis, the research will contribute to a deeper understanding of the mechanisms through which locust invasions disrupt agricultural productivity, disrupt traditional livelihood practices and exacerbate existing challenges related to food security.

The study's significance extends to informing policy formulation and decision-making at both local and regional levels. Findings elucidating the specific consequences of desert locust invasions on food security within Loima Sub-County will provide empirical evidence that will guide the development of targeted interventions and strategies. Such insights are crucial for the Turkana County Government, NGOs and other stakeholders to design effective responses that mitigate the effects of locust invasions, protect vulnerable populations, and enhance overall resilience against future crises.

Furthermore, this study will contribute to the broader body of research on environmental degradation and their effects on food security. As desert locust invasions are increasingly linked to climatic fluctuations, the findings from this research can contribute to a better understanding of how changing environmental conditions amplify the vulnerability of certain regions to these threats. This knowledge has implications beyond Loima Sub-County and could potentially inform regional and even global strategies to address the challenge of desert locust outbreaks.

## 1.5 Scope of the Study

The geographical scope of this study was limited to Loima Sub-County, which is located within Turkana County, Kenya. The study covered a period of five years from 2019 to 2023 and was conducted on households of Loima Sub-County. This was because between 2019 and 2023, there was a significant surge in desert locust invasions across various parts of Africa, including Kenya. This period witnessed a high frequency of locust swarms, making it a critical time frame to assess their impact on food security in Loima Sub-County.

## 1.6 Assumptions of the Study

The study assumed that the respondents would give honest answers. It also assumed that the findings of this area of study could be extrapolated to reflect the status of locust infestation in Kenya. The study assumed that the selected sample of households and communities in Loima Sub-County was representative of the broader population and that their experiences could be extrapolated to draw meaningful conclusions. The study assumed a degree of homogeneity in the effect of locust invasions on different households and communities within Loima Sub-County, although variations in susceptibility and vulnerability might have existed. The study assumed that external factors unrelated to locust invasions did not significantly affect food security outcomes during the study period.

## 1.7Limitations of the Study

During the course of this study, the researcher anticipated encountering the challenge of insecurity in parts of Loima Sub-County, Turkana County. The researcher had to explain her mission to the local leaders and request their support before commencing the research in order to gain confidence and acceptability while conducting the research.

During the course of the interviews, it was observed that some respondents exhibited prolonged response times, which could be attributed to a lack of literacy in the specific field of study. In instances of this kind, the researcher undertook the task of translating the questionnaire into the Turkana language. The restrictions associated with questionnaire responses were mitigated via the use of focus group talks. These discussions were primarily conducted in a manner that was linguistically and methodologically conducive to the preferences and needs of the local community members.

# II. LITERATURE REVIEW

## 2.0 Introduction

In this section, the literature significant for the research is reviewed thematically. The chapter also addresses the theoretical and conceptual foundations on which the investigation is founded.

2.1 Empirical Literature Review

### 2.1.1 Effect of Desert Locust Invasion on the Availability and Accessibility of Food Due to Climatic Conditions

Desert locust swarms have a profound impact on agricultural productivity, directly affecting food availability. The desert locusts can consume vast quantities of crops in a short period, leaving fields barren. The Food and Agriculture Organisation (FAO) estimates that a one-kilometre-square locust swarm can consume as much food in one day as 35,000 people, highlighting the sheer magnitude of their destructive potential (FAO, 2020). In East Africa, the 2019-2023 desert locust upsurge resulted in an acute food shortage. Nations like Kenya, Ethiopia and Somalia saw extensive crop damage as locust swarms devoured staple crops such as maize, sorghum,

and millet. This resulted in a drastic reduction in food availability for local communities who rely on these crops as dietary staples (FAO, 2020). Furthermore, locust invasions not only damage standing crops but also disrupt planting seasons. As a result, farmers in affected regions may experience delayed or failed planting, further exacerbating food scarcity (Cressman *et al.,* 2020).

Various studies have endeavoured to unveil the intricate dynamics between climate change, desert locust outbreaks, and their profound implications on the availability and accessibility of food sources. Zhao et al. (2020) have directed their focus toward the transformative impact of land use changes on the prevalence of locust outbreaks in Inner Mongolia in China. Central to their argument is the idea that human activities, including deforestation, urbanisation and alterations in land management practices, exert profound modifications on locust habitats and their sources of sustenance. However, it becomes apparent that a noteworthy gap exists in this line of inquiry. While the influence of climate change on locust swarms is addressed, there is limited empirical investigation into the complementary aspects of food aid assistance, food stock depletion, and income loss as indicators of locust invasions. These facets are intrinsic to understanding the multifaceted ramifications of locust infestations on food availability and accessibility.

Thomas and Nigam (2018) have offered a critical perspective on the potential intensification of extreme weather events, which could stimulate swarm formation in locust outbreak in the Sahel regions. They emphasise the vulnerabilities posed by climate change, including events such as droughts and floods, as catalysts for locust outbreaks. Despite this insightful analysis, there exists an empirical void regarding how these climatic shifts translate into concrete indicators of food scarcity and accessibility, such as food aid assistance provided during and after locust invasions.

Salih *et al.,* (2020) have delved into the intricate nexus between climate change, locust outbreaks and food availability in Ethiopia. Their research cogently argues that shifting climatic patterns, characterised by rising temperatures and altered precipitation, create conducive environments for locust breeding and migration. This, in turn, leads to food scarcity as a direct consequence of locust invasion. Nevertheless, this line of inquiry could benefit from an empirical exploration of how these climatic shifts manifest in terms of food stock depletion within households, as well as the resultant income loss experienced by farming communities. The impact of desert locust swarms on food accessibility merits in-depth scrutiny. As locusts devastate crops, they often drive-up food prices due to a reduced supply, rendering food less accessible to vulnerable populations. Notably, the empirical literature is sparse when it comes to comprehensive assessments of food aid assistance during locust invasions, which plays a pivotal role in ensuring that affected communities have access to essential sustenance. Additionally, the economic consequences of locust invasions, including reduced household income and purchasing power, require more rigorous empirical examination, especially in the context of income loss as an indicator of food accessibility.

Meynard *et al.,* (2020) contend that the convergence of favourable weather, soil conditions, and vegetation health is pivotal for the occurrence of desert locust invasions in East Africa. These confluence of factors sets the stage for locusts to congregate, proliferate exponentially, and embark on extensive migrations, often evolving into devastating plagues that obliterate vast expanses of vegetation and crops. Nevertheless, it is discernible that the empirical literature overlooks certain critical dimensions, particularly the assessment of food aid assistance, food stock depletion, and income loss as tangible indicators of locust invasions exacerbated by climate change. These dimensions merit comprehensive exploration as they form intrinsic components in understanding the multifaceted challenges imposed by locust infestations on food security.

Andrew et al. (2017) accentuates the temperature-dependent nature of locust life cycles, highlighting its pivotal role in dictating the ingress of invasive pests such as desert locusts into new territories. As temperatures evolve due to climate change, the implications for locust invasions necessitate empirical examination, especially in the context of income loss as an indicator of food accessibility. Dingle (2010) sheds light on the migratory patterns of locusts, emphasising their proclivity to move toward regions recently blessed with rainfall, where green foliage abounds for feeding and breeding. The requirement for damp soil for egg incubation further underscores the influence of climate on locust dynamics. However, while this insight is invaluable, there is a noticeable dearth of empirical research addressing how climate-induced shifts directly manifest as food stock depletion within households.

Tratalos *et al.,* (2010) aptly assert that reduced temperatures can significantly affect desert locust migrations, development rates, and survivability. This assertion aligns with the empirical underpinning of climate change-induced locust invasions. Yet, the literature falls short in providing a systematic analysis of how these climatic shifts translate into quantifiable indicators of food scarcity and accessibility, particularly in terms of food aid assistance. Saha *et al.,* (2021) offer a compelling examination of the connection between rainfall patterns and locust outbreaks. Their research underscores how changing rainfall patterns can contribute to the proliferation of locust populations, impacting vegetation growth, breeding habitats, and migration patterns. This information is pivotal, yet there remains a noticeable empirical gap concerning income loss as an indicator of food accessibility in regions afflicted by desert locust invasions.

Kimathi *et al.,* (2020) meticulously scrutinised the diverse environmental and climatic factors that influence the suitability of breeding environments for desert locusts. Their work diligently identified conditions such as soil type, sand content, soil moisture, surface air temperature, rainfall, and vegetation presence as pivotal in shaping these environments. While this research admirably underscores the significance of these factors in the occurrence of desert locusts, it falls short of addressing the empirical dimensions related to food aid assistance and the consequences of locust invasions on household food stocks and income loss.

Salih *et al.,* (2020) conducted an extensive examination of the influence of rising temperatures, altered precipitation patterns, and climate variability on the emergence and proliferation of desert locust swarms. Their research compellingly links these changing climate factors to various aspects of locust behaviour, breeding, and migration, ultimately exacerbating the frequency of outbreaks. However, there is an empirical gap concerning the quantification of food stock depletion and income loss as direct manifestations of locust invasions intensified by climate change, especially in the context of food accessibility.

Chapuis *et al.,* (2020) diverge into a different realm, investigating the subspecific divergence timeline of the desert locust population. Their study explores the temporal aspects of genetic differentiation within the locust population, providing valuable insights into evolutionary dynamics. Yet, it remains critical to bridge this research with concrete empirical examinations of food aid assistance, food stock depletion, and income loss as they relate to locust invasions and climate change. While existing empirical studies admirably shed light on the intricate interactions between climate change, desert locust outbreaks and their implications for food availability and accessibility, there exists a tangible gap in systematically exploring indicators such as food aid assistance, food stock depletion, and income loss. Bridging this gap through rigorous investigations, the current study will seek to analyse the effects of desert locust invasion on food security crisis in Loima Subcounty, Turkana County a more holistic understanding of the multifaceted challenges posed by locust infestations intensified by climate change on food security and nutrition.

## 2.2 Summary of Research Gaps

Existing literature has aptly highlighted the adverse effects of desert locust invasions on crop production and economic losses, there exists a notable gap in research concerning the frequency of meals and dietary patterns as indicators of food security in the aftermath of locust invasions. Additionally, the existing empirical literature has commendably addressed the intricate relationship between climate change, locust outbreaks, and food availability and accessibility. However, it falls short in systematically exploring indicators such as food aid assistance, food stock depletion, and income loss as tangible manifestations of locust invasions resulting from climate change. Lastly, even as the existing empirical literature provides valuable insights into coping strategies related to desert locust invasions, it falls short in addressing key aspects such as food consumption patterns, market access and community support mechanisms. The current study will endeavour to analyse the effects of desert locust invasion on food security crisis in Loima subcounty, Turkana County.

xplains the behaviour of locust swarms during an invasion. Originating from Uvarov's work in the 1930s and subsequently refined by various researchers (Uvarov, 1966), Phase theory categorises the different stages of a locust invasion, including the solitary phase, the gregarious phase and the swarming phase. This theory is especially valuable in describing the distribution of desert locusts in Turkana County between 2019 and 2023, with a focus on the gregarious and swarming phases, which are particularly destructive and cause food insecurity.

The Phase theory also considers the various environmental factors that can trigger a transition between these phases, such as temperature, rainfall, food availability and population density (Uvarov, 1966). The strengths of the Phase theory include its detailed explanation of locust behaviour during different phases, considering factors such as population density, temperature, rainfall and food availability. It is also well-suited to analyse the distribution of locusts during critical phases of an invasion, aligning with the study's objectives. However, it has been critiqued as primarily focusing on ecological and biological factors, often overlooking the socio-economic dimensions of locust invasions. Moreover, it primarily deals with locust behaviour and may not encompass broader systemic influences on food security. It is in this regard that systems theory will be employed to address these weaknesses in the study.

The Systems Theory complements Phase theory by providing a broader perspective on the coping strategies employed by local communities in response to desert locust invasions. Rooted in the work of von Bertalanffy (1959), Systems theory conceptualizes societies as open systems with interconnected parts. It emphasises that various societal components rely on each other for survival and that actions affecting one part can have cascading effects on others. This theory is instrumental in understanding the multifaceted coping mechanisms adopted by communities.

Strengths of Systems theory include its ability to offer a holistic view of how various coping strategies interact within the broader societal context, considering economic, social and environmental factors. It also highlights the interdependencies within a system, allowing for a deeper understanding of the intricacies within dietary diversity, availability and accessibility of food in the aftermath of desert locust invasions.

By anchoring the study on these theories, the research aims to provide a comprehensive understanding of the effects of desert locust invasion on food security crisis, bridging the ecological and societal dimensions of this complex issue. The integration of both theories recognises that desert locust invasions are not isolated events but are deeply intertwined with the ecosystems they affect and the communities they impact. By leveraging the strengths of Phase theory in ecological analysis and Systems theory in socioecological understanding, this study aims to offer practical insights and recommendations.

# III. RESEARCH METHODOLOGY

## 3.0 Introduction

This chapter lays out the research design that will be utilised to carry out the study on the desert locust invasion crisis on food security in Loima Sub-County, Turkana County. It will also cover the study region, target population, sampling strategies, sampling procedures, data collecting instruments, pilot testing of the instruments, reliability and validity, data collection procedures, data analysis and ethical issues for the study.

## 3.1 Research Design

The mixed research designs were used in this study. The researcher offered, observed, and summarised the research elements without affecting anything in mixed research (Creswell, 2013). Mixed research design could be quantitative or qualitative, with quantitative research just telling us what it is rather than determining cause and effect. A mixed research design was used to enlighten the current state of the Locust invasions on the food security situation.

The research design table 3.1 outlined the key elements of a research study, including the specific objectives, measurable variables, and research designs. The purpose of this table was to provide a clear overview of the research design to aid in the planning and execution of the study.

**Table 3. 1: Research Design**

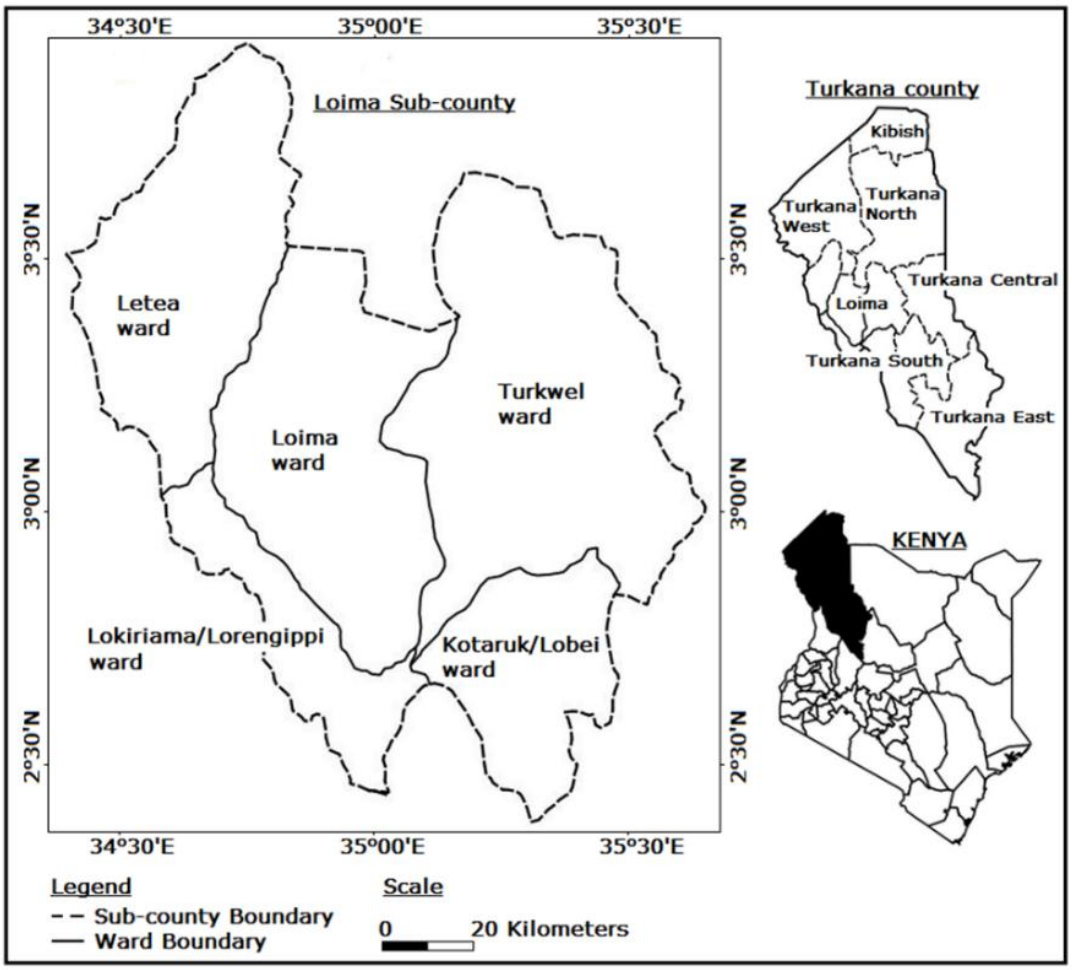
| Specific objectives | Measurable valuables | Research Design |
|---|---|---|
| b) To examine the effect of desert locust invasion on the availability and accessibility of food due to climatic conditions within households in Loima Sub-County, Kenya | • Food stock depletion<br>• Income loss<br>• Crop loss and damage<br>• Food aid and assistance | Mixed method approach(qualitative &quantitative design) |

**Source: Author (2023)**

## 3.2 Study Area

The research was carried out in the Loima Sub-County as shown in Figure 3.1. The Sub-County was chosen on purpose since it was afflicted by desert locust invasions. Loima Sub- County was characterised primarily by high levels of insecurity, locust invasion, underdevelopment, low levels of state presence, and insufficient state protection, therefore exhibiting the ideal features of most pastoral areas in Kenya (Akall, 2021).

**Figure 3. 1 : Map of Loima Sub-County**




**Source: Adapted from QGis (2023)**

## 3.3 Target Population

The target population for the study in Loima Sub County consisted of 19,599 households. This figure was obtained by dividing the overall population of Loima Sub County, which was 107,795, by the average number of individuals per family in Turkana, as reported by the Kenyan census conducted by the Kenya National Bureau of Statistics (KNBS) in 2019.

## 3.4 Sampling Technique

The study employed Slovin's formula, a statistical tool, to rigorously ascertain the appropriate sample size. The formula developed by Slovin was employed to ascertain the optimal sample size for a research investigation in cases where the population size was exceedingly high (Anggita & Ali, 2017). Initially, the researcher determined the number of sub-locations to be included in the study. It was deemed appropriate to select 35 percent of the total 31 sub-locations as representative, as recommended by Mugenda and Mugenda (2020), who suggested utilising a minimum of 30 percent of the available population. Consequently, the inquiry encompassed a total of 11 randomly selected sub-locations.

Slovin's formula was employed to determine the sample size for the households. The equation presented by Alemeda et al. (2010) demonstrated a margin of error of 0.05, which was deemed acceptable according to the formula.

$n = N / [1 + N (e)^{2}]$

Where; n = the sample size

N = the finite population

e = the level of significance (0.05)

1 = unit or a constant

$$n = \frac{N}{1 + N (e) 2}$$

$$n = \frac{19,599}{1 + 19,599\ (0.05)\ 2}$$

n = 399.97

n = 400 households

**Table 3. 2: Sample Size**

| No. | Sub Locations | Population (N) | No. of HH | Sample size (n) |
|---|---|---|---|---|
| 1 | Kotaruk | 4670 | 600 | 25 |
| 2 | Naipa | 3248 | 659 | 28 |
| 3 | Turkwel | 24,396 | 4435 | 50 |
| 4 | Naipekar | 5500 | 917 | 34 |
| 5 | Lorugum | 11,200 | 1867 | 37 |
| 6 | Nadapal | 29,000 | 5272 | 49 |
| 7 | Kawalathe | 4000 | 667 | 36 |
| 8 | Lochor Edome | 4500 | 750 | 38 |
| 9 | Lochor Ekuyen | 4183 | 667 | 26 |
| 10 | Lochor Alomala | 6907 | 1151 | 37 |
| 11 | Lokiriama | 9865 | 1644 | 40 |
| | **Total** | **109,795** | **19,599** | **400** |

**Source: KNBS (2019)**

## 3.5 Sample Procedure

To determine the sample size for the study, a combination of purposive sampling and simple random sampling was used in the sample design. Simple random sampling was used for the first household, and systematic sampling was employed to determine the 10th households that participated in the sub-locations during the research. Purposive sampling was used to select key informants for key informant interviews, who in this instance were the project managers for the NGOs and governmental programs dealing with food security.

The study employed the systematic sampling method in the sub-locations to ascertain the number of households included in the research. The process was carried out methodically, beginning with the mapping of households, followed by assigning them numbers. Subsequently, the heads of households were selected in a systematic manner to complete the questionnaires.

Taherdoost (2016) asserted that a systematic sampling technique resulted in a sample size that was larger and had a lower sampling error. Mertens (2014) supported the use of purposeful sampling and claimed that doing so assisted the researcher in comprehending the true issue at hand while also saving time. According to Doyle et al. (2020), the purposive sampling strategy was considered an essential element for researchers to explore, understand, and gain insights into the topic of study, hence further supporting the assertion.

## 3.6 Research Instruments

This research used questionnaires, key informant interview guides, and observation checklists as data gathering instruments. The questionnaires aligned with Likert's Scale approach, which is widely recognised as an effective method for collecting and analysing data on people's attitudes and opinions. The researcher managed these data gathering tools with the assistance of qualified research assistants. Data from oral interviews, especially during focus group discussions and key informant interviews, were collected through notetaking and tape-recording. Note-taking was also used to collect secondary data.

## 3.7 Pilot Testing of the Research Instruments

The Loima Kalemunyang Sub-Location hosted the pilot study since it had many features like the actual research sites in terms of respondents, projects, and geography. Ten surveys were distributed, and two interviews were conducted. A pilot research sample size was 10% of the planned study sample size, according to Connelly (2008). The goal of the pilot test was to ensure that the responders fully comprehended and could answer the questions. The accuracy and dependability of the data gathering technologies were evaluated using the Cronbach alpha method.

## 3.8 Reliability and Validity of the Research Instruments

The research instruments were evaluated to ensure their validity in properly measuring the target constructs. The three fundamental domains of validity that needed assessment were criterion validity, construct validity, and content validity. This was achieved by the thorough evaluation of research instruments by experts in the respective domains and research supervisors, who provided valuable suggestions for enhancement (Heale &

Twycross, 2015). Topic validity assessed the extent to which the instrument adequately encompassed the specific topic it was intended to measure (Heale and Twycross, 2015).

In their study, Henseler et al. (2015) defined construct validity as the ability of a research instrument to accurately assess the specific attribute it purports to evaluate. This was achieved by assessing if there was a correlation between the variables, using the data collected from the pilot research. Respondent validation, which entailed the examination and critique of the transcribed manuscripts after the pilot test, guaranteed the authenticity of the interview guide.

#### 3.8.1 Reliability of the Research Instruments

The accuracy, consistency, and reproducibility of a test were the foundations for the research instrument's dependability. By calculating a Cronbach alpha value, a reliability coefficient based on the results of the pilot study, the validity of the research tools was confirmed. The Cronbach alpha coefficient was a statistical measure that quantified the internal consistency or reliability of a set of items within a questionnaire or survey. A high Cronbach alpha value indicated strong internal consistency among the items, which suggested that the research instruments were dependable and could yield consistent results (Ledford and Gast, 2018).

### 3.9 Data Collection Procedure

Strict compliance with the necessary protocols for data collecting in Kenya was ensured. The necessary research clearances were acquired from pertinent institutions, including the National Defence University-Kenya (NDU-K) Graduate School, the Kenya National Commission for Science, Technology and Innovation (NACOSTI), and the Turkana County Government. Data collection was conducted with the assistance of research assistants, all of whom were undergraduate students. Prior to commencing data collection, the research assistants received training in several research methodologies. Given that most homes were not proficient in the English language, the research assistants, who were local community members, aided in translating the questionnaire into the local dialect. The respondents were informed of the research goals and that the information they gave would only be used for academic purposes, not to raise money on their behalf.

### 3.10 Data Analysis

The data was analysed using both qualitative and quantitative methods. The Statistical Package for Social Scientists (SPSS) version 28 was used to analyse quantitative data. Focus group discussion and key informant interview data were analysed through coding, transcription, triangulation, and interpretation. The completeness and consistency of all surveys were checked. The collected data from the questionnaires were numerically coded based on the objectives for easy analysis. The analysis was descriptive in nature, with tables, measures of percentage, frequency, central tendency, standard deviation, charts, and graphs used to show the results. Qualitative data was evaluated using qualitative approaches such as connecting dots and forming inferences about the objectives. The Pearson product moment correlation coefficient was used to ascertain the extent of the relationship between the desert locust invasions and the food security situation. Samuel and Okey (2015) asserted that the Pearson product moment correlation coefficient was the optimal method for assessing the linear relationship between two variables.

### 3.11 Ethical Considerations

The ethical principles that govern social science research were rigorously adhered to. The initial stage required acquiring authorisation from National Defence University – Kenya, followed by securing a research permit from the Kenya National Commission for Science, Technology and Innovation (NACOSTI). Additional permissions and authorisations were pursued from the County Government of Turkana, as well as the local administration of Loima Sub-County, which encompassed the chiefs, assistant chiefs, and village elders. Prior to their participation in the research, the respondents were required to provide consent. Additionally, participants received detailed information on the study's objectives and the significance of their contribution in producing unbiased and accurate data. Participants also received information on the study's objective, which was solely for academic purposes and did not include any desire to request funding on behalf of the community. The confidentiality of personal information was strictly maintained, and only those who were 18 years of age or older were eligible to participate in the research. The ethical issues in this study were guided by Rubin and Babbie's (2016) assertion that researchers have a responsibility to uphold the rights, needs, values, and preferences of the participants.

The observation of values such as honesty and cultural sensitivity was undertaken. During the process of data analysis and reporting, it was imperative for the researcher to uphold accuracy in accordance with the prescribed academic standards.

## IV. DATA ANALYSIS, FINDINGS AND DISCUSSIONS

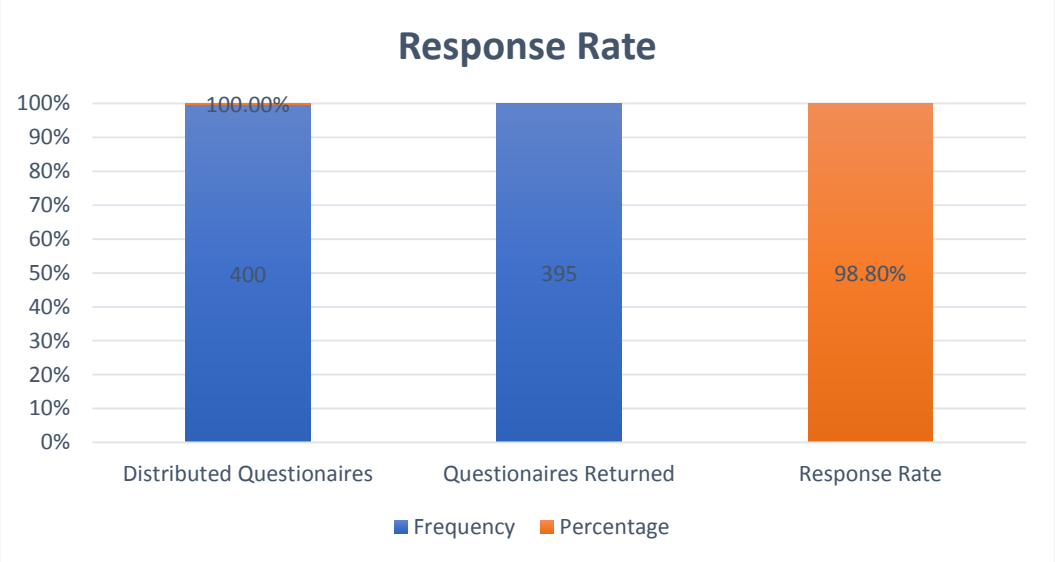
### 4.1 Introduction

The chapter presents the findings of research conducted among 400 respondents from Loima Sub County, which is divided into four sections: response rate, background information of respondents, and descriptive and inferential analysis. The findings are presented thematically and in line to the research questions and the objectives of the study.

### 4.2 Response Rate

The data was collected from residence in Loima Sub County and a total of 400 questionnaires were administered and 395 were received as complete, and therefore, all of them were viable for consideration. This represented 98.8% response rate as shown in table 4.1 below.

**Table 4. 1: Response Rate**




**Source: Researcher (2024)**

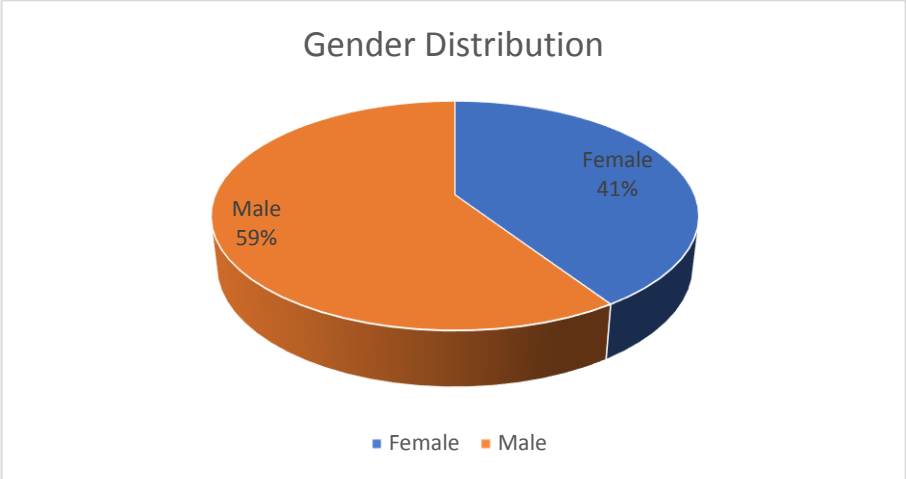
The response rate is deemed highly satisfactory according to the guidelines outlined by Wu et al. (2022). They suggest that a response rate of 50% is sufficient for analysis and reporting, with 60% considered good and over 70% excellent. Sileyew (2019) shares a similar perspective, stating that a response rate exceeding 70% is very good. Therefore, based on these criteria, it can be concluded that the response rate in this study was robust enough to draw conclusions, as a majority of respondents successfully returned their questionnaires.

### 4.3 Demographic Data

#### 4.3.1 Gender Distribution

Figure 4.1 presents demographic data on the gender distribution of respondents in the context of the desert locust invasions crisis affecting food security in Loima Sub-County, Turkana County, Kenya.

**Figure 4. 1: Gender Distribution**



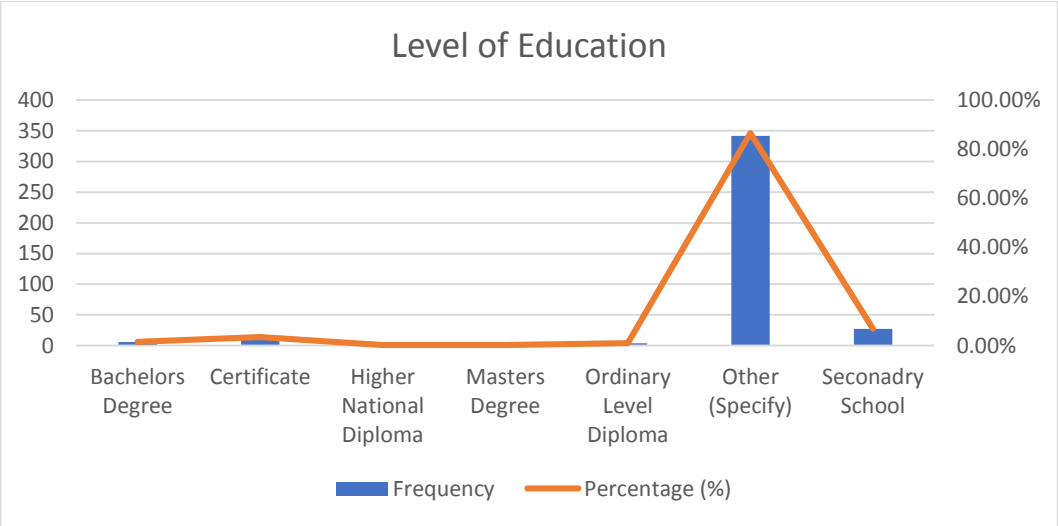

**Source: Researcher (2024)**

The survey was completed by 395 persons, including 234(59.24%) males and 161(40.76%) females. Perhaps this gender imbalance might propose the following possibilities.
The gender imbalance, with 59.24% males and 40.76% females, could be attributed to traditional gender roles in Loima Sub-County, where men are more likely to participate in public activities like interviews and surveys. This reflects cultural norms where men are often the primary decision-makers and representatives of households.

### 4.3.2 Level of Education

Table 4.2 presents data on the level of education among respondents in Loima Sub-County, Turkana County, Kenya, amidst the Desert Locust invasions crisis affecting food security.

**Table 4. 2: Level of education**




**Source: Researcher (2024)**

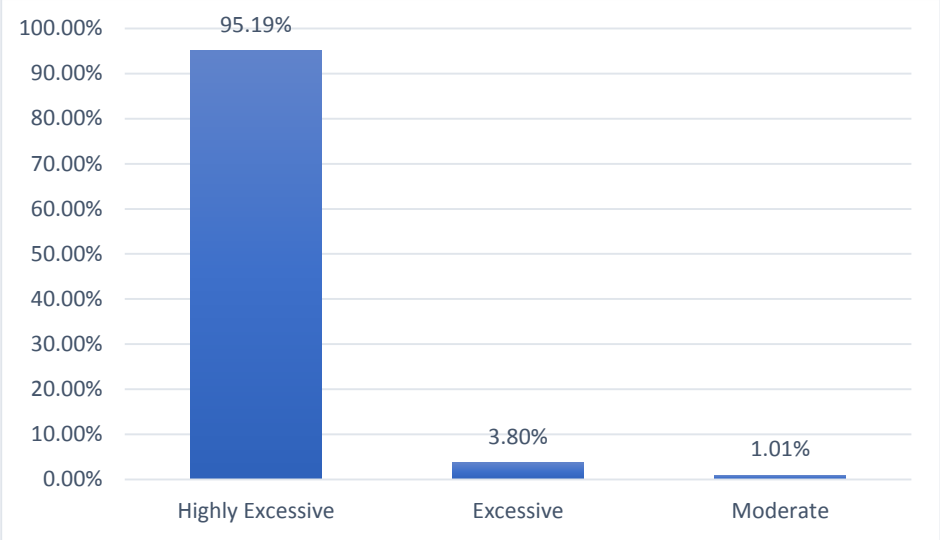
The statistics shows marked educational disparities in Loima Sub-County, Turkana County, Kenya, in which the number of people with formal tertiary qualifications is minuscule (less than 1%) and the majority (92.9%) supply unspecified information on their education backgrounds. Secondary education, which is almost non-existent (7.3%), is a further proof of low educational access.

The research findings suggest a significant knowledge deficit in Loima Sub-County, where formal tertiary qualifications are rare, and secondary education is minimal (7.3%). This educational disparity, driven by poverty, cultural ignorance, and insecurity, hampers efforts to address the desert locust invasion's impact on food security. Insecurity is a key factor that threatens education.

The findings concur with research by He and Lam (2024), who revealed that educational disparities exacerbate vulnerability to environmental shocks such as desert locust invasions. Their study in Turkana County, Kenya, demonstrated that limited access to formal education impedes communities' capacity to respond effectively to such crises, thereby compromising food security.

## 4.4 Descriptive Analysis

Descriptive analysis entails employing statistical techniques to portray the characteristics of the population under examination. Within this section, you will find the compiled responses to each variable's items along with the corresponding means and standard deviations. Story and Tait (2019) emphasised the significance of descriptive statistics, highlighting their usefulness in interpreting and analysing data effectively. The data is displayed through tables and percentages, facilitating a clearer understanding of the dataset.



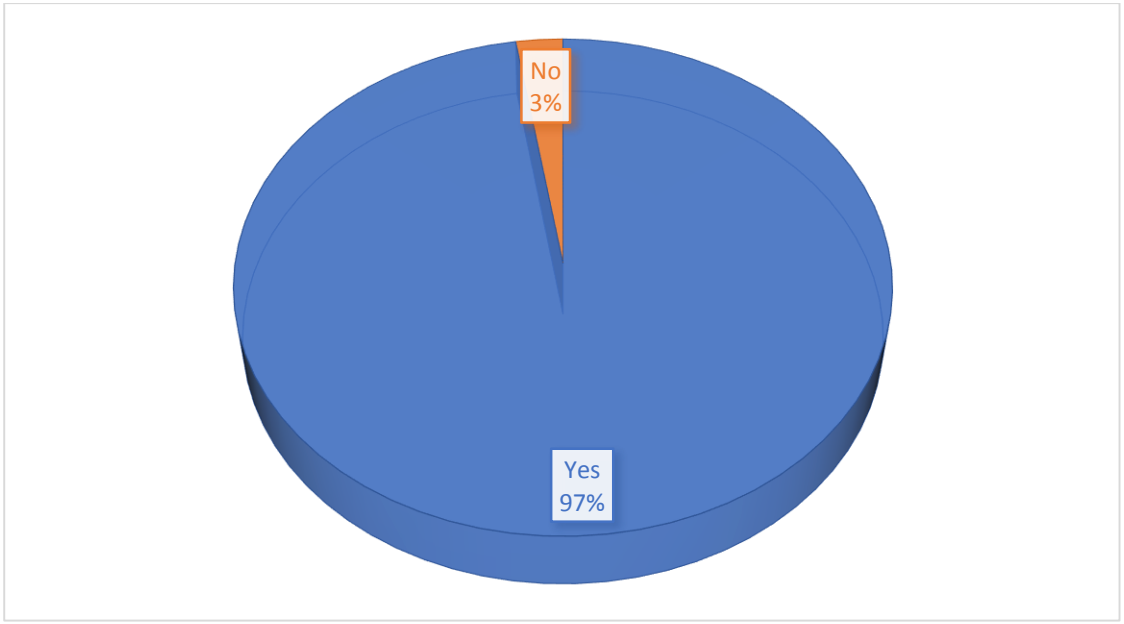

**Source: Researcher (2024) Table 4.2**

The study's results, shown in Table 4.2, emphasise the significant impact of desert locust invasions on the surveyed population. A vast majority, 95.19% of respondents, viewed the severity of these invasions as "extremely high," while only 3.80% perceived them as "high," and a mere 1.01% as "moderate." This widespread agreement highlights the severe consequences of locust infiltrations, consistent with scholarly findings such as Meynard et al. (2020), which links the increase in locust populations to favourable climatic conditions. The prevalence of respondents describing the invasions as "highly excessive" indicates extensive and disproportionate destruction of crops and vegetation within Loima Sub-County.

**Impact of Desert Locust Invasions on Food Availability in Loima Sub-County**

Table 4.3 presents the responses regarding whether desert locust invasions have led to noticeable decreases in food resources availability within the community.

**Table 4. 3: Impact of Desert Locust Invasions on Food Availability**




**Source: Researcher (2024)**

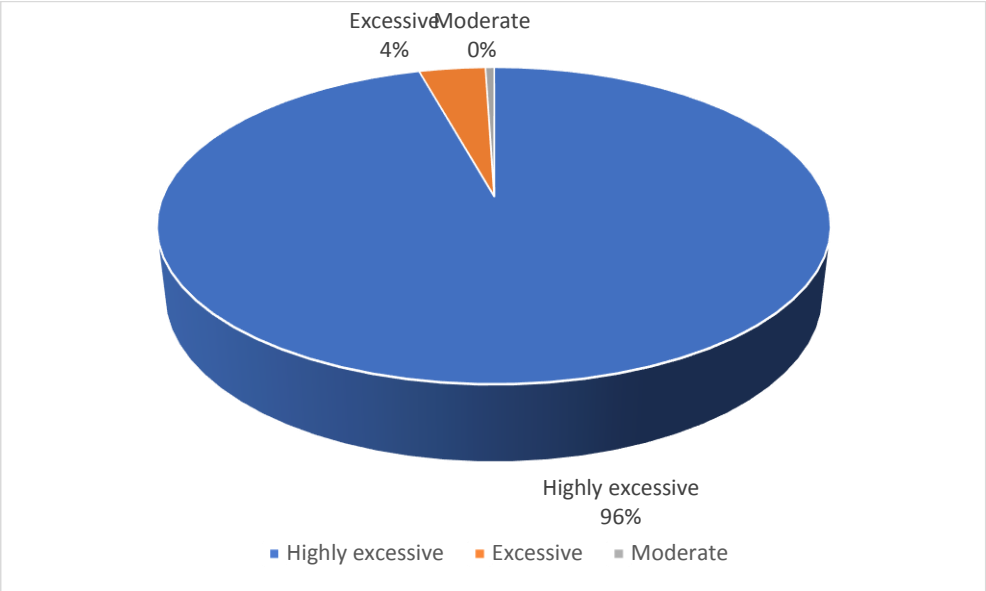
According to the study, most respondents, a whopping 97.47%, noticed a significant drop in food availability, while only 2.53% did not notice any change. This highlights how much desert locust invasions affect communities, especially those already struggling. It is consistent with past research, like Brader et al. (2006),

which linked locusts to food shortages by showing how they harm farming and food production. This strengthens the current findings by showing the real impact of locusts on food security.

**Impact of Desert Locust Invasions on Local Food Availability in Loima Sub-County**

Table 4.4 illustrates respondents' perceptions of the severity of desert locust invasions on local food availability, encompassing both crops and livestock.

**Table 4. 4: Impact of Desert Locust Invasions on Local Food Availability**




**Source: Researcher (2024)**

As illustrated in Table 4.4, a significant majority, comprising 95.70% of respondents, rated the impact as "highly excessive," signifying a profound and widespread disruption to food supplies. This aligns with studies like the thorough analysis by Riaz et al. (2024), which showed the wide-ranging effects of locust infestations on farming and people's lives. The few instances of "excessive" and "moderate" ratings underscore how serious the situation is, emphasising the need for effective interventions to protect food security in the community

**Pre-Invasion Food Stock Assessment**

Before the desert locust invasion 2019 and 2020, respondents were asked to assess the overall level of food stock in their households.

The respondents revealed that before the desert locust invasion, their households commonly had sufficient food stock, primarily sourced from successful harvests and agricultural activities. This abundance ensured food security and stability within communities. However, the invasion directly impacted agricultural yields, leading to diminished reserves and heightened vulnerability to food insecurity.

Specifically, certain crops such as maize, sorghum, and beans, along with vegetables like cowpeas, "local term *kunde*," and tomatoes, were disproportionately affected by the invasion, resulting in the destruction of these staple foods and exacerbating shortages.

In response to reduced food stock, households adapted their dietary patterns, shifting from three meals a day to one or two meals, reflecting the scarcity of resources and the need to ration available supplies.

Additionally, households diversified their income sources through activities such as selling vegetables, livestock, or handmade products to supplement food reserves and support livelihoods. Despite challenges, many households remained heavily dependent on agriculture for food security, but the invasion disrupted agricultural production, leading to diminished yields and heightened vulnerability to food shortages.

Furthermore, the invasion contributed to increased food prices in local markets, further exacerbating food insecurity and posing affordability challenges for households. Despite adversity, households demonstrated resilience by employing coping strategies such as prudent resource management, income diversification, and reliance on alternative food sources.

Community networks played a crucial role in supporting affected households, with merry-go-round groups, local self-help groups known as "chamas" in Kiswahili chamas, and organisations providing financial

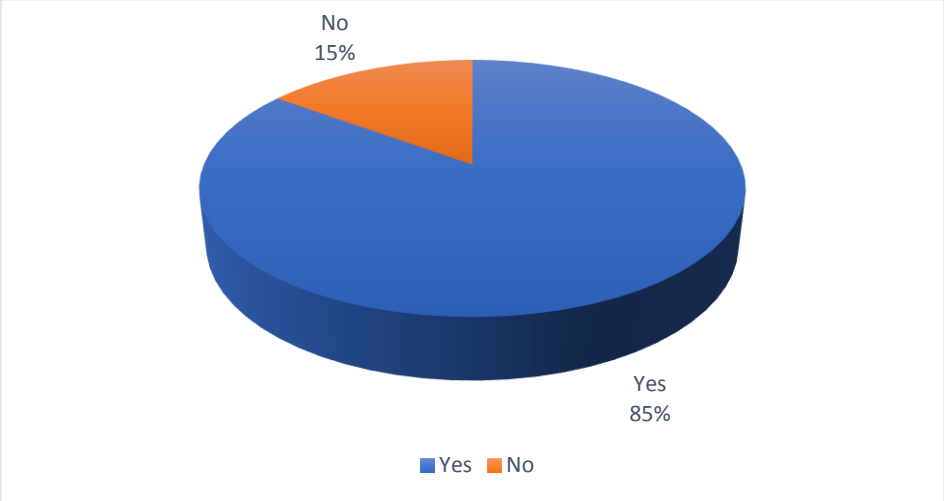
assistance and solidarity to help alleviate food insecurity during challenging times. However, there remains concern about the invasion's long-term impact on food security and livelihood sustainability, with recognition of the need for sustainable solutions to rebuild food reserves and enhance resilience.

Climatic conditions, economic disruptions, reduced food stock implications for household health and nutrition, and the invasion's environmental impact further compound food security challenges. Therefore, addressing these challenges requires comprehensive policy interventions at local, national, and regional levels to build sustainable food systems resilient to future shocks.

**Impact of Desert Locust Invasions on Household Income**

Table 4.6 delves into the repercussions of desert locust invasions on household income, with respondents asked whether they experienced financial losses as a result.

**Table 4. 5: Impact of Desert Locust Invasions on Household Income**




**Source: Researcher (2024)**

Majority of the respondents 85.19% affirmed such losses, indicating a significant economic toll on affected households. This aligns with research by Zembe (2017), which highlights the direct correlation between locust outbreaks and income reduction, particularly in agricultural-dependent communities. The high percentage of affirmative responses underscores the widespread economic ramifications of locust invasions, emphasising the need for targeted interventions to support affected households and mitigate the long-term consequences on livelihoods.

Delving deeper into the repercussions of the invasion, respondents elucidated how the upheaval extended to the very functioning of local markets. Market closures became a common occurrence as a consequence of diminished supplies from small-scale farmers and the loss of livestock, causing disruptions in the supply chain. These disruptions not only impeded access to essential goods but also created an atmosphere of uncertainty and financial strain among market participants. The invasion exacted a heavy toll on households' livelihoods, as revealed by the respondents.

Livestock losses and the destruction of crops dealt severe blows to income streams, forcing some households to shutter their businesses due to the unpredictable fluctuations in prices resulting from the invasion. This compounded existing financial challenges, exacerbating the struggle to secure necessities.

Respondents articulated a prevailing apprehension regarding the safety of food items available in local markets in the aftermath of the invasion. The presence of locusts engendered fears of contamination, dissuading individuals from engaging in market activities and exacerbating the challenges of procuring food. This heightened concern over food safety reflected a shift in consumer behaviour and further hindered market access for affected households.

In response to the scarcity plaguing local markets, the respondents disclosed an increased reliance on external markets to fulfil their dietary needs. The inadequacy of local supplies necessitated sourcing food from distant markets, underscoring vulnerabilities in the resilience of local food systems. This heightened dependency underscored the imperative for households to diversify their sourcing strategies to ensure food security amidst crises like the desert locust invasion.

The invasion precipitated significant disruptions in the dynamics of local markets, particularly impacting businesses dealing in perishable goods such as vegetables. Respondents recounted financial constraints hindering their ability to procure essential

**4.5 Inferential Statistics**

4.5.1 Correlation Analysis

Pearson's product-moment correlation coefficients were used to test for linearity in the relationships between the variables.

**4.5.2 Pearson Correlation Coefficient Matrix**

The research employed the variables (Extent and severity of desert locust invasions, Food availability and accessibility, Coping Strategies, and Food Security) to perform Correlation analysis. Karl Pearson's coefficient of correlation was utilised in the analysis to gauge the strength of relationship between the variables. The Pearson Correlation test was conducted at 95% and 99 confidence levels, as depicted in Table 4.10 provided herein.

**Table 4. 6: Pearson Correlation Coefficient Matrix**

| | | ESDLI | FAA | CS | FS |
|---|---|---|---|---|---|
| **ESDLI** | R | 1 | | | |
| | Sig. (2-tailed) | | | | |
| | N | 395 | | | |
| **FAA** | R | .675** | 1 | | |
| | Sig. (2-tailed) | .000 | | | |
| | N | 395 | 395 | | |
| **CS** | R | .821** | .496** | 1 | |
| | Sig. (2-tailed) | .000 | .000 | | |
| | N | 395 | 395 | 395 | |
| **FS** | R | .793** | .469** | .611** | 1 |
| | Sig. (2-tailed) | .001 | .000 | .000 | |
| | N | 395 | 395 | 395 | 395 |

*****. Correlation is significant at the 0.01 level (2-tailed).***

***Key: ESDLI: Extent and severity of desert locust invasions, FAA: Food availability and accessibility, CS: Coping Strategies, and FS: Food Security***

***Source: Researcher (2024)***

The study revealed a positive and significant association between independent factors (Extent and severity of desert locust invasions, Food availability and accessibility, Coping Strategies) and the food security in Loima Sub-County, Turkana, Kenya. This reveals that any positive change in Extent and severity of desert locust invasions, Food availability and accessibility, Coping Strategies lead to the food security in Loima Sub-County, Turkana, Kenya.

Moreover, the analysis revealed a significant positive correlation between the Extent and severity of desert locust invasions and food security in Loima Sub-County, Turkana, Kenya ($r = 0.675$, $p < 0.001$). This finding underscores that heightened levels of locust invasions coincide with enhanced food security within the area.

Additionally, the study emphasised the pivotal role of Food availability and accessibility in maintaining food security in Loima Sub-County, Turkana, Kenya.

The results demonstrated a strong positive association between Food availability and accessibility and food security ($r = 0.821$, $p < 0.001$), underscoring the significance of ensuring ample food supplies and easy access to sustenance in sustaining food security.

Furthermore, the research affirmed the importance of Coping Strategies in bolstering food security in the region. The findings revealed a significant positive association between Coping Strategies and food security ($r = 0.793$, $p < 0.001$), highlighting the effectiveness of adaptive measures in enhancing food security outcomes in Loima Sub-County, Turkana, Kenya. Generally, the study outcomes concur with Ritzema et al. (2019) who in their study indicated that diversified agroecosystems, which incorporate a variety of crops, livestock, and ecological management practices, have several advantages over monoculture systems in terms of food security.

**Regression Analysis**

The study aimed at finding out the overall influence of the independent variables that is Extent and severity of desert locust invasions, Food availability and accessibility, Coping Strategies on food security in Loima Sub-County, Turkana County, Kenya. The model $Y = \beta_0 + \beta_1 X_i + \beta_2 X_{2+} \beta_3 X_3 + \varepsilon$ explained 74.26% of the variations in food security in Loima Sub-County, Turkana County, Kenya as shown in Table 4.11. This showed that Extent and severity of desert locust invasions, Food availability and accessibility, Coping Strategies, and Food Security

explained 74.26% of the variation in food security in Loima Sub-County, Turkana County, Kenya. This is an implication that the remaining 25.74% of the variation in could be accounted for by other factors not involved in this study.

**Table 4.7: Model Summary**

| Model | r | r Square | Adjusted r Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .8255 | 0.7743 | 0.7426 | 0.1358 |

**a. predictors: ESDLI: Extent and severity of desert locust invasions, FAA: Food availability and accessibility, CS: Coping Strategies.**

The analysis of variance (ANOVA) results in Table 4.12 demonstrates a significant relationship between the predictor variable (model) and the outcome variable. The regression model accounts for a substantial portion of the variance in the data, as evidenced by the large F-statistic (12.928) and the associated p-value ($p < .001$). This indicates that the regression model is statistically significant in explaining the variability in the outcome variable, suggesting a meaningful association between the predictor and outcome variables.

**Table 4.8: Analysis of Variance (ANOVA)**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 4110.751 | 1 | 10.753 | 12.928 | .000[b] |
| | Residual | 3165.518 | 393 | .832 | | |
| | Total | 7276.269 | 394 | | | |

**Source: Researcher (2024)**

**Determination of Regression Co-efficient**

The findings provide valuable insights into the relationship between the extent and severity of desert locust invasions, food availability and accessibility, coping strategies, and food security in Loima Sub-County, Turkana County, Kenya. The regression analysis reveals a positive relationship between these variables and food security as shown in Table 4.13.

**Table 4. 9: Regression Analysis Results**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | | |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | T | Sig. |
| 1 | (Constant) | 1.198 | 3.851 | | 6.032 | .000 |
| | Extent And Severity of Desert Locust Invasions | 0.552 | 0.136 | 0.366 | 3.862 | .000 |
| | Food Availability and Accessibility | 0.427 | 0.107 | 0.321 | 3.261 | .000 |
| | Coping Strategies | 0.441 | 0.123 | 0.341 | 2.172 | .000 |

**a. Dependent Variable: Food Security and Food Security in Loima Sub-County, Turkana County, Kenya**

**Source: Researcher (2024)**

Using the table's unstandardised beta coefficients, the overall equation was obtained as proposed by the framework. When these beta coefficients are substituted in the equation, the model becomes:

$Y = 1.198 + 0.552X_1 + 0.427\ X_2 + 0.441X_3$ where

The regression coefficients reveal the magnitude and direction of these effects. Holding all other factors constant, the intercept (constant) in the model is 1.198, indicating the baseline level of food security in the absence of any influencing factors.

Among the independent variables, the Extent and severity of desert locust invasions (ESDLI) has the least impact on food security, with a coefficient of 0.552. This suggests that a one-unit increase in ESDLI leads to a slight increase of 0.552 units in food security.

Additionally, food availability and accessibility also significantly influence food security, with a coefficient of 0.427. This indicates that improvements in food availability and accessibility result in a notable enhancement of 0.427 units in food security.

Similarly, Coping Strategies (CS) demonstrates the greatest impact on food security, with a coefficient of 0.441. This implies that a one-unit change in Coping Strategies leads to a substantial increase of 0.441 units in food security.

The findings highlight the importance of addressing food availability, accessibility, and Coping Strategies in enhancing food security in Loima Sub-County, Turkana County, Kenya, with Coping Strategies demonstrating the strongest influence on food security outcomes.

# V. SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

## 5.1 Introduction

This study aimed to examine the impact of desert locust invasions on food security in Loima Sub-County, Turkana County, Kenya. This chapter provides a summary of the study, outlining the specific objectives and hypotheses. Additionally, it presents the conclusions drawn from the findings, along with recommendations and suggestions for further research.

## 5.2 Summary of Major Findings

### 5.2.1 Food Accessibility and Availability

The research indicated that desert locust invasions had a significant impact on the availability and accessibility of food among households in Loima Sub-County, Turkana County, Kenya. Prior to the invasion in 2019 and 2020, families had an adequate supply of food. However, the crisis caused extensive damage to crops, especially important staples like maize and sorghum. As a consequence, food reserves decreased and the risk of food insecurity increased. As a result, families have to adjust their eating habits and utilize tactics like increasing their sources of income to lessen the effect. Although communities shown resilience, the invasion resulted in substantial economic losses, as reported by 85.19% of respondents. Furthermore, a significant 80.25% of individuals encountered a total loss of crops, emphasizing the immediate need for intervention strategies. Although the help supplied by many organizations provides immediate assistance to impacted families, it is essential to implement long-term initiatives to strengthen resilience, address underlying vulnerabilities, and assure continuous food security. The research emphasized the pivotal role of community networks and government help in easing access to food supplies and providing support to impacted people throughout the crisis.

## 5. 3Conclusion

The study determined that desert locust infestations had caused extensive and severe damage, greatly undermining food security in Loima Sub-County, Turkana, Kenya. The survey revealed that a large majority of participants reported significant levels of crop and vegetation destruction, leading to a significant decrease in food availability. These findings highlight the immediate need for well-coordinated and strong interventions to effectively reduce the severity of the crisis. The responses emphasized the significant disruption caused by the invasion, stressing the severity of its effect on local food supplies. Furthermore, the susceptibility of crops and agricultural techniques to locust infestations was well recognized, underscoring the urgent need for customized measures to reduce agricultural losses. While local authorities and communities made some steps to mitigate the situation, the assessment of government and NGO response was varied, with most people ranking it as moderate. Therefore, the research determined that immediate and efficient actions are necessary to tackle the substantial difficulties caused by desert locust invasions on food security in the area.

The research also indicated that desert locust infestations have significantly affected the capacity of families in Loima Sub-County, Turkana County, Kenya to acquire and get food. Prior to the invasion, families had an ample supply of food supplies, mostly obtained from staple crops that were collected during good seasons. Nevertheless, the crisis caused extensive damage to crops, especially essential ones like maize and sorghum, leading to reduced stockpiles and increased susceptibility to food shortages. As a result, families were forced to adjust their eating habits and utilize tactics like increasing their sources of income to lessen the effect. Although communities showed resilience, the invasion resulted in substantial economic losses, as reported by a vast majority of respondents. Moreover, the profound encounter with total crop failure emphasized the pressing need for intervention methods. While the help supplied by different organizations provides immediate assistance to impacted families, the research determined that long-term initiatives to develop resilience are needed to address underlying vulnerabilities and assure ongoing food security. The research highlighted the vital importance of both community networks and government help in enabling access to food assistance and providing support to impacted populations throughout the crisis.

Ultimately, the research determined that the desert locust invasion had a significant influence on both food security and livelihoods in Loima Sub-County, Turkana County, Kenya. Prior to the invasion, families had ample food stockpiles, mostly obtained from staple crops gathered during fortunate seasons. Nevertheless, the invasion resulted in a rapid exhaustion of these stores, resulting in notable changes in food consumption habits.

The majority of participants saw significant alterations in their eating patterns, with a considerable number reporting a total absence of plant-based foods. Households used coping tactics such as obtaining loans, cutting down on unnecessary spending, liquidating assets, and expanding their sources of income. In addition, the invasion had a significant impact on local markets, leading to shortages, price increases, and closures, exacerbating

the problem of food poverty. Households saw difficulties in obtaining safe and reasonably priced food, leading to a greater dependence on external markets. The issues were further exacerbated by transportation restrictions. Local community groups played a vital role in giving help to impacted homes, even in the face of challenges. However, there were observed deficiencies in inclusion and accessibility. Hence, the research determined that it is necessary to make collaborative endeavours to tackle the complex difficulties caused by desert locust invasions on food security and livelihoods. This highlights the need of using flexible techniques and community support systems to enhance resilience against future disruptions.

The study has uncovered the profound ramifications of the recent desert locust incursions on the state of food security in Loima Sub-County, located in Turkana County, Kenya. The data indicate that the locust swarms have caused extensive damage to crops, pastures, and other plants, resulting in significant food shortages, animal fatalities, and economic difficulties for the local populations. The current crisis has beyond the ability of municipal and county-level authorities to respond effectively, revealing deficiencies in the present disaster management system.

The magnitude and severity of the locust infestations have worsened the existing vulnerabilities of the area, including poverty, inadequate infrastructure, and the consequences of climate change. The current scenario emphasized the imperative need for the National Disaster Management Authority (NDMA) to enhance its readiness and ability to respond, while also incorporating locust control into its wider policies for reducing catastrophe risks. To effectively tackle the lasting consequences of desert locust invasions on food security, a holistic strategy is needed that integrates prompt relief measures with enduring, community-driven programs to enhance resilience.

## 5.4 Recommendations

The study's findings and conclusions propose several measures to alleviate desert locust infestations and enhance food security in Loima Sub-County, Turkana County, Kenya. Establishing dedicated Desert Locust Control Research Centres in strategic locations like as Turkana University, Garissa, Isiolo, and Marsabit is vital. These facilities should prioritize the development of effective control methods, research on the behaviour and reproductive patterns of locusts, and the creation of innovative, sustainable pest management measures. Additionally, they should serve as hubs for training local farmers and extension workers on the latest techniques and advancements in pest control. Furthermore, it is essential to enhance the early warning system.

By using dependable systems that integrate ground observation, satellite imagery, and predictive modelling, prompt alerts may be created, enabling the swift implementation of control measures and minimizing crop damage. The implementation of community-based monitoring and reporting systems will facilitate the exchange of real-time information and prompt response actions. Providing education to local community members on locust monitoring and reporting may enhance the efficiency and accuracy of data collection, leading to the timely and effective implementation of control measures.

In order to facilitate economic recovery, it is essential to establish comprehensive assistance initiatives for households affected by locust infestations. These programs should include financial assistance, instruction in sustainable farming techniques, and provision of agricultural supplies such as fertilizer and seeds. In order to provide equitable access to these resources and support services, it is important to prioritize disadvantaged groups, such as families led by women and small-scale farmers. It is recommended to promote other methods of obtaining food in order to reduce dependence on agriculture and mitigate the impact of crop failures. Households have the potential to create additional sources of income by engaging in activities such as microenterprise development and non-farm income-generating activities. Investments in infrastructure, such as storage facilities and irrigation systems, are necessary to enhance agricultural productivity and safeguard against fluctuations in food supply.

To strengthen the ability of local communities to withstand and respond to desert locust invasions, it is essential to establish effective collaboration between government agencies, non-governmental organizations, and community organizations, with a focus on supporting community-led initiatives. Enhancing the effectiveness of these activities will encourage joint efforts, skill development, and sharing of information.

Promoting community ownership of response efforts and using traditional knowledge and approaches may improve the effectiveness and long-term sustainability of interventions. Promoting social cohesion and fostering networks of solidarity may strengthen mutual support and bolster communities' resilience in the face of adversity.

Further study is required on the enduring socioeconomic impacts of the crisis on households, the effectiveness of government interventions, strategies for enhancing community resilience, and the ecological consequences of locust infestations.

In order to bolster resistance against desert locust incursions and guarantee food security in Loima Sub-County, Turkana County, Kenya, it is imperative to tackle the issues of water security and accessibility. Implementing comprehensive water resource management strategies, which include the construction of water harvesting infrastructure and the use of enhanced irrigation methods, would guarantee a consistent supply of water

for both agricultural and domestic purposes. By advocating for climate-smart agricultural techniques, such as drip irrigation and drought-resistant crops, in conjunction with improvements in water infrastructure, we can enhance the efficiency and dependability of water use. Enhancing the involvement of local people in the adoption of sustainable water use practices and reinforcing policies via cooperation among government agencies, non-governmental organizations (NGOs), and international partners will greatly improve water security. These combined initiatives will enhance the region's ability to manage desert locust incursions and guarantee long-term food security.

To effectively address these challenges, it is also essential for various stakeholders, including the National Disaster Management Authority (NDMA), local governments, agricultural bodies, and international partners, to collaborate on a holistic approach. This should encompass anticipatory action and the integration of early warning systems (EWS) to bolster readiness and response capabilities. Key measures include improving food security and community resilience, incorporating locust management into broader disaster risk reduction strategies, and fostering the sharing of research and knowledge. Enhancing coordination and investment in control measures, delivering timely food assistance and livelihood support, advocating for climate-smart agricultural practices, and facilitating the exchange of best practices with regional and international collaborators are crucial steps. By following these recommendations, stakeholders will strengthen the resilience of Loima Sub-County and other vulnerable areas in Kenya against the devastating impacts of desert locust invasions, ensuring long-term food security and sustainable development.

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