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**Research Article**

# Climate Change and Food Insecurity Among Pastoral Households: Assessing the Role of Information System-Based Early Warning Systems

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**ABSTRACT**

**Introduction**: This study was conducted in the Adadle district of the Somali Regional State of Ethiopia to assess the extent of climate change-induced food insecurity among pastoral households and explore the role of information systems in mitigating its impact. Pastoral communities are highly vulnerable to climate-related shocks due to their dependence on climate-sensitive natural resources, making it crucial to investigate sustainable early warning strategies for food security enhancement.

**Objectives**: The study aimed to assess the levels of household climate change-induced food insecurity and identify the role of information systems as an early warning strategy in mitigating food insecurity.

**Methods**: A total of 156 pastoral household respondents were selected through random sampling. Descriptive statistics were employed to summarize household characteristics, while inferential analyses such as t-tests and chi-square ($\chi^2$) tests were used to examine relationships between household attributes and food insecurity. Additionally, logistic regression models were applied to explore determinants of food insecurity status.

**Results**: The findings revealed that 61% of the surveyed households were food insecure. Among these, 33% were marginally, 17% moderately, and 11% severely food insecure. Furthermore, more than two-thirds of the respondents acknowledged the importance of an integrated information system as a tool for early warning and climate adaptation.

**Conclusions**: The study highlights the critical role of information systems in addressing food insecurity challenges faced by pastoral communities under climate change stress. It emphasizes the need for increased food production, accessibility, and utilization, alongside capacity building to enhance resilience. The study recommends raising awareness among local communities on the value of information systems, fostering institutional development, improving access to climate-related data, and enhancing food and nutrition literacy to combat food insecurity effectively.

**Keywords:** Food security, information system, early warning system, coping strategies, resilience, Adadle, Somali, Ethiopia.

## INTRODUCTION

Over the past decades, millions of dollars have been set aside by governments, donors, international aid agencies, and multi-lateral development bodies to address the problem of food insecurity in the Horn of Africa and elsewhere due to climate change. Food insecurity is a situation where people experience limited or uncertain physical, social, and economic access to enough safe and nutritious food to meet their dietary desires or food preferences for a healthy and active life (Keino et al, 2014). According to recent estimates, more than 9% of the world's population (more than 700 million people) are exposed to severe levels of food insecurity, implying reductions in the quantity of food produced to the extent that they have possibly experienced hunger (FAO, 2019).

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Ending hunger, achieving food security, and improving nutrition are at the heart of the Sustainable Development Goals. At the same time, climate change is already impacting agriculture and food security, and will make the challenge of ending hunger and malnutrition even more challenging. The effects of climate change on our ecosystem's functions are so severe and widespread that ensuring food security in the face of climate change has become a daunting challenge. While some of the problems associated with climate change are emerging gradually, action is urgently needed now to allow enough time to build resilience into agricultural production systems (Birch, 2018).

Targeted action to eradicate hunger, food insecurity, and malnutrition is only possible if actors understand why people are deprived. Such understanding requires the availability of reliable data, statistics, and information, adequate capacity to analyse the available information, and good communication skills to inform decision-makers (FAO, 2015). Livestock production is the major source of food (milk and meat), income, and employment for pastoralists. However, the pastoral production system has been threatened by climate change impacts, other man-made risks like land degradation, and a lack of proper data and information management for early awareness and decision making, leading to food insecurity and loss of livelihoods. Climate change affects livestock production in multiple ways, both directly and indirectly, and attaining and accessing climatic and weather-related information is crucial (Abdirahman, 2022).

The losses of hundreds of thousands of livestock due to climate change-induced drought, because of poor information system access, coupled with deteriorating terms of trade because of inflation, worsened food insecurity in many parts of the Ethiopian Somali region. The degree of food insecurity reached its climax in 20013/14 because of the prolonged drought conditions. Despite intervention by developmental projects intended to avert climate change-induced food insecurity, the livelihoods of pastoralist populations have not shown significant improvement. For example, per capita calorie intake levels remain very low in the pastoral regions compared with the national average of 2,200 kcal. Per capita calorie intake in Somali pastoralists slightly increased over 5 5-year period from 1,617 kcal in 2000 to 1,861 kcal in 2005 (PFE, 2017).

The entire region has been heavily dependent on external food aid since 1984, with an increasing number of households currently in need of support. In the Somali region, about 22% (1,533,970) are in an acute food insecure phase, and the necessary information system infrastructure exacerbates the condition (IPC, 2019). Although Adadle is located around the Shabelle River, the area has increasingly become vulnerable to food insecurity due to the failure of the main rainy season, lack of climatic information, and also due to the cumulative effect of past droughts and other triggering factors (Lin et al., 2015).

The current study will explore the relationship between climate change and food insecurity and the role of information systems as an early warning strategy on pastoral households of Adadle district in the Somali regional state. Finally, it will put forward scientifically sound and contextually viable recommendations to deal with the challenge of food insecurity as a result of climate change in the pastoral settings.

## OBJECTIVES

This study aims to critically examine the climate change-induced food insecurity status of pastoral households and assess the role of information system-based early warning mechanisms in Adadle district, Somali Regional State, Ethiopia. It seeks to understand how pastoral communities are affected by the gradual and abrupt effects of climate change, which disrupt food production, reduce household resilience, and deteriorate traditional coping mechanisms. In doing so, the study investigates the levels and dimensions of household food insecurity, while also evaluating how socio-demographic and economic characteristics interplay with vulnerability to climate shocks.

It further explores the relevance and recognition of information systems as strategic tools in reducing risks and enhancing preparedness in the face of climate-related hazards. Through mixed methods, including structured surveys, key informant interviews, and focus group discussions, the research identifies critical gaps in information access and dissemination, which limit timely decision-making and exacerbate livelihood insecurity. By integrating local perceptions and empirical data, the study ultimately aims to propose context-sensitive strategies to enhance resilience, promote adaptive capacity, and recommend effective early warning system frameworks that are grounded in the lived experiences of pastoralists and responsive to their dynamic environmental realities.



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## METHODS

This study employed a mixed-methods research design combining both quantitative and qualitative approaches to provide a comprehensive understanding of climate change-induced food insecurity and the application of early warning information systems among pastoral households in Adadle district, Somali Regional State, Ethiopia.

A multistage sampling technique was used to select representative respondents from the study area. The quantitative data were gathered through structured household surveys targeting selected pastoral households, with questions tailored to capture data on socio-demographic characteristics, food security status, coping strategies, climate-related shocks, and access to information systems. In addition, qualitative data were obtained through key informant interviews with community leaders, local administrators, and relevant stakeholders, alongside focus group discussions with community members to capture in-depth narratives and indigenous perspectives on food insecurity and early warning practices. The Central Composite Design under Response Surface Methodology was applied to structure data analysis where appropriate, especially in understanding patterns of interaction among variables affecting household food security.

Quantitative data were analyzed using SPSS for descriptive statistics, correlation, and regression analyses, while qualitative data were coded and thematically analyzed to draw meaningful interpretations. Ethical considerations, including informed consent, confidentiality, and respect for local norms, were strictly observed throughout the research process to ensure the credibility and cultural sensitivity of the study. The integration of both data sources facilitated triangulation, allowing for validation of results and a holistic interpretation of the complex dynamics shaping food insecurity and resilience mechanisms in the pastoral context.

## RESULTS

### Food security status of households

The results showed that more than half of the respondents (approximately 61%) were food insecure, based on the recommended daily calorie intake of 2,200 kcal as adopted by the Ethiopian Health and Nutrition Research Institute (EHNRI). The average calorie intake in the study area was 2,006.85 kcal (Table 1). The average calorie intake of food-secure households stood at 2,700 kcal, which is higher than the national average. The average and maximum calorie intakes of food-insecure households were below the national average. It is important to mention that there was a statistically significant difference between food-secure and food-insecure households ($P < 0.01$). Consequently, the study area can be regarded as significantly food insecure given the fact that most of the population (61.9%) of the study area could not meet the nationally recommended daily calorie intake of 2,200kcal.

Table 1: Energy available per adult equivalent, per day (kcal) among sample households.

| Energy available per AE | Food secure (N=61) | Food insecure (N=95) | Total (N=156) | t-value |
|---|---|---|---|---|
| Minimum | 2,200 | 863 | 863 | |
| Maximum | 3,000 | 2,167 | 3,000 | |
| Mean | 2,388.05 | 1,762.8 | 2,006.85 | 14.977 |
| Standard deviation | 183.524 | 291.226 | 397.969 | |

Source: survey result, 2022

Note: Significant at 1% probability level. Source: field survey, 2022.

Logistic regression analysis was performed to assess the impact of other contributing factors (other than climate change) on the likelihood that respondents would report that they are food insecure. Thus, family size, educational status, and livestock holding were positively related to the state of food insecurity posed by climate change, while sex and age were negatively related.

“One of the challenges of the recent food insecurity posed by climate change is the demand for a multisectoral response. Earlier food crises were not so severe. They were limited to water shortage or pasture scarcity, but now water and pasture scarcity, disease epidemics, food availability, conflict over the scarce resources, and many more tend to happen at once, which is above our coping and managing capacity.” FGD2.

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"This area is on the frontline of climate change and suffers from a dichotomy of natural hazards, drought followed by floods, both of which are causing disasters and exacerbating the fragile food security and living system of the pastoralist communities." KII

## Level of climate change-induced food insecurity

The level of food insecurity was measured to understand the intensity of the food insecurity experienced by the local population as a result of climate change. This will help identify the percentage of food-insecure households at each level of the food insecurity phase to guide interventions designed to avert the negative effects of climate change and promote food security in the area. The calorie intake shortfalls during climate change, posing food insecurity, are estimated based on the nutritional threshold level (2,200 kcal/day/adult) adopted by EHNRI.

Based on the survey result categorizing the level of food security, 95 (60.9%) of the households sampled were food insecure at different levels, and 61(39.1%) were food secure. Out of 95 food-insecure households, 51(32.7%) were marginally food insecure, 27(17.3%) were moderately food insecure, and 17(10.9%) were severely food insecure.

"Most of the pastoral communities residing in this area are experiencing a certain level of climate change-induced food insecurity. Immediate climate-smart interventions are required to avert this challenge given their living conditions, which are directly dependent on climate-sensitive resources." KII2. "We don't even know when we are food secure and when we are not, let alone identifying the level of food insecurity." FGD3. Interventions will first target the severely food-insecure households, followed by moderate and marginal ones, as depicted in Table 2.

Table 2: Food insecurity as a result of climate change

| Food security status | Calorie consumption per person per day | Survey result (on households) | |
|---|---|---|---|
| | | Number | Percent |
| Food secure | Above 2,200 | 61 | 39.1 |
| Marginally food insecure | Between 1,800 and 2,200 | 51 | 32.7 |
| Moderately food insecure | Between 1,500 and 1,800 | 27 | 17.3 |
| Severely food insecure | Below 1,500 | 17 | 10.9 |
| Total | | 156 | 100 |

Source: Survey result, 2022

## Role of information systems for pastoral food security

The importance of information systems was measured to identify pastoral communities' attitude towards applying sophisticated information systems as a means of addressing climate change-induced food insecurity.

Table 3: Importance of Information Systems for Pastoral Food Security

| Importance of Information Systems | Survey result (on households) | |
|---|---|---|
| | Number | Percent |
| Very important | 133 | 87 |
| Important | 14 | 9 |
| Less important | 6 | 4 |

Source: survey result, 2022

"It's very imperative for us to have an information system infrastructure so that we will find it easy to attain climatic information and weather variabilities. We fear dealing with sudden cases like flooding, heavy rains, and extreme drought," KII3. "Access to information will ease our livelihoods by at least making us know what preparations we



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need to make ahead of time to avoid the huge losses we always experience, and particularly dealing with the food insecurity posed by a more than ever-changing climate," FGD4.

## DISCUSSION

This study sheds light on how climate change and food insecurity are deeply intertwined in the lives of pastoral households in Adadle district, Somali Region, Ethiopia. The evidence gathered paints a clear picture: unpredictable weather patterns, especially droughts and erratic rainfall, have significantly disrupted the livelihoods of many households. For communities that depend almost entirely on livestock and natural resources, these environmental changes are more than just inconvenient; they are life-altering, often pushing families into cycles of food shortages and vulnerability. One of the most striking findings is the limited use of early warning information systems. While many households are aware of the signs and risks of climate-related disasters, this awareness often doesn't translate into action. In part, this is due to limited access to timely and clear information. But it's also about trust and relevant information that isn't rooted in local knowledge or delivered in ways that people understand and relate to tends to go unused. This highlights a key opportunity: strengthening the way we communicate risk and ensuring early warning systems are not only technically sound but also community-centered and culturally appropriate. The study also found that household characteristics like education, income sources, and access to extension services play a major role in shaping how people respond to climate stress.

Families with more diverse sources of income and better access to services were more likely to act when faced with risk. These households used strategies like moving their livestock early, relying on community networks, or temporarily shifting their economic activities. This confirms what many other studies have also noted: resilience isn't just about resources, it's about access, support, and the ability to make informed choices. Conversations with community members provided even deeper insight. People spoke openly about their worries, shrinking grazing lands, drying water points, and increasing conflict over limited resources. Yet despite these challenges, there was also a sense of determination. Many community members expressed a strong interest in working together and being more involved in decision-making around climate response and development planning. They want solutions that respect their way of life but also help them adapt to a changing world. Taken together, the findings point to a clear conclusion: building food security in pastoral areas requires more than short-term aid or reactive measures. It calls for long-term, collaborative approaches that combine modern tools like early warning systems with local knowledge and that build the capacity of communities to act. Investing in education, communication, infrastructure, and trust will go a long way toward helping pastoral communities not only survive but thrive in the face of climate uncertainty.

## CONCLUSION

This study highlights the critical food insecurity challenges facing pastoral communities in the Somali Regional State, with 60.9% of surveyed households failing to meet the minimum daily energy requirements due to the impacts of climate change. Most of the study respondents (86%) also recognized the role of information systems in averting the prevalent climate change-induced food insecurity, exacerbating the pastoral livelihoods. The findings underscore the urgent need for comprehensive and integrated efforts to build sustainable and climate-resilient livelihoods. As part of this, developing a concrete information system to enable pastoral communities to access the climatic and weather variability information is crucial. Moreover, given the high dependence of these communities on climate-sensitive resources, addressing food insecurity requires more than temporary relief; it demands strategic investments in food production, access, utilization, and the capacity to adapt to and manage climate risks. Sustainable transformation is only possible through developing appropriate information systems, resilience-building, improved climate information access, herd diversification, strengthened social protection, effective disaster risk management, and inclusive climate adaptation strategies tailored to the unique context of pastoral systems. Without these efforts, the cycle of vulnerability and food insecurity will continue to persist among the pastoral population.

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