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To Assess The Extent And Severity Of Desert Locust Invasions On Food Security In Loima Sub-County, Turkana, Kenya.

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Abstract
The purpose of this study was to assess the extent and severity of desert locust invasion on food security,the study aimed to assess the overall impact of these invasions on food security in the area. The specific research objectives were: to evaluate the extent and severity of desert locust invasions on food security; to examine the effect on food availability and accessibility due to climatic conditions; and to assess the coping strategies adopted by local communities in response to the invasions. 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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I. Introduction

This section contains the background of the study, the statement of the problem, the research objectives and research questions. Additionally, it contains the significance of the study as well as the scope and limitations**.**

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.

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.

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.

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.

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.

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.

Limitations 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

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.

Empirical Literature Review

Extent and Severity of Desert Locust Invasions

The global phenomenon of desert locust invasions has been a recurring agricultural and environmental concern in arid and semi-arid regions for centuries. These voracious insects, when forming swarms of biblical proportions, can decimate crops, devastate vegetation and disrupt the delicate balance of ecosystems. Among the many regions that have been susceptible to these devastating invasions, Turkana County in Kenya, and more specifically, Loima Sub-County, has not been spared the impacts of these marauding pests.

Sultana *et al.,* (2021) centred on the desert locust upsurge that occurred in Pakistan between 2019 and 2020, with a specific emphasis on its consequential effects. The research offered valuable observations on the magnitude and intensity of the desert locust increase in Pakistan during 2019 and 2020, emphasizing the difficulties it presented. Additionally, the investigation explored the measures used by both government and communities to address the locust infestation and safeguard food security. The research conducted in Pakistan primarily examined the desert locust increase that occurred over the period of 2019-2020 and its associated consequences. In contrast, the next study to be conducted in Loima Sub County, Kenya, would specifically concentrate on the time frame spanning from 2019 to 2023.

Shao *et al.,* (2021) examined how to monitor and forecast the severity of desert locust plagues in Asia and Africa using multisource remote sensing time-series data. The investigation demonstrated how well remote sensing tools work to track outbreaks of desert locust. For early warning systems and reaction plans, it underlined the need of timely and accurate data. Even if the research provides insightful information, a study conducted in Loima Sub County will modify its conclusions to fit the regional setting.

Ghaffar *et al.,* (2015) explored the role of climate change in influencing the severity and frequency of desert locust outbreaks in Pakistan. They argued that changing climate patterns could exacerbate the problem, emphasizing the need for adaptive strategies in agriculture to maintain food security. The study above narrowed itself to climate change in influencing the severity and frequency of locust outbreak in Pakistan whereas the current study is Extent and severity of desert locust invasions on food security crisis in Loima sub county, Turkana County.

Bhat *et al.,* (2003) highlighted the historical incidence of invasions by desert locusts. They contended that these incursions have posed a persistent risk to India's food security, resulting in significant crop losses over time. Because of the geographical context and environmental factors, the arguments and emphasis vary. With regard to the crops cultivated and how vulnerable they are to locust damage; the research aims to highlight the unique agricultural practices in Loima Sub-County. The significance of resilient agricultural methods and crop diversity will be investigated in this research.

Ceccato *et al.,* (2007) carried out research that examined the 2003–2005 spike in desert locust populations in West Africa. The efficiency of the Desert Locust Early Warning System and the possibility of using seasonal climate forecasting to lessen the influence of desert locusts on local food security were the main concerns of this research. The aforementioned study aims to take into account the particular local context, community-based strategies, resource constraints, and a comparative analysis to address the challenges in this region, even though the West Africa study offers a useful model for addressing desert locust upsurges and food security.

Pandey *et al.,* (2021) examined possible management approaches to lessen the effect on food security and was centred on the invasion of desert locusts in Nepal. The research emphasized the potential for major crop destruction and its effects on Nepal's food security, as well as the localized effects of desert locust incursions. While the research conducted in Nepal provides valuable insights into the management of locusts, a study in Loima Sub County will use these insights while tailoring them to the unique requirements and circumstances of the Kenyan location. Analysing in comparison to the Nepal research will provide insightful information.

Alemu *et al.,* (2022) main goal was to distinguish between agriculture damage in Ethiopia due to drought and that caused by desert locusts utilising multi-source remote sensing. The study stressed how critical it is to use remote sensing technology to differentiate farmland consequences of drought from those of desert locust damage. The ability to differentiate is essential for focused reactions. Although the Ethiopian study provides insightful information about the application of remote sensing, a study conducted in Loima Sub County will be different since it will not concentrate on remote sensing.

Nguyen (2021) focused on the Republic of Niger and examined the repercussions of desert locust infestations on the well-being of children. He emphasised the possible health implications associated with desert locust infestations, particularly in relation to susceptible demographics such as children. The study emphasised the correlation between food insecurity caused by locust infestations and the occurrence of child malnutrition and associated health problems. The significance of food security in relation to child health was further underscored. The argument posits that the incursions of desert locusts have the potential to disrupt the accessibility of nourishing sustenance, hence resulting in adverse health consequences for children. The research conducted in the Republic of Niger offers valuable insights into the correlation between desert locust infestations and child health. However, in order to comprehensively address this issue, it is crucial for future studies to take into account the distinct local context, dietary patterns, child health practices, community involvement, resource limitations and conduct a comparative analysis. By doing so, strategies can be tailored to meet the specific needs of this particular region.

Brader *et al*., (2006) examined the phenomenon of desert locust invasions and its consequences on food security, livelihoods, and poverty. They emphasised the immediate consequences of desert locust infestations on both food security and the socioeconomic well-being of communities residing in the afflicted areas. The aforementioned situation highlighted the possibility of experiencing crop failures and a decrease in income. The study established a correlation between the management of desert locusts and wider initiatives aimed at reducing poverty. It is contended that the proficient control of locusts has the potential to help to the alleviation of poverty by safeguarding crops and sources of income. Although the study provides interesting insights, it is important to note that a study conducted in Loima Sub-County will tailor its findings to the specific characteristics and circumstances of the local setting. A comparative analysis conducted in conjunction with the study will yield valuable insights regarding the efficacy of various tactics implemented in disparate geographical areas.

Showler *et al.,* (2021) focused on early intervention techniques targeting desert locusts and examined the viability of sustainable measures for preventing outbreaks. They underscored the need of proactive strategies in averting and alleviating desert locust infestations. The study examined the importance of early monitoring, surveillance, and prompt response in order to mitigate the scope of incursions. The study took into account the regional environment and recognised the necessity of fostering collaboration among the countries involved. The aforementioned observation underscored the importance of collaborative endeavours in effectively mitigating desert locust infestations.

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.

Theoretical Framework

The theoretical framework of this study draws upon two prominent theories, the Phase theory and the Systems theory, to provide a comprehensive understanding of the dynamics surrounding the effects of desert locust invasion on food security crisis. These two theories complement each other, addressing specific aspects of the research, and together, they offer a robust analytical framework.

The Phase theory is a well-established framework that explains 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 to mitigate the food security crisis caused by desert locust invasions in Loima Sub-County, Turkana County.

Conceptual Framework

Figure 2.1 shows the relationship between the variables in the study. The independent variable is desert locust invasion, which progresses through phases influenced by ecological factors (Phase theory). This in turn triggers various responses within the community (Systems theory). The first objective on dietary diversity's indicators, dietary patterns, frequency of meals and dietary monotony, are affected by the ecological impact of locust invasions as implied in Phase theory and their influences food consumption patterns as laid out in Systems theory. The second objective on the effect of desert locust invasion on food availability and accessibility due to climatic conditions, the indicators therein are food stock depletion, income loss, crop loss and damage, food aid and assistance. They are shaped by the extent of locust damage and environmental factors. The third objective on ccoping strategies for communities and the indicators are food consumption patterns, coping strategy index, market access, community support mechanisms. They are developed in response to locust invasions and their consequences anchored in Systems theory. The dependent variable is food security crisis whose indicators are food consumption score which is affected by dietary, food availability and accessibility as well as coping strategies. The intervening variables which will not be presented in the findings but will be studied as challenges and opportunities. In this case, it will be agricultural practices influenced by locust invasions and their impact on agriculture. It mediates the relationship between locust invasions and food consumption patterns as depicted by the systems theory.

This conceptual framework guides the study's exploration of how desert locust invasions trigger a chain of events, from ecological changes to coping strategies and, ultimately, to food security outcomes in Loima Sub-County, Turkana County.

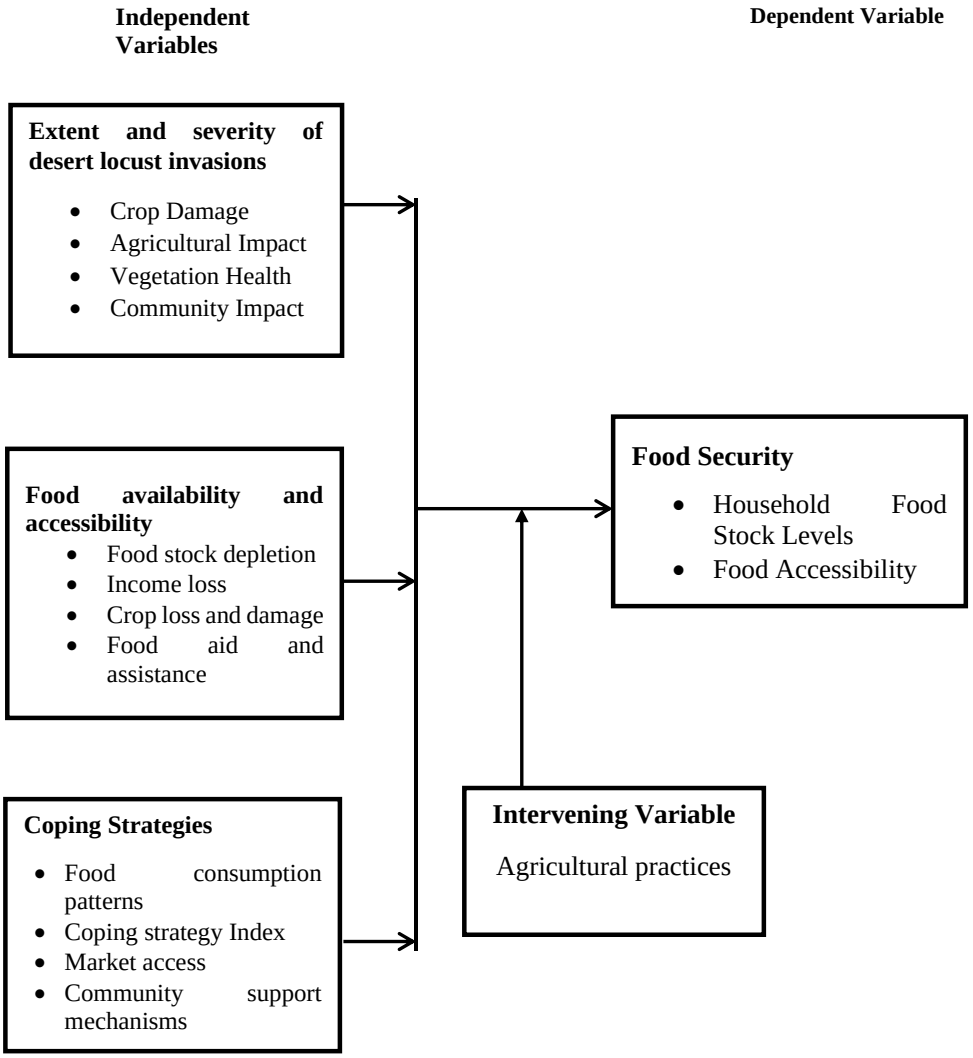


Figure 2. 1: Conceptual Framework Source: Researcher (2024)

III. Research Methodology

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.

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

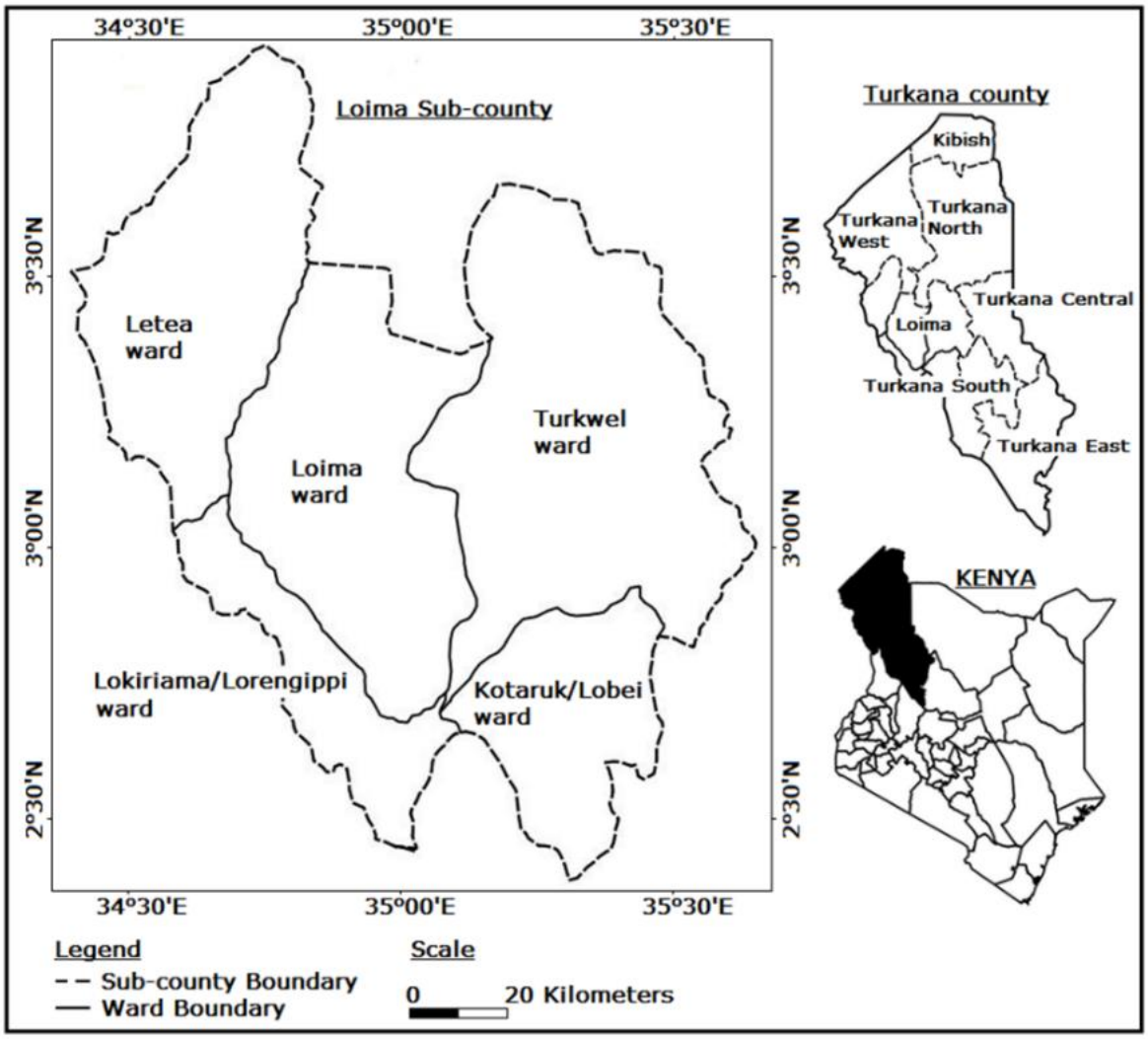
Specific objectives	Measurable valuables	Research Design
a) To assess the extent and severity of desert locust invasions on food security in Loima Sub-County, Turkana, Kenya	• Crop Damage Assessment • Agricultural Impact • Community Impact	Mixed method approach(qualitative &quantitative design)
b) To 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 • Income loss • Crop loss and damage • Food aid and assistance	Mixed method approach(qualitative &quantitative design)
c) To evaluate coping strategies adopted by local communities in Loima Sub-County, Kenya, in response to desert locust invasions and their effect on food security	• Food consumption patterns • Coping strategy Index • Market access • Community support mechanisms	Mixed method approach(qualitative &quantitative design)

Source: Author (2023)

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)

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.

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)

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.

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.

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.

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.

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).

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.

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

IV. Data Analysis, Findings And Discussions

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.

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

	Frequency	Percentage (%)
Distributed Questionnaires	400	100.0
Questionnaires Returned	395	
Response Rate		98.8

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.

Demographic Data

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.

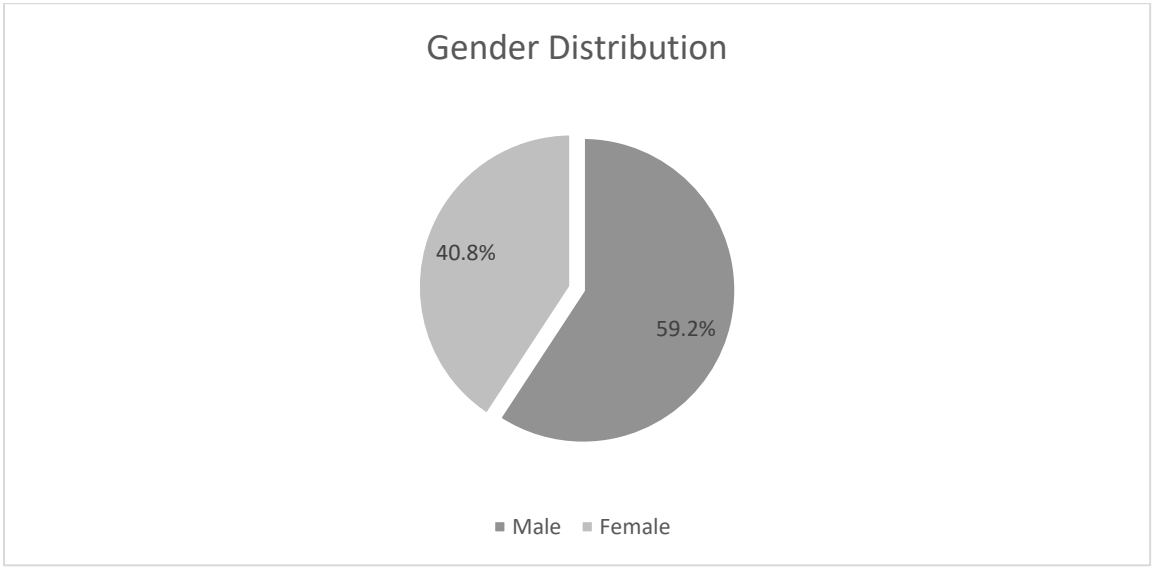


Figure 4. 1: Gender distribution
Source: Researcher (2024)

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.

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

Category	Frequency	Percentage (%)
Bachelor's degree	6	1.52%
Certificate	14	3.54%
Higher National diploma	1	0.25%
Master's degree	1	0.25%
Ordinary level diploma	4	1.01%
Other (specify)	342	86.58%
Secondary school	27	6.84%
Total	**395**	**100%**

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.

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.

Extent and Severity of Desert Locust Invasions

Desert locust invasions on crops and vegetation

In assessing the impact of desert locust invasions on crops and vegetation in Loima Sub-County, respondents were asked to rate the extent of their personal witnessing on a scale of 1 to 5 and the findings are as displayed in Figure 4.2 below.

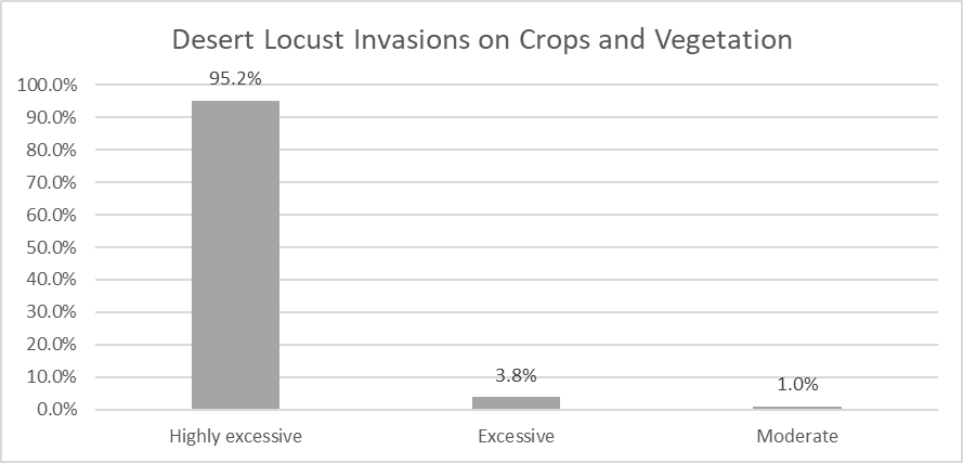


Figure 4. 2: Desert Locust Invasions on Crops and Vegetation
Source: Researcher (2024)

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

Category	Frequency	Percentage
Yes	385	97.47%
No	10	2.53%
Total	**395**	**100.00%**

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

Category	Frequency	Percentage
Highly excessive	378	95.70%
Excessive	15	3.80%
Moderate	2	0.51%
Total	395	100.00%

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.

Vulnerability of Crops and Agricultural Practices to Desert Locust Invasions

Figure 4.3 presents respondents' beliefs regarding the vulnerability of specific crops or agricultural practices to desert locust invasions.

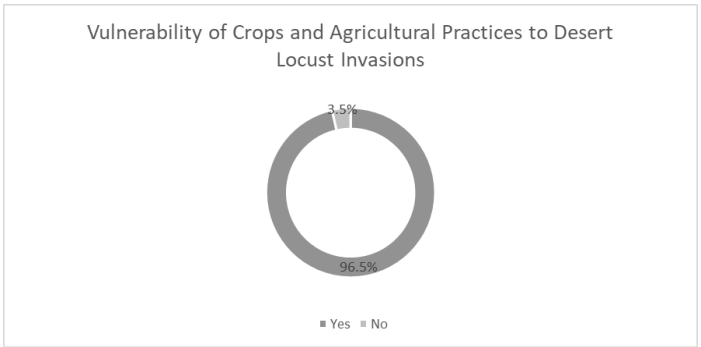


Figure 4. 3: Vulnerability of Crops and Agricultural Practices to Desert Locust Invasions
Source: Researcher (2024)

The study found that most respondents, about 96.46%, agreed that crops and certain farming practices are vulnerable to locust invasions. This matches what Debaeke et al. (2017) discovered about factors like plant species, growth stage, and proximity to breeding grounds affecting vulnerability. The widespread agreement among respondents underscores the community's awareness of crop losses and the need for customised strategies to reduce them.

Implementation of Strategies to Mitigate Desert Locust Impact on Food Security

Table 4.5 outlines respondents' perceptions regarding the implementation of strategies by local authorities and communities to mitigate the effects of desert locust invasions on food security.

Table 4. 5: Implementation of Strategies to Mitigate Desert Locust Impact on Food Security

Category	Frequency	Percentage
Yes	301	76.20%
No	94	23.80%
Total	**395**	**100.00%**

Source: Researcher (2024)

It is encouraging to note that 76.20% of respondents recognised the implementation of such strategies. This demonstrates an active response from both local authorities and communities to tackle the challenges presented by locust invasions. Research conducted by Wiggins et al. (2020) emphasises the significance of community-based interventions, like early detection and coordinated response mechanisms, in reducing the impact of locust outbreaks on food security. These findings imply a collaborative effort to address the effects of locust invasions, although there is still scope for improvement and additional intervention.

Effectiveness of Government and NGO Responsiveness to Desert Locust Invasions

Figure 4.4 illustrates the perceived effectiveness of both government and non-governmental organisations (NGOs) in responding to desert locust invasions.

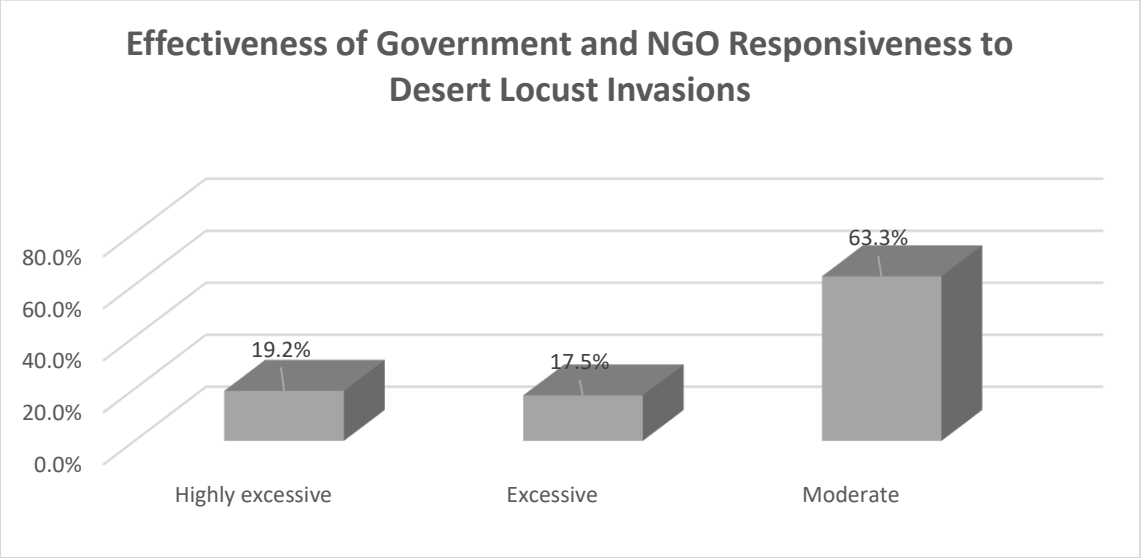


Figure 4. 4: Effectiveness of Government and NGO Responsiveness to Desert Locust Invasions
Source: Researcher (2024)

As indicated, most respondents (63.29%) rated the responsiveness as "moderate," with only a small percentage considering it "highly excessive" (19.24%) or "excessive" (17.47%). This implies a perceived mismatch between the response level and the severity of challenges posed by locust invasions. Research by Fowowe (2022) highlights the crucial role of prompt and coordinated action by governmental and non-governmental organisations in effectively combating locust outbreaks. The findings underscore the necessity for improved coordination and resource allocation to strengthen response efforts and mitigate the impact of future invasions.

Food Accessibility and Availability

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 *kundee*," 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. 6: Impact of Desert Locust Invasions on Household Income

Category	Frequency	Percentage
Yes	336	85.19%
No	59	14.94%
Total	395	100.00%

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.

Extent of Crop Damage Caused by Desert Locust Invasions

Figure 4.5 outlines the extent of crop damage inflicted by desert locust invasions, providing insights into the severity of the impact on vegetation.

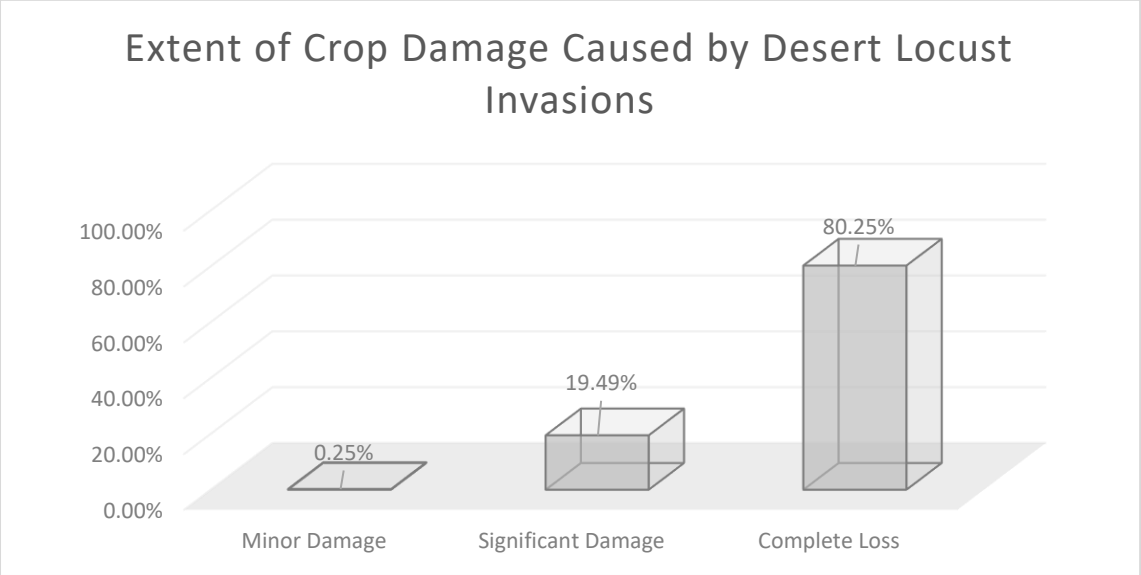


Figure 4. 5: Extent of Crop Damage Caused by Desert Locust Invasions
Source: Researcher (2024)

The study found that 80.25% of respondents experienced complete crop loss, with 19.49% reporting significant damage. However, only a tiny 0.25% reported minor damage. These results align with Hassan and Aslam's (2024) study, emphasising how locust swarms severely affect agricultural yields, especially in areas relying on subsistence farming. The high rate of complete crop loss highlights the urgent need for strong intervention measures to address the severe impact on food security and livelihoods in affected communities.

Receipt of Food Aid Following Desert Locust Invasion

Table 4.7 presents data on whether households have received food aid or assistance from various entities since the desert locust invasion.

Table 4. 7: Receipt of Food Aid Following Desert Locust Invasion

Category	Frequency	Percentage
Yes	272	68.86%
No	123	31.14%
Total	**395**	**100.00%**

Source: Researcher (2024)

A significant proportion, 68.86% of respondents, acknowledged receiving aid, while 31.14% reported not receiving assistance. This corresponds with research by Mena and Hilhorst (2022), emphasising the essential role of government agencies, NGOs, and community organisations in offering relief to communities affected by natural disasters like locust invasions. The substantial affirmative responses indicate the critical support provided to affected households, yet also emphasise the continued necessity for sustained assistance to alleviate food insecurity and enhance resilience within impacted communities.

Impact of Food Aid on Coping with Desert Locust Invasion

Respondents were questioned about the ways in which food aid or assistance had aided their households in coping with the impact of the desert locust invasion on food availability and accessibility.

The respondents revealed that food aid provided by NGOs and local authorities offered immediate relief to households affected by the invasion. Assistance in the form of chickens for rearing, cash transfers, and direct provision of food helped sustain families during times of scarcity.

The respondents revealed that cash transfers enabled households to address immediate needs such as school fees payment and essential purchases. This financial support alleviated financial burdens, allowing families to focus on securing food and other necessities.

The respondents revealed that food aid provided a temporary reprieve, allowing households to explore alternative avenues for food procurement. With the immediate needs addressed, families could allocate resources towards long-term solutions and income-generating activities.

The respondents revealed that borrowing food aid from neighbours and beneficiaries of other programs demonstrated the strength of community support networks. Collaboration and solidarity within communities facilitated access to resources during times of crisis.

The respondents revealed that food aid was utilised for various purposes, including purchasing school requirements, medical expenses, and household foodstuffs. This flexibility ensured that aid catered to the diverse needs of households beyond just food provision.

The respondents revealed that the aid provided a buffer, enabling households to prepare adequately for future uncertainties. Boosted food stocks and financial stability empowered families to better withstand future shocks and challenges.

The respondent's revealed gratitude for the assistance received, acknowledging its significant impact on food availability and accessibility. The aid provided a lifeline during a period of heightened vulnerability, fostering appreciation for the support received.

For households that did not receive aid, the respondents revealed that coping with the invasion's impact was more challenging. The absence of assistance exacerbated food shortages and accessibility issues, underscoring the importance of timely intervention.

The respondents revealed that aid provided by NGOs, local authorities, and government agencies played a crucial role in facilitating access to food during the crisis. These interventions helped bridge gaps in food availability and accessibility for affected households.

The respondents revealed that despite facing adversity, households demonstrated resilience in navigating the challenges posed by the invasion. Whether through aid assistance or community support, families adapted to the circumstances and persevered through the crisis.

The respondents revealed that aid programs also had broader implications for household livelihoods, with cash transfers and financial support enabling families to sustain themselves beyond immediate food needs. This holistic approach addressed multifaceted challenges faced by households.

The respondent's revealed appreciation for the aid received, recognising its instrumental role in alleviating food insecurity. The support provided a sense of relief and security during a period of uncertainty and hardship.

Role of Government Assistance: The respondents revealed that aid provided by the county government, such as maize assistance, bolstered food stocks and eased the burden on households. Government interventions complemented NGO efforts, collectively supporting affected communities.

The respondents revealed that while aid provided immediate relief, its long-term impact on household resilience and sustainability remains a consideration. Efforts to build resilience and enhance food security must extend beyond short-term interventions to address underlying vulnerabilities.

The respondents revealed that the provision of aid fostered a sense of empowerment within communities, enabling households to support one another and collaborate on solutions to shared challenges.

V. Summary Of Findings, Conclusion And Recommendations

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.

Summary of Major Findings

Extent and Severity of Desert Locust Invasions

The study revealed that desert locust invasions have had a profound and widespread impact on food security in Loima Sub-County, Turkana, Kenya. A staggering 95.19% of respondents rated the extent of crop and vegetation destruction as "highly excessive." This aligns with perceptions of a significant decrease in food availability, as reported by 97.47% of respondents. Furthermore, 95.70% of respondents highlighted the severity of the impact on local food availability as "highly excessive." The vulnerability of crops and agricultural practices to locust invasions was acknowledged by 96.46% of respondents, indicating a pressing need for tailored strategies to mitigate losses. While 76.20% of respondents recognised the implementation of mitigation strategies by local authorities and communities, perceptions of government and NGO responsiveness were mixed, with the majority rating it as "moderate" (63.29%). These findings underscore the urgent need for coordinated and effective interventions to address the significant challenges posed by desert locust invasions on food security in the region.

Food Accessibility and Availability

The study revealed that desert locust invasions profoundly disrupted food availability and accessibility within households in Loima Sub-County, Turkana County, Kenya. Before the invasion in 2019 and 2020, households enjoyed sufficient food stocks, but the crisis led to widespread crop destruction, including staple foods like maize and sorghum, resulting in diminished reserves and heightened vulnerability to food insecurity. Consequently, households had to adapt their dietary patterns and employ coping strategies such as income diversification to mitigate the impact. Despite resilience shown by communities, the invasion caused significant economic losses, with 85.19% of respondents reporting such impacts. Moreover, 80.25% experienced complete crop loss, underscoring the urgent need for intervention measures. While aid provided by various entities offered immediate relief to affected households, long-term resilience-building efforts are necessary to address underlying vulnerabilities and ensure sustained food security. The study highlighted the crucial role of both community networks and government assistance in facilitating access to food aid and supporting affected communities during the crisis.

Conclusion

The study concluded that desert locust invasions have inflicted profound and widespread devastation, significantly compromising food security in Loima Sub-County, Turkana, Kenya. With an overwhelming majority of respondents indicating highly excessive levels of crop and vegetation destruction, alongside substantial decreases in food availability, the findings underscored the urgent need for coordinated and robust interventions to mitigate the severity of the crisis effectively. The severity of the impact on local food availability was also underscored, with nearly all respondents highlighting the profound disruption caused by the invasion. Moreover, the vulnerability of crops and agricultural practices to locust invasions was widely acknowledged, further emphasising the pressing necessity for tailored strategies to mitigate agricultural losses. Although some mitigation efforts by local authorities and communities were recognised, perceptions of government and NGO responsiveness were mixed, with the majority rating it as moderate. Thus, the study concluded that concerted and effective measures are urgently required to address the significant challenges posed by desert locust invasions on food security in the region.

The study also concluded that desert locust invasions have profoundly disrupted food accessibility and availability within households in Loima Sub-County, Turkana County, Kenya. Before the invasion, households enjoyed sufficient food stocks sourced mainly from staple crops harvested during favourable seasons. However, the crisis led to widespread destruction of crops, including staples like maize and sorghum, resulting in depleted reserves and heightened vulnerability to food insecurity. Consequently, households were compelled to adapt their dietary patterns and employ coping strategies such as income diversification to mitigate the impact. Despite the resilience demonstrated by communities, the invasion caused significant economic losses, with a large majority of respondents reporting such impacts. Furthermore, the overwhelming experience of complete crop loss highlighted the urgent need for intervention measures. Although aid provided by various entities offered immediate relief to affected households, the study concluded that long-term resilience-building efforts are necessary to address underlying vulnerabilities and ensure sustained food security. The study emphasised the crucial role of both community networks and government assistance in facilitating access to food aid and supporting affected communities during the crisis.

The study lastly concluded that the desert locust invasion had a profound impact on food security and livelihoods in Loima Sub-County, Turkana County, Kenya. Before the invasion, households had sufficient food reserves, primarily sourced from staple crops harvested during favourable seasons. However, the invasion caused rapid depletion of these reserves, leading to significant alterations in food consumption patterns. The majority of respondents reported noticeable changes in their dietary habits, with many experiencing a complete loss of vegetation.

Recommendations

Based on the study findings and conclusions, the study recommends that the following measures should be implemented to address the desert locust invasions and enhance food security in Loima Sub-County, Turkana County, Kenya:

Establishment of Desert Locust Control Research Centres:

The study recommends that dedicated Desert Locust Control Research Centres should be established in strategic locations such as Turkana University, Garissa, Isiolo, and Marsabit. These centres should focus on developing and implementing effective control mechanisms, conducting research on locust behaviour and breeding patterns, and innovating sustainable pest management solutions. Additionally, these centres should serve as hubs for training local farmers and extension officers on the latest control techniques and technologies.

Strengthening Early Warning Systems:

The study recommends that robust early warning systems should be implemented to detect locust swarms promptly. This involves the integration of satellite imagery, ground surveillance, and predictive modelling to accurately forecast locust movements and breeding sites. By providing timely alerts, these systems will enable rapid deployment of control measures, thereby minimising crop damage and mitigating the impact on food security.

Establishing Community-Based Surveillance and Reporting Mechanisms:

The study recommends that community-based surveillance and reporting networks should be developed and supported to facilitate real-time information sharing and rapid response efforts. Training local community members in locust monitoring and reporting can enhance the accuracy and speed of data collection, ensuring that control measures are implemented swiftly and effectively.

Comprehensive Support Programs for Affected Households:

The study recommends that support programs should be implemented to assist households affected by locust invasions in recovering from economic losses. These programs should provide financial assistance, agricultural inputs (such as seeds and fertilizers), and training in sustainable farming practices. Special attention should be given to vulnerable groups, including smallholder farmers and women-headed households, to ensure equitable access to these resources and support services.

Diversification of Income Sources and Strengthening Resilience:

The study recommends that alternative livelihood strategies should be promoted to reduce dependency on agriculture and mitigate the impact of crop failures. Initiatives such as non-farm income-generating activities and micro-enterprise development can provide households with additional income streams. Investments in infrastructure, such as irrigation systems and storage facilities, should also be made to enhance agricultural productivity and buffer against fluctuations in food availability.

Supporting Community-Based Initiatives:

The study recommends that collaboration among community organisations, government agencies, and NGOs should be fostered to enhance local resilience to desert locust invasions. Community-based initiatives should be supported and strengthened to facilitate information sharing, capacity building, and collective action. Empowering communities to take ownership of their response efforts and leveraging traditional knowledge and practices can improve the effectiveness and sustainability of interventions. Promoting social cohesion and solidarity networks will further foster mutual support and strengthen community resilience in the face of adversity.

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