

Analysis of Climate Change Impacts on Food Security in Somalia

Mohamed Said^{1*}, Abdullahi Bashir Adan² and Abdikarim Barre Hussein²

¹Faculty of Agriculture, Department of Field Crops, Erciyes University, Türkiye

²Faculty of Agriculture, Zamzam University of Science and Technology, Somalia

*Corresponding author: Mohamed Said, Faculty of Agriculture, Department of Field Crops, Erciyes University, Kayseri, Türkiye

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ABSTRACT

This comprehensive study employs a dual-method research approach, encompassing qualitative and quantitative methods, to meticulously explore the intricate dynamics linking climate change and food security within Somalia. Through an extensive survey involving 80 participants – spanning farmers, agricultural educators, students, and environmental professionals – the investigation illuminates the profound ramifications of shifting climatic patterns on the country's agricultural landscape. Notably, discernible shifts in precipitation and temperature are identified as catalysts for land degradation and associated environmental challenges. These shifts consequently contribute to water scarcity and compromise the yield of both crops and livestock. In response, the study advocates for policy interventions focused on alleviating food shortages, spotlighting sustainable research for resilient crop development, efficient adoption of adaptive agricultural technologies, and empowering farmers to navigate evolving environmental scenarios. The investigation delves into the nuanced impact of climate change on rainfed crop production, particularly cereal crops that serve as essential sources of sustenance and fodder. Additionally, it addresses the substantial role of climate change in livestock production, particularly concerning greenhouse gas emissions. Synthesizing these findings, the study underscores the urgency of implementing climate adaptation policies in Somalia. It highlights the dearth of localized scientific knowledge and the critical need to combat the escalating frequency of droughts and floods. Ultimately, this study presents a comprehensive overview of the intricate interplay between climate change, food security, and land degradation in Somalia, underlining the imperative for integrated measures to enhance resilience and ensure sustained food stability in the nation's future.

Keywords: Climate Change; Food Security; Environmental Issues; Somalia

Introduction

Combating hunger is one of the most pressing issues of our time. Hunger has several dimensions and causes, ranging from macro- and micronutrient deficiencies to short-term food availability shocks to chronic shortages. Causes range from a lack of appropriate amount and quality food, as well as a lack of purchasing power, to intricate relationships between nutrition and sanitation, which lead to ill health. Several of these factors have been addressed in recent decades, with significant progress made in lowering the share of the world's undernourished population from an estimated 980 million in 1990-92 to around 850 million in 2010-12. However, based on other nutrition-related indicators such as child underweight and stunting, as

well as health surveys, an estimated 2 billion individuals still suffer from micronutrient deficiencies today. (Wheeler [1]) Scientists and researchers agree that climate change has an impact on 36 types of agriculture. Food consumption is predicted to rise in the future as the world's population grows, diet patterns change, and wages rise. (Warsame [2]) Over the following decades, climate change is anticipated to have an impact on food security in Africa in addition to population expansion. Undernourishment is still a major issue in Africa, despite the advancements made over the past 25 years, and there is still much room for development. In fact, the area still lags behind the rest of the globe in eradicating chronic hunger. Fighting hunger and attaining food security in Africa continue to be difficult tasks, especially consid-

ering climate change, as is the case with achieving food security on a worldwide basis (C Hall [3]).

Crop productivity and soil water balance have been investigated using crop growth models and characteristics from several climate models. Meanwhile, even in high-yielding and high-technology agricultural areas, climate variability is one of the most significant elements determining year-to-year crop productivity. In recent years, there has been an increasing focus on the hazards connected with climate change, which will raise unpredictability in food production. Food security is defined by the Food and Agriculture Organization (FAO) as "a situation in which all people have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life at all times." The definition of food security includes four components: food availability, food stability, food access, and food usage. However, previous studies are primarily concerned with the effects of climate change on food supply, with little attention paid to the effects of possible increases in climate variability, frequency, and intensity of extreme events on food stability. According to the FAO, biotechnology can help increase food security while also reducing the environmental burden. Meanwhile, modified crop types that are resistant to drought, waterlogging, salt, and harsh climate can enhance crop plantareasarea, such as in degraded soils, and so increase food availability in the future. Because of rising temperatures and shorter crop growth seasons, climate change will have an impact on food quality. Droogers used the HadCM3, SWAP, and water-salinity basin models to simulate evapotranspiration and available water at the field size, allowing him to determine the relationship between irrigation depth, crop acreage, and food quality (Kang [4]).

Almost all African economies are estimated to be at risk from the adverse effects of this climate change, which affects millions of people's food security and loss of livelihoods. East and South Africa also made some progress, but the central sub-region fell behind on both targets. Because of population expansion and violence, the number of undernourished persons in Central Africa has increased dramatically since 1990. (FAO [5]) In fact, according to the Global Development Center based in Somalia, which is one of the safest countries in the world regarding climate change, environmental factors, especially climate change, are the biggest problems. (Carty [6]) The purpose of this study is to investigate how climate change is affecting food security in Somalia. It combines qualitative and quantitative methods to un-

derstand the impact on agriculture, water availability, and livelihoods. The study aims to provide actionable recommendations for policies that promote sustainable farming practices and mitigate climate-related food shortages.

Materials and Methods

This study uses descriptive research methods and specifically explores research objectives using research methods. The target group includes small farmers engaged in agriculture. Data were collected through structured questionnaires and in-depth interviews, which are the main data collection tools. The study group includes 100 workers, including ranchers, agriculture teachers from Somalia Agricultural University, students and environmental workers. A sample size of 80 participants was selected using intentional sampling. This exemplary design allows participants to be selected based on their skills and research relevance, ensuring accuracy and knowledge of data collection. The sample consisted of primary informants including 21 farmers, 9 agricultural instructors, 36 students, and 14 ecologists. These people are specially selected for their knowledge of and involvement in agriculture, making them the best fit to understand the research topic. The research used Slovene's formula to select the respondents of the study from the population; using the following formula:

$$n = \frac{N}{1 + N(e)^2} = \frac{1}{1 + 100(0.0025)} = 80$$

Data analysis was performed using the Statistical Package for the Social Sciences (SPSS) program. This analysis tool provides a good and thorough analysis of the collected data, making it easy to organize the data and tabulate and calculate its frequencies. In this study, purposive sampling technique was employed, Purposive sampling is the type of sampling where the researcher uses his/her judgment or common sense regarding participants from whom the information was collected. The researchers used purposive sampling in order to choose the respondents that he believes to have the information concerning this study by using his own judgment, and then the researcher distributed the questionnaire to them. Moreover, the researcher chose purposive sampling because the researcher wanted to get the key informants of this study, for that reason; selecting the respondents is more useful for this study than the representativeness of the sample (Figure 1).

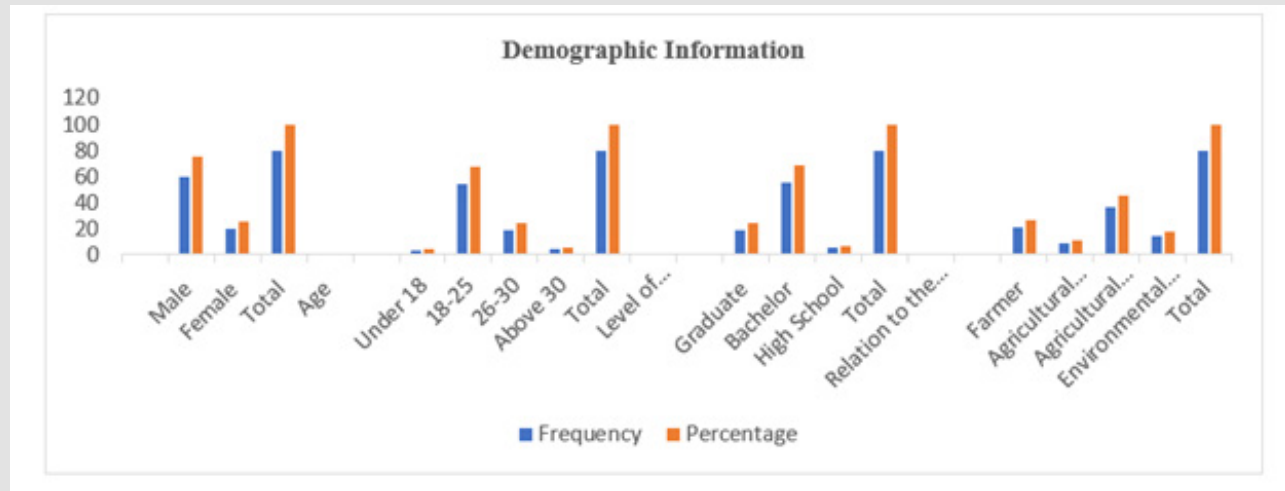


Figure 1: Sociodemographic characteristics of the respondents.

Results

As shown in the above figure 75% of the majority of respondents were male and 25% were female. In age respondents, 67% were at the age of 18-25 Years, while 24% of the respondents are at the age between 26-30 Years, likewise, 5% of the respondents are above 30 Years, and 4% of the respondents are under 18 years. According to the above table, 69% of the majority of respondents were Bachelor holders while 24% of respondents were Graduate students, the minority of respondents 7% were High school level, and none of the partici-

pants were non-formal educated as the study emphasizes. The above table indicates that 45% majority Contributed were Students 26% of the study respondents were farmers 18% of the study participants were Environmental activists and 11% were lecturers (Table 1). Respondents in the study area noted changes in precipitation patterns. About 63% of respondents agreed with non-uniformity in precipitation, and 26% acknowledged a decrease in precipitation. Another 11% reported no change given that precipitation is constant. Interestingly, none of the respondents reported an increase in precipitation compared to the previous year.

Table 1: Impacts of Climate Change on Food Security in Somalia.

Variables	N	Percentage
Perceptions about Changing Rainfall in Somalia		
Irregularity	50	63
Decreased	21	26
Constant	9	11
Perceptions about Temperature Change Somalia		
Increased	52	65
Constant	16	20
Decreased	12	15
Climate Change has Affected on the Performance of Rainfed Crop Production		
Strong agree	22	28
Agree	41	51
Disagree	5	6
Strong disagree	12	15
Climate Change Results Destroyed the Potential for Livestock Production		
Strong agree	22	27

Agree	39	49
Disagree	5	6
Strong disagree	14	18
Farmers in Somalia Will Need to Adapt to inevitable Environmental Changes And their Destructive impacts		
Strong agree	45	56
Agree	19	24
Disagree	8	10
Strong disagree	8	10
Without Climate Change Adaptation Policies, the Food insecurity Situation will Continue to Worsen		
Strong agree	35	44
Agree	22	27
Disagree	13	16
Strong disagree	10	13
Food Security Challenges in Somalia are Caused by the Severe Change in Weather Patterns		
Strong agree	15	19
Agree	36	45
Disagree	18	22
Strong disagree	11	14
Land Degradation, Exacerbated by Climate Change and Population Pressure, is A Significant Driver of Food insecurity in Somalia		
Strong agree	16	20
Agree	40	50
Disagree	18	22
Strong disagree	6	8
Agriculture and Livestock Production Systems Get Damaged, or Annihilated in Some Cases, it Takes A Long Time to Regenerate and Recover		
Strongly agree	11	14
Agree	46	57
Disagree	15	19
Strongly disagree	8	10
The Most Common Driver of Food Insecurity in Somali		
Floods	20	25
Drought	41	51
Lack of climate change adaptation policies.	19	24

As for the temperature, 65% of those surveyed agreed that it had risen. Conversely, 20% believe temperatures are generally constant, while 15% believe temperatures have decreased compared to the previous year. Those who acknowledged the rise in temperature said they felt hotter than in the past. They noted that the intensity and spread of heat increased both indoors and outdoors. Conversely, those who reported constant temperature levels did not observe any noticeable change, as consistent strong sunlight continued to appear throughout the region. Some respondents who cited a decrease in temperature attributed this to an increase in wind, which would lead to a decrease in hot days. The data reveals that 51% of the respondents agreed that climate change has negatively impacted rainfed crop production, while 28% strongly agreed. In contrast, 15% strongly disagreed and

6% disagreed with this statement. The data also shows that climate change has reduced the potential of livestock production. 49% of respondents agree to reduce livestock production, while 27% strongly agree. Conversely, 16% strongly objected and 6% disagreed with this opinion. The data supported the existence of cointegration between precipitation, temperature, rural population, and livestock production, highlighting the sensitivity of livestock to temperature changes in the short and long term. The data in the table shows that a majority of respondents (56%) strongly agree that Somalia's farmers must adapt to inevitable environmental changes and the resulting damage. Another 24% agreed, 10% disagreed, and 10% strongly disagreed. The data also shows that 44% of respondents strongly agree that food insecurity in Somalia will worsen without climate change adaptation

policies. 27% agree, 16% disagree, and 13% strongly disagree. This underscores the importance of implementing effective adaptation strategies to mitigate the country's worsening food insecurity.

The table also shows the impact of changing weather conditions on food security in Somalia. 45% of respondents agreed that severe food insecurity is caused by changes in weather patterns, with 19% strongly agreeing. Conversely, 22% disagree and 14% strongly disagree. These findings highlight the role of climate change in exacerbating food security challenges. The data in the table also shows that 50% of respondents agree that land degradation, exacerbated by climate change and population growth, is a major cause of food insecurity in Somalia. Additionally, 20% of respondents strongly agree that these patterns affect food security, 22% disagree and 8% strongly disagree. These findings underscore the role of land degradation and population pressure as key factors contributing to food insecurity in Somalia. Respondents highlighted that land degradation results from various factors, including extreme weather conditions, particularly drought, and human activities that degrade soil quality and land utility. This degradation negatively impacts food production, livelihoods, and the provision of ecosystem goods and services, with desertification being a specific form of land degradation where fertile land transforms into desert. The table also reveals that 57% of the respondents agree and 14% strongly agree that the regeneration and recovery of agriculture and livestock production systems take a significant amount of time.

Conversely, 19% of the respondents disagree, and 10% strongly disagree. These findings indicate that the restoration of damaged agriculture and livestock production systems requires a lengthy process. Despite the importance of agriculture and livestock in the battle against climate change, respondents recognize the substantial challenge of recovering these systems after they have been compromised. This emphasizes the complexity and time-consuming nature of restoring agricultural and livestock production following climate-related damage. Furthermore, the respondents from the study area confirmed that drought is the most common driver of food insecurity in Somalia. Approximately 51% of the respondents agreed that drought is the primary driver of food insecurity, while 26% acknowledged floods as the second most common driver. Another 24% of respondents agreed that the lack of climate change adaptation policies is a major cause of food insecurity.

Discussion

The demographic analysis in this study reveals interesting trends. The smallest age group was those below 18 years old, making up 4% of participants. The largest age group was the 18-25 bracket, comprising 67%, while 24% fell into the 26-30 range, and 5% were over 30. In terms of gender, 75% of participants were male, and 25% were female. Regarding education, 69% held bachelor's degrees, and 24% were Graduate students. A smaller group, 7%, had a high school education, and none had non-formal education. Occupation-wise, stu-

dents were the largest group at 45%, followed by farmers at 26%. Environmental activists and lecturers made up 18% and 11% respectively. This breakdown gives insight into the diverse demographics of the participants, with a significant presence of young adults aged 18-25 and a notable gender difference. Most of the responses suggesting a decrease in precipitation indicate a recent decrease. Additionally, the respondents agreed that water availability is a problem, primarily due to its unpredictability, which has significantly impacted agricultural production. According to the Heritage Institute's report, climate change has emerged as a significant threat to food security in Somalia. The impact is particularly felt in the livelihoods of rural communities, as climate directly affects the quality and availability of both livestock and rain-fed crops. Somalia's climate is characterized as semi-arid, with only two regions experiencing 400-600 mm of rain: a small area in the northwest and the Shabelle and Juba valleys.

The country frequently faces droughts, with mild to moderate ones happening every 3-4 years and more severe droughts occurring every 8-10 years (Heritage [7]). 65% of the respondents agreed that the temperature had risen. As stated by the Somali Federal Government's report on climate change countermeasures, rising temperatures have had a significant impact on Somalia's agriculture. These warmer temperatures increase evaporation and lower humidity, resulting in drier weather and less rainfall. As a result, the availability of water for irrigation has decreased, leading to a sharp decline in crop yields. In recent years, Somalia has experienced a drought that negatively impacts agricultural development. As per the findings of the FAO and the World Bank (2018), the 2017 drought caused substantial losses, amounting to US\$71 million, in the four main crops cultivated in Somalia. Specifically, corn and sorghum suffered losses of US\$35 million, while cowpea and other crops recorded losses of US\$9 million and US\$28 million, respectively (Somalia [8]). According to Zhao [9], Climate change threatens agricultural production. Understanding climate change, particularly its temperature implications, is crucial for policymakers, agriculturalists, and crop breeders if global food security is to be ensured. The results vary greatly between crops and geographical areas, with some positive impact estimates. Multi-method evaluations increased confidence in future climate impacts on global key crops and suggested crop- and region-specific adaptation options to sustain food security for a growing global population.

The study also indicates that climate change has significantly affected the performance of rainfed crop production, particularly cereal crops that serve as both food and fodder. According to Al-Bakri [10], Rainfed agriculture was extremely vulnerable to climate change due to higher air temperature and decreased precipitation. Increased air temperature had a negative influence on barley yield across the various future scenarios, while precipitation loss had a negative impact on both wheat and barley. As a result, adopting soil water conservation to enhance crop-accessible water could be viewed as an important adaptation tool to climate change. Another adaptation measure that should be addressed to mitigate the negative effects of climate

change is the selection of drought-tolerant genotypes with shorter growth seasons than the current genotypes. On the otherhand the data highlight the detrimental effects of climate change on livestock production. Similarly, Cheng [11], stated that cattle production has an impact on climate change by accounting for 14.5% of worldwide anthropogenic GHG emissions.

Mitigation techniques on the livestock side could aid in addressing enteric emissions and improving manure management, as well as more emission-efficient feed production through reduced N-fertilizer use and land carbon sequestration. The study highlights the urgency of implementing climate change adaptation policies in Somalia given the limited scientific knowledge and region-specific research. Forecasts for the Horn of Africa say the region will experience more frequent and extreme droughts and floods that already exist in Somalia. These climate disasters have led to widespread famine, loss of life, and loss of livestock. Therefore, it is important to reduce vulnerability to climate-related risks in critical sectors and communities. In the previous studies' hypothetical situation which they adapted, the impact of adaptation on production is smaller for farm households that really did adapt than for farm households that did not adapt. Furthermore, if the nonadapters adapted, they would generate the same results as the adapters (Di Falco [12]).

The findings highlighted that widespread drought followed by floods is a major cause of food insecurity in Somalia. Respondents reported a food security crisis as a direct cause of these climate events. Flooding usually occurs during the rainy season when rainwater overflows from existing rivers. For example, recent flooding in 2019 claimed many lives, displaced 412,000 people, and destroyed crops. (GIEWS [13]) Overall, the data underscores the complex relationship between climate change, food insecurity, and land degradation in Somalia. Drought emerges as the most significant driver of food insecurity, while the impact of floods and the absence of climate change adaptation policies are also recognized. Additionally, the data emphasize the challenges of land degradation and the time required for the regeneration and recovery of agriculture and livestock production systems following climate-related damage. These findings highlight the urgent need for effective climate change mitigation and adaptation strategies to address food security challenges in Somalia.

Conclusion

In conclusion, this comprehensive study sheds light on the profound implications of climate change on food security in Somalia by employing a combination of qualitative and quantitative research methods. The data collected through questionnaires and interviews with a diverse group of participants underscore the undeniable impact of changing climate patterns on the country's agriculture. The research reveals a disturbing trend of diminishing precipitation and rising temperatures, leading to land degradation, water shortages, and a decline in crop and livestock productivity. These environmental challenges directly contribute to food shortages, exacerbating the

already precarious food security situation in the region. The study emphasizes the urgency of adopting policy interventions to address these challenges and build resilience against climate-related risks. The suggested policy measures encompass sustainable research and development of crops, promotion of adaptive agricultural technologies, and support for farmers in adapting to changing environments. By focusing on sustainable crop production, the study posits that Somalia can mitigate the adverse effects of climate change on its food security and reduce vulnerability to climate-related disasters. The demographic analysis included in the study underscores the importance of involving diverse stakeholders, particularly the youthful population, in formulating and implementing effective policies to combat climate-induced food insecurity.

Furthermore, the research delves into the nuanced impact of climate change on various crops and livestock. It highlights the vulnerability of rainfed crop production, particularly cereals, and underscores the need for adaptation strategies such as soil water conservation and the selection of drought-tolerant genotypes. The study also underscores the significant role of livestock production in climate change and offers potential mitigation approaches to address emissions and improve overall efficiency. Overall, the study contributes vital insights to the ongoing global discourse on climate change and its repercussions on food security. By presenting a detailed picture of the challenges faced by Somalia, the research serves as a call to action for the implementation of targeted and timely climate adaptation policies. The findings resonate not only with Somalia but also with regions worldwide facing similar climatic threats, reiterating the critical need for proactive measures to ensure a more secure and sustainable food future.

Recommendations

The findings of this research highlight the urgent need for action by various stakeholders to address the challenges posed by climate change in Somalia. The study is recommending;

- 1. Invest in Drought-Resistant Crop Varieties:** Allocate resources to research and develop crop varieties that are specifically adapted to drought conditions, considering the significant impact of decreased precipitation on crop yield in Somalia.
- 2. Promote Efficient Water Management Techniques:** Initiate programs to educate farmers about efficient water management practices, given the reported water scarcity due to changing precipitation patterns. Techniques like rainwater harvesting and proper irrigation methods can enhance agricultural resilience.
- 3. Strengthen Climate-Resilient Livestock Farming:** Develop strategies to support livestock farmers in the face of rising temperatures and decreased water availability. This might include promoting heat-tolerant livestock breeds and providing training on livestock management under changing climate conditions.

4. **Establish Flood-Ready Infrastructure:** Invest in flood-resistant infrastructure, especially in areas prone to flooding. This is crucial, as flooding during rainy seasons has been identified as a major cause of food insecurity, leading to crop destruction and displacement of communities.
5. **Formulate Integrated Climate Adaptation Policies:** Develop comprehensive policies that integrate climate adaptation measures across various sectors, considering the complex interplay between climate change, food security, and land degradation. These policies should involve collaboration among government agencies, local communities, and relevant stakeholders to ensure effective implementation.

Compliance with Ethical Standards

We affirm that this study was conducted in strict compliance with ethical standards and guidelines. All necessary protocols for research involving human subjects were followed, and informed consent was obtained from all participants.

Conflict of Interest

The authors declare no conflicts of interest that could potentially influence the objectivity or validity of the findings presented in this work.

Author Contributions

Each author made significant contributions to various aspects of the study, including conception, design, data collection, analysis, and interpretation. Their individual roles and contributions have been duly acknowledged and appropriately documented.

Ethical Approval

This study obtained ethical approval from the relevant institutional review board (IRB) or ethics committee, ensuring that all ethical considerations were addressed appropriately.

Data Availability

The datasets used and/or analyzed during the current study are available upon reasonable request from the corresponding author, in compliance with data protection and privacy regulations.

Consent for Publication

Informed consent was obtained from all participants involved in this study to publish the research findings, ensuring confidentiality and anonymity wherever necessary.

Acknowledgment

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Mohamed Said. Biomed J Sci & Tech Res



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