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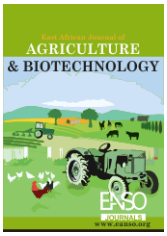

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*Original Article*

# Environmental Factors Contributing to Food Insecurity in Arid and Semi-Arid Regions of Baringo County-Kenya

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**ABSTRACT**

Sub-Saharan countries depend on agriculture as the primary driver of their economies. It is the leading Gross Domestic Product (GDP) contributor in this region. It also provides livelihoods and subsistence crops for a significant African population. Therefore, agriculture is a fundamental instrument of securing livelihoods, improving food security and reducing poverty. Arid and Semi-arid zones cover 45.4% of the land surface of the earth, support 36% of the global population, of which 90% of them live in developing countries. However, these zones have been characterised by varied levels of food insecurity corresponding to varied levels of environmental variability and related agro-pastoral production. The objective of this study was to assess the environmental factors contributing to food insecurity in arid and semi-arid regions of Baringo County-Kenya. The study was based on a survey research design. The study was conducted in three locations of Baringo County, namely: Emining, Salabani and Loboi locations. The population of the proposed study was 3267 households distributed across the three locations. Using Yamane's (1967) formula for small populations and the table by Krejcie & Morgan (1970), a sample size of 351 was required. The key data collection method was a structured questionnaire supplemented by Focus group discussion and a key informant guide. Data was analysed using descriptive statistics. Overall, the results evidenced that environmental factors had major negative impacts on food security, with 76% percent of the respondents citing its severe negative impact. Specifically, Low and unreliable rainfall (89.9%), shortage of water (87.3%), increasing cycles of drought (87.2%) and insufficient pasture for livestock (75.7%) were presented to have a major negative impact on food security. The study recommends the need to adopt a resilient agro-pastoral production system that addresses environmental shocks to promote food security in arid and semi-arid regions.

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## INTRODUCTION

Food Insecurity is a critical issue in many Countries in Africa, particularly Sub-Saharan African Countries (Abdi et al., 2024; FAO et al., 2023). The situation is predominantly more severe in the Arid and Semi-Arid Zones because the environmental factors negatively affect agricultural production and food security (Kalele et al., 2021; Mossissa, 2024). In Kenya, the dryland zones have been expanding through the years, as evidenced by a study conducted by Lawrence et al. (2023). The findings present that presently, dryland zones cover over 80% of Kenya's land mass. Therefore, making communities more vulnerable to food insecurity (Kippra, 2024).

The Government of Kenya has initiated various strategies and policies to address the food insecurity situation. These policies and strategies focus on climate resilience, subsidies on farm inputs and increasing agricultural production (Yılmaz & Njora 2021; Mwangi & Minja 2023). Some of the notable programs by the Kenyan Government are the fertiliser subsidy program aimed at making fertilisers more affordable to farmers (Ayalew et al., 2024). The Agricultural Sector Transformation and Growth Strategy aims to promote value-added agriculture. The strategy specifically aims at improving agricultural production and promoting value addition of agricultural output (Agricultural Sector Coordination Unit, 2019).

However, despite the Government's effort to enhance food security, millions of Kenyans are largely food insecure (Mutea et al., 2022). Baringo County has been predominantly classified as largely arid and semi-arid (Koskei, 2022), subsequently leading to low agricultural production and food security (Masinde et al., 2023). The arid and semi-arid zones of Baringo County are characterised by low, erratic rainfall, high temperatures and recurrent droughts (Okuku et al., 2024).

These climatic conditions have consequently made the communities in these zones vulnerable to food insecurity (Masinde et al., 2023). This is because agriculture is the primary source of food and income in this region (Bett et al., 2021). When households do not harvest due to low and unreliable rainfall, they fall into a situation of food poverty (Obwocha et al., 2022). The situation is also exacerbated by environmental stressors such as water scarcity, Invasive species, land degradation and overgrazing (Cheplogoi, 2021; Githu, et al., 2022; Mwaniki, 2023).

The aim of this study is to explore the environmental factors contributing to low food production in the Arid and Semi-Arid Regions of Baringo County. Information on environmental drivers of food insecurity in arid and semi-arid regions of Baringo County would inform resilient strategies for improving food production in this

 

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region. To achieve the overall objective, this study was guided by the following research question

- What are the environmental factors contributing to food insecurity in Baringo County?

## METHODOLOGY

### Study Site

The study was carried out in three locations of Baringo County in Kenya. Baringo County is one of the 47 Counties in Kenya, located in the Central Rift Valley Region. The County is divided into six (6) sub-counties (administrative units), namely 1) Eldama Ravine, 2) Mogotio, 3) Baringo South, 4) Baringo Central, 5) Baringo North and 6) Tiaty (East Pokot); each with 4 or 5 Wards with a number of locations. Baringo County borders Turkana and Samburu Counties to the north, Laikipia to the east, Nakuru and Kericho to the south, Uasin-Gishu to the southwest, and Elgeyo-Marakwet and West Pokot to the west (Baringo County Government, 2023; Pepela et al., 2019)

Baringo County has typically been classified as an arid and semi-arid region. Most parts of the Mogotio Sub-County, Baringo Central, Marigat, Baringo North and Tiaty (East Pokot) are generally low-dryland zones. Rainfall varies from 1,000mm to 1,500mm in the highlands to 350mm to 600mm per annum in the lowlands. Medium and highlands are categorized as 1) Agro-Alphine, 2) High Potential, 3) Medium Potential agro-ecological zones (AEZ) and the low lands are categorized as 4) Semi-Arid, 5) Arid, 6) Very arid based on topography (landform), average rainfall, soil texture, average temperature and adequate moisture for the growth of the agricultural crops. The lowland sub-counties of Mogotio and Marigat receive relatively low amounts of rainfall (MoALF, 2017; Ochieng et al., 2017).

Baringo County was chosen in this study because the County is largely arid and semi-arid, hence susceptible to environmental variability, which affects food production. Further, the rural population in Baringo County mainly depend on livestock rearing and crop farming, thus providing an opportunity to understand the factors affecting agro-pastoral production systems (Githu et al., 2022). Given this situation, a study in this County is essential in providing lessons on the environmental stressors negatively impacting food security. Specifically, the study was carried out in three ASAL locations, namely 1) Emining location, 2) Ilchamus (Salabani) location and 3) Loboi Location. These three locations were specifically chosen because they are mainly inhabited by different communities of Baringo County, namely the Tugen, the Eldorois and the Ilchamus communities, thus to a great extent representing the ethnic diversity of the County. The population of the study is presented in Table 1 below.

**Table 1: Population of the Study Area**

| | Location | Population | Households |
|---|---|---|---|
| 1 | Emining | 18,221 | 1875 |
| 2 | Salabani | 18,191 | 520 |
| 3 | Loboi | 14,685 | 872 |
| | **Total** | 51,097 | 3267 |

**Source**: *KNBS 2019 & Baringo ICDP 2018-2022*

### Sampling Techniques and Sample Size

#### *Representative Sample*

A sample size is the fraction of the population representing all characteristics of the population members. A representative sample must reflect the size and characteristics of the population. This study targeted a population of 3267 households with a desired probability of confidence, i.e. 95% or 99% (Fisher, 1925; 1954; Yamane, 1967; Krejcie & Morgan, 1970; Cochran, 1963; 1977; Hinkley, 1980; Cohen, 1988). Given this requirement, the

 

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sampling procedure for the sample size was based on the corresponding margin of error (1% or 5%) and probability of precision or confidence (95% or 99%). Most studies in social sciences adopt these criteria. Therefore, this study adopted a probability of precision or confidence of 95% and thus a possibility of error of 0.05%.

Accordingly, the study used Yamane's (1967) formula for the determination of a sample size with respect to small or finite populations, at 95% probability of confidence and therefore 0.05% Possibility of error; i.e.

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$

Use of this formula and the table by Krejcie & Morgan (1970) resulted in a required sample size of 351. The table by Krejcie & Morgan also recommends sample sizes for different population levels at a 95% confidence level or an inverse of 0.05 probability error.

***Distribution of Required Sample***

A determined sample of 351 was distributed to the three (3) locations in proportion to the population as follows;

**Table 2: Sample Size**

| Location | Household | Percent | Required Sample |
|---|---|---|---|
| Emining | 1875 | 57% | 200 |
| Salabani | 520 | 16% | 56 |
| Loboi | 872 | 27% | 95 |
| **Total** | **3267** | **100** | **351** |

***Sampling Method***

The study drew respective samples from the study location using a systematic sampling method. The registers (lists) of the households in the three (3) locations and the distributed required sample formed the sampling framework for the study. Accordingly, the study secured the registers (lists) of the households in the three locations, after which systematic sampling was carried out based on the register (list) in each Location. The required sample was drawn every Kth (5 cases) until the required sample was obtained in each location and added to 351.

**Research Instruments**

The instruments used to collect data were a structured survey questionnaire supplemented by a key informant guide and a focus group discussion guide.

**Reliability and Validity**

Issues of omissions, clarity, reliability and validity were addressed through a number of approaches. 1) adoption of well-established data collection instruments, 2) carrying out a pretest of the draft data collection instruments. A pretest was carried out among 36 households in the ASAL location of Lembus- Mogotio. The purpose of the pretest was to address omissions and gain greater insight into the issues related to food insecurity, clarity of the questions and responses, reliability and validity. The feedback informed a few amendments on the questionnaire to improve the wording of the questions to enhance the validity and reliability of the instrument.

**Data Analysis**

The study used both quantitative and qualitative approaches to analyse data. Thematic analysis and narrative were used to analyse qualitative data.

 

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Quantitative approaches used in this study include frequencies, percentages and measures of central tendency.

## RESULTS AND DISCUSSIONS

### Environmental Factors Contributing to Food Insecurity

The environmental factors in this study were identified to have a major impact on food insecurity and had a high score of 76%. Just 10% of the respondents indicated that environmental factors had no contribution to food insecurity. The results on environmental factors contributing to food insecurity are presented in the table below.

**Table 3: Environmental Factors Contributing To Food Insecurity**

| | 1 No impact on the availability of food | 1 Mild contribution to increased food insecurity | 2 Moderate contribution to increased food insecurity | 3 Extensive contribution to increased food insecurity | 4 Severe negative impact on the availability of food | Total | Mean |
|---|---|---|---|---|---|---|---|
| Shortage of Pasture | 0 | 0 | 3.2 | 21.1 | 75.7 | 100 (351) | 4.73 |
| Shortage of Water | 0 | 0 | 0.3 | 12.4 | 87.3 | 100 (351) | 4.87 |
| Drought | 0 | 0 | 0.3 | 10.2 | 87.2 | 100 (351) | 4.88 |
| Prosopis juliflora | 52.9 | 2.3 | 4.7 | 9.6 | 30.2 | 100 (351) | 2.64 |
| Land degradation | 1.4 | 5.8 | 8.7 | 50.0 | 34.1 | 100 (351) | 4.10 |
| Low Rainfall | 0 | 0 | 0.3 | 9.8 | 89.9 | 100 (351) | 4.90 |
| Floods | 16.2 | 37.1 | 30.4 | 6.4 | 9.9 | 100 (351) | 2.57 |
| **Average** | **10.1** | **6.5** | **6.8** | **17.1** | **59.2** | | |

Most of the respondents (75.7%) indicated that a shortage of pasture had a major negative impact on food security. This can be attributed to the area being largely agro-pastoral, therefore, without enough pasture, livestock productivity goes down. Further, the majority of the respondents (87.3%) indicated that water shortage had a major negative impact on the availability of food in the area. Consequently, most of them (87.2%) pointed out that drought severely impacted crop and livestock productivity.

According to 89.9% of the respondents, low rainfall had a major negative impact on agro-pastoral production. Rainfall is essential for crop health, as it provides the water and nutrients needed for the growth and development of plants. When rain is plentiful, crops can absorb the water and nutrients they need. Additionally, with sufficient rainfall, livestock would have water and pasture necessary for improved production. Further, 87.2% of the respondents indicated that drought had a major negative impact on agro-pastoral production. Drought contributes to food insecurity when crops and animal production fail, which leads to low production and, in worst-case scenarios, death of livestock.

A focus group discussion session on the role of environmental factors in aggravating food insecurity is presented below.

> *"In this area, we hardly produce enough food, mainly because of drought. Adoption of*

 

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> *irrigation, which could possibly help cushion us from the adverse effects of drought, is practised only by a few households. The fertility of our lands is also wanting because fertilisers are not affordable to some of the households. When soil fertility is not enhanced, food production is lower than expected." (FGD 1, 2023)*

A report by a key informant below also evidences the effect of drought on production.

> *"Communities here desire to invest extensively in crop farming, however, the uncertainties that come with living in drylands discourage them from fully investing in their land because they are not certain of harvesting." (KII 1, 2023)*

With arid and semi-arid regions having insufficient rainfall, rain-fed agriculture alone cannot guarantee food security. In such areas, irrigation plays a critical role in supplementing the elusive rainfall. Results of this study also align with those of Randel et al. (2022), whose study suggests that rainfall generally has a positive effect on household food security, particularly in areas that are largely dependent on agro-pastoral production.

According to 82.9% of the respondents, land degradation had a major impact on crop productivity. This can be attributed to the deterioration or loss of the productive capacity of the soils as a result of land degradation. Land degradation reduces agricultural profits through two main mechanisms, affecting both agricultural outputs and inputs. Firstly, land degradation reduces crop productivity, hence lowering crop harvests and farmer revenues. Secondly, degraded soils require more inputs for crop cultivation, such as more fertilisers, more labour for agronomic operations, and more water for leaching soil salinity (Alisher et al., 2023). Results of this study are similar to those of Mganga (2022), whose research indicates that nearly 80% of Kenya's landmass is affected by land degradation, thus negatively affecting agricultural production.

Floods affect crop productivity in terms of damaged farmlands, reduced yields, and accessibility difficulties. According to 16.3% of the respondents, floods had a major negative impact on agro-pastoral production, compared to 53.3% of the respondents who cited that floods do not have a major impact on agro-pastoral production. The percentage that indicated that floods had a major impact on food security is those whose households are close to Lake Baringo, whereas those whose households are far from Lake Baringo have not been affected much by floods.

Qualitative data from focus group discussions and key informant interviews indicate that insufficient and erratic rainfall contributes to food insecurity in the area. This includes prolonged drought periods leading to insufficient harvest. Further, some smallholder farmers, due to fear of crop failure, do not invest much in the land, therefore, they plant crops in a small area. Moreover, due to short, erratic rainfall, floods are imminent, hence reducing productivity. With climate change, periods of drought have become longer, and in worse case scenario, the area is hit by drought after every three years. The following information from a FGD session indicates the adverse effects of floods in the area.

> "When *there are floods in this area, households are plugged into food insecurity. The adverse effects of floods not only affect the crops on the farm but also livestock production. During periods of floods, households are forced to seek relief food." (FGD 2, 2023)*

This excerpt from the FGD evidence the effects of floods on food production.

**Biological and Social Factors Contributing to Food Insecurity**

This study also presents the effects of biological and social factors on food insecurity. Even though these factors are not directly environmental factors, they are largely influenced by the physical and social environment. These factors include: Livestock

 

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diseases, attack by predators, crop diseases, crop pests, theft, conflicts and cattle rustling. Overall, the biological and social factors contributing to food insecurity was presented by 66.1% of the respondents as having a major negative impact on food security. The results are presented in Table 4 below.

**Table 4: Biological and Social Factors Contributing to Food Insecurity**

| | 1 No impact on the availability of food | 1 Mild contribution to increased food insecurity | 2 Moderate contribution to increased food insecurity | 3 Extensive contribution to increased food insecurity | 4 Severe negative impact on the availability of food | Total | Mean |
|---|---|---|---|---|---|---|---|
| Livestock diseases | 0 | 1.4 | 5.8 | 39.8 | 53.0 | 100 (351) | 4.44 |
| Attack by predators | 2.5 | 10.2 | 26.8 | 30.3 | 30.4 | 100 (351) | 3.80 |
| Crop diseases | 0 | 0 | 3.2 | 50.9 | 46.0 | 100 (351) | 4.43 |
| Crop pests | 0 | 2.6 | 4.7 | 53.2 | 39.5 | 100 (351) | 4.30 |
| Theft | 9.8 | 7.5 | 23.7 | 38.4 | 20.5 | 100 (351) | 3.52 |
| Conflicts | 17.2 | 19.7 | 24.6 | 25.3 | 13.3 | 100 (351) | 2.98 |
| Cattle rustling | 59.9 | 8.7 | 9.3 | 10.5 | 11.6 | 100 (351) | 2.05 |
| **Average** | **12.8** | **7.2** | **14.0** | **35.5** | **30.6** | | |

According to 52.4% of respondents, livestock diseases severely impacted livestock productivity, while 1.4% cited a mild contribution. When livestock are attacked by diseases, productivity goes down. Studies by Kappes et al. (2023) evidenced a direct economic impact of livestock disease conditions on the loss of, or reduced efficiency of, production. Low production affects food access, wealth, and income.

Respondents assessed the impact of diseases on crop productivity. According to 96.9% of the respondents, crop diseases had an extensive to major impact on productivity. Crop production has a direct relationship with food security. If production is low, it directly leads to food insecurity. Crop pests are organisms that feed on and destroy or damage crops in the field or in storage. In this study, 90.3% of the respondents indicated that crop pests had a major negative impact on crop productivity.

Pests burrow into leaves, the stems, fruits or roots of a plant, thus affecting its capacity to produce. Qualitative data from focus group discussion sessions indicate that maize was the most affected by pests. Besides the losses incurred on the farm, a key informant presented that pests also affect crops in the store. The report by the key informant is presented below.

> *"Poor storage is a factor that negatively affects crop production. Farmers incur post-harvest losses because of pests which attack crops in the store. These reduce food availability, contributing to food insecurity." (KII 2, 2023)*

A related study by Savary and Willocquet (2020) indicates that crop diseases potentially create food

 

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shortages, which in turn affect food security. The findings of this study also align with those of Gudeta and Gebeyehu (2021), which evidenced that plant diseases lead to losses, consequently threatening food security in Africa.

Results from this study further show that 2.5% of the respondents indicated that attack by predators has no contribution to agro-pastoral production. Whereas about 30.4% of the respondents indicated that an attack by predators had a major impact on food production. Predators include birds and wild animals. Birds and wild animals could damage crops before harvesting, if this happens it lowers the possible harvest by farmers, thus reducing crop production on a farm.

A report by a key informant also shows the negative impact of predators on food security. The excerpt from the interview is presented below.

> *"We live close to Lake Bogoria reserve. As such, there are cases of human-wildlife conflict. Wild animals such as Zebras, hyenas, baboons and leopards attack crops on the farm, leading to losses. We have complained to the relevant authorities, but they are taking a long time to compensate us." (KII 3, 2023)*

These results are in line with those of Alemayehu and Tekalign (2022), which presents that birds and wild animals attack crops, thus reducing productivity. The findings also align with those of Kenalekgosi et al. (2018), which evidence that attacks by wild animals destroy agricultural production, leading to food insecurity.

Theft can happen to crops on the farm or in the store. When food crops are stolen, it reduces the amount of food in the household. Theft was found to have a significant impact on food insecurity by 58.9% of the respondents. This is because farm thefts compromise food security, nutrition, and poverty reduction efforts. Qualitative data from focus group discussions and key informant interviews also indicate that there were cases of theft of crops and livestock in the study area, which negatively impacted food security.

The findings of this study are in line with those of Bunei (2018), which evidenced that farm theft is costly not only in terms of the cost of the item stolen but also on other factors such as loss of income and time. Research by Dyer (2023) indicates that improved farm security against theft leads to farmers planting more high theft-risk crops, farmers marketing more of their crops off-farm, and farm yields also increase for crops that are less at risk of theft. Theft has a very direct impact on food security as it leads to reduced livestock and food reserves.

According to 38.6% of the respondents, conflicts had a major impact on agro-pastoral production. Some parts of the study area have been affected by communal conflicts, thus affecting agro-pastoral production. The findings also agree with those of Warsame et al. (2024), who established that communal conflicts have a negative impact on food production and subsequently on food security.

Some respondents (22.1%) indicated that cattle rustling has majorly affected agro-pastoral production. Some parts of Baringo County have historically been affected by cattle rustling. When cattle rustling happens, livelihoods are affected, and these territories become no-go zones. The victims more often resort to famine relief donations, while others abandon cattle keeping completely to concentrate on non-cattle sources of livelihood.

Information from focus group discussions indicates that conflicts and cattle rustling play a role in exacerbating food insecurity, this is presented below.

> *"When there are conflicts or cattle rustling in this area, we can hardly engage in any agricultural production. In worst-case scenarios, livestock are stolen and people are displaced. This situation contributes to food insecurity in the area." (FGD 3, 2023)*

 

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The issue of conflicts and banditry was further reinforced by a key informant. The report by the key informant is presented below.

> *"Conflicts and banditry contribute to food insecurity in this area because of the following reasons. First, communities lose their livestock and agricultural production, secondly, they are displaced from their land as they seek safer grounds, and thirdly, they are unable to confidently invest on their land because of fear of attack." (KII 4, 2023)*

From these results, it is evident that conflicts and cattle rustling play a role in exacerbating the food insecurity situation in the area. According to Gumba (2020), cattle are an agricultural and cultural mainstay for agro- pastoralists and the impact of cattle rustling on these communities is severe leading to loss of livelihood and increased poverty levels. A related study by Bersaglio et al. (2015) evidence that cattle raiding in pastoral areas contributes to food insecurity, forcing communities to seek relief food.

## CONCLUSION

Environmental, biological and social factors that were identified to contribute to food insecurity include drought, insufficient pasture, crop and livestock diseases, attack by wild animals and invasive species such as Prosopis juliflora, floods/heavy rainfall, cattle rustling, theft and conflicts. Results evidenced that these factors had a major impact on food insecurity and had a high score of 79.9%.

## RECOMMENDATIONS

Results of this study show that 39.8% of the respondents have had their livestock and crops severely affected by Prosopis juliflora. Prosopis juliflora was intentionally introduced in arid and semi-arid areas for its adaptability to desert conditions. Unfortunately, the concept has not worked as a mitigation measure against food insecurity. The species has continued to spread with devastating negative consequences on agro-pastoral production. The study therefore recommends that the government of Kenya should support the residents in getting rid of this invasive species to enhance food production and security in the area.

Some respondents (22.1%) indicated that cattle rustling has majorly affected agro-pastoral production. Some parts of Baringo County have been affected by cattle rustling. When cattle rustling happens, livelihoods are affected, and these territories become no-go zones. The victims more often resort to famine relief donations because their livestock are stolen, and they can hardly engage in any agricultural production. The study recommends that the government of Kenya should enhance the security situation in the areas and strengthen policies on cattle rustling. This will deter the occurrence of communal conflicts and cattle rustling.

The study recommends the need to adopt a resilient agro-pastoral production system that addresses environmental shocks to promote food security in arid and semi-arid regions. Further, it's essential to support farmers through training and agricultural extension services to enable them to improve their crop and animal production, thus improving food security. The Government should also come up with policies and long-term strategies to address the recurring floods during rainy seasons.

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