

The Effects of Climate Change on Agricultural Sustainability in Somalia

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Abstract

Securing agricultural sustainability and food security is a major significant challenge facing developed and undeveloped countries. Rising temperatures, changing precipitation patterns, sea level rise, ocean acidification, and increased extreme weather events, which are climate change properties, are the main barriers to achieving them. This study investigates the perceived effects of climate change on agricultural sustainability in Somalia through a survey approach. The survey targets farmers, students, environmental researchers, and academicians related to agriculture fields. It aims to assess how farmers perceive changes in temperature, rainfall patterns, and drought frequency and how these changes affect agricultural practices, crop yields, and overall farm productivity. The survey also explores farmers' knowledge of climate change and their current adaptation strategies. Descriptive statistics were statistical techniques employed for this study and analysed using SPSS (version 25). According to the results, 80.4%, 75%, and 70% of the respondents strongly declared that changes in rain patterns, increasing temperature, and less water available for irrigation, respectively, existed in recent years in Somalia. These changes not only affected agriculture but also livestock production, as agreed by 71.4% of the participants. Ultimately, this study highlights key strategies that can be implemented for achieving agricultural sustainability in the face of climate change.

Keywords: Agricultural Sustainability, Climate Change, Environmental Challenges, Somalia

1. Introduction

Agricultural sustainability refers to methods that fulfill the community's current food and fiber requirements without compromising future generations' capacity to meet their needs. Agricultural sustainability is the vice versa of conventional farming, which relies heavily on high input, synthetic chemical pesticides, mechanization, extensive land use, and monoculture farming and often prioritizes quantity over quality [1-4]. It encompasses environmental, economic, and social dimensions, which are the three main keys to ensuring long-term agricultural viability, reducing reliance on synthetic fertilizers and pesticides, protecting natural resources, and increasing production [5-7]. Integrated pest management (IPM),

crop rotation, biodiversity conservation, polyculture, sustainable livestock farming, and use of renewable energy are primary principles of Agricultural sustainability [8-13]. Agricultural sustainability is an essential pathway to achieving global food security but faces many problems including soil degradation, depletion of nutrients, water scarcity, and loss of pollinators and beneficial insects [14-19]. Climate change is the biggest obstacle contributing to the above challenges by intensifying droughts, floods, and extreme weather events. Consequently, this can lead to crop failures, livestock death, increased pest problems, and lower yields, which harm sustainable agriculture in the long run [20-23].

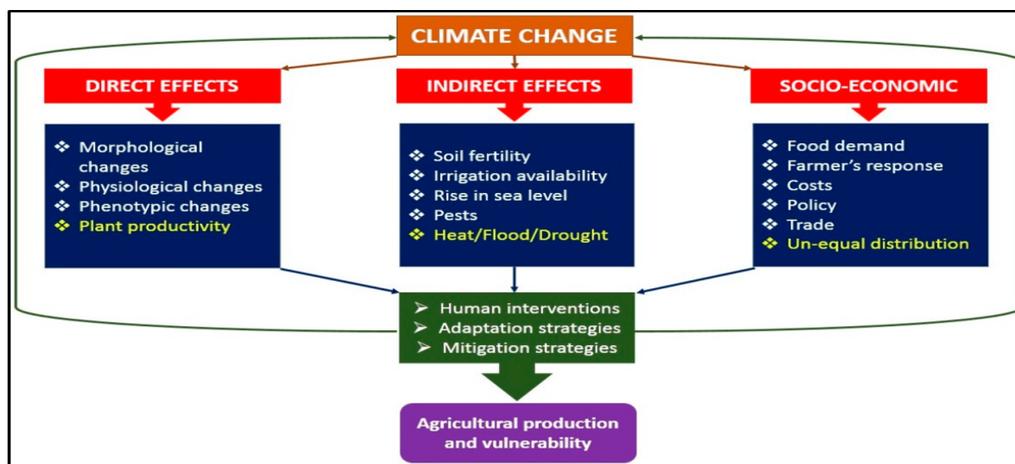


Figure 1: Effects of Climate Change on Agricultural Production through Direct, Indirect, and Socioeconomic Means [24]

Globally, climate change directly influences cereal crops and legume yield through water and heat stresses and indirectly affects pests, rise in sea level, irrigation and fertilizer availability, and pathogens, as shown in Figure 1 [24,25]. In Africa, agriculture represents 30-40% of the GDP and is the primary economic activity of more than 70% of the poorest individuals on the continent [26-28]. There are significant concerns regarding agriculture in Africa, even in the absence of climate change, due to conflict, degraded soil, and irregular water supplies [29-31]. Over three decades have seen a rise in the severity and frequency of floods and droughts. For example, the Sahelian drought was a series of droughts that hit the Sahel region of Africa, stretching from West Africa to Ethiopia [8]. Due to this drought, millions of animals and nearly 300,000 people died [32,33]. Several African countries are experiencing more frequent droughts and floods, which are increasingly negatively impacting the population [34].

The agricultural sector in Somalia continues to be the foundation of the nation's economy, accounting for over 75% of the GDP and 93% of all earnings from exports [35]. However, several political, economic, and environmental barriers hinder the development of a strong agriculture sector [36-38]. Additionally, Somalia is one of the world's most vulnerable countries to climate change. The agricultural production of Somalia is negatively impacted by the rising temperatures. In addition to decreasing soil moisture and increasing evaporation, it also results in drier weather and rain failures. This would ultimately result in less water being available for irrigation, which would further significantly reduce the yield of crops [39,40]. In recent years, due to recurrent floods and droughts that reduce crop productivity, damage property, and uproot households, a quarter of Somalia's population (4.3 million people) is in danger of "crisis-level hunger or worse" [41-43]. This research aims to evaluate the effects of climate change on agricultural sustainability in Somalia. Additionally, we declare the distribution of perceptual statements of climate change impacts through qualitative and quantitative methodologies. Finally, we examined the best solutions to Somalia's climate change challenges.

2. Material and Methods

2.1. Study Design and Area

The research was designed as a descriptive study that utilizes quantitative data to explore the effects of climate change (rainfall decrease, temperature increase, and recurring floods) on agricultural sustainability in Somalia, providing a snapshot of current conditions and perceptions. Structured questionnaires, which are a classic and widely used method for data collection, were employed to gather information on the population's knowledge, opinions, behaviours, and other details [44,45].

2.2. Population and Sample

The survey targeted local farmers, agricultural experts, students, environmental activists, and residents significantly impacted by climate change, with a research population of 65 people. To ensure representation across demographics such as gender, age, marital status, and occupation, the study group was chosen through a random selection process from the population. Three different factors were taken into consideration to determine the sample size. Firstly, the intended confidence level (95%), followed by the sample's estimated proportion, and lastly, the margin of error. 56 participants in total were surveyed using Yamane's sample size formula [46].

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

Where

n = Sample size

N = population size

e = 0.05 Proportion of estimated sample, e = 0.05 Margin of Error (MoE),

$$n = \frac{65}{1 + 65(0.05)^2} \quad (2)$$

$$n = \frac{65}{1.1625} = 56. \quad (3)$$

The data collected through this study was analysed using the Statistical Package for Social Sciences (SPSS) version 25. To ensure ethical considerations were addressed, informed consent was obtained from all participants.

3. Results and Discussion

The demographic data of the fifty-six (56) participants is shown in Figure 2. 71.4% of the respondents were male, while 28.6% were females. In marital status, most of the respondents were

single (42.9%), compared to 35.7% and 21.4% for married and divorced respondents, respectively. Among the respondents, the largest group were those with graduate (42.9%) and non-formal (25.0%) qualifications. Secondary (17.9%) and primary (14.2%) qualifications represent the smallest groups. Additionally, 42.9% of participants fell within the 18-25 age range, followed by 25.0% between 26-33, 17.8% between 34-44, and 14.3% over 50 years old.

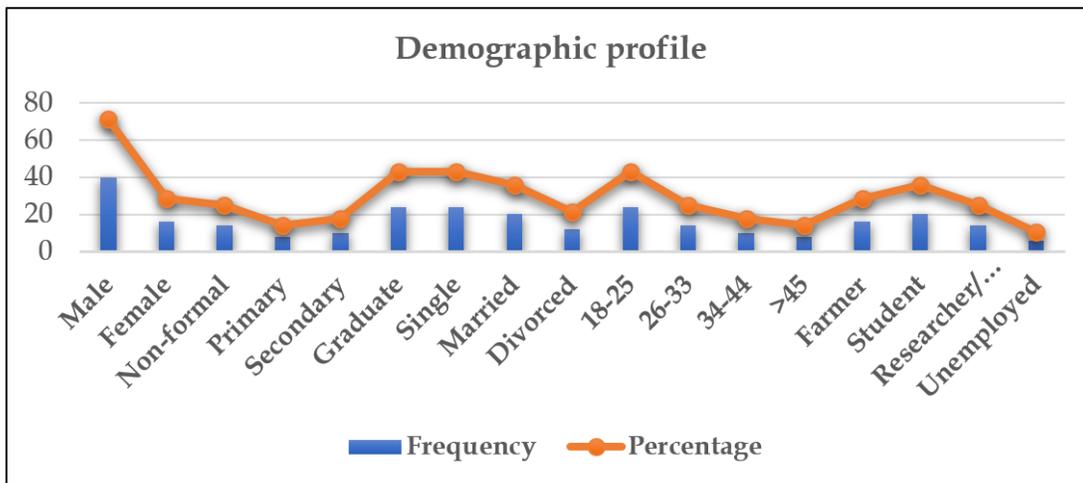


Figure 2: Demographic Profile of the Participants

In this study, researchers surveyed students (28.6%), farmers (35.7%), researchers/academician (25.0%), and unemployed individuals (10.7%).

Variable	n	%
Have you observed any recent changes in the patterns of rainfall in Somalia?		
Yes	45	80.4
No	11	19.6
Total	56	100.0
As you have observed, has the temperature increased in Somalia?		
Yes	42	75
No	14	25
Total	56	100.0
Is there less water available in Somalia for irrigation because of climate change?		
Yes	39	70
No	17	30
Total	56	100.0

Table 1: People's Perceptions of Climate Change

According to the people's perceptions of climate change, as illustrated in Table 1, a significant majority of respondents (80.4%) have observed the changes in the patterns of rainfall in Somalia, while a smaller percentage (19.6%) reported that they have not observed any changes in rainfall patterns in Somalia. Three-quarters of the participants (75%) expressed that temperatures have increased in Somalia in recent years. Various studies have expressed the existence of decreasing rainfall and rising temperatures in Somalia [47-50]. A 2023 survey in Somalia

highlighted changes in rainfall patterns and temperature. 63% of respondents reported experiencing irregular rainfall, while 65% indicated increasing temperatures [51]. In Somalia, climate change has not only led to observed changes in temperature and rainfall, but it has also caused a significant increase in water scarcity for irrigation [52-54]. 70% of the respondents also strongly supported that there is less water availability for irrigation, which can be devastating for agricultural production, potentially leading to food insecurity and malnutrition [55-57]. Additionally, due to

climate change, agricultural intensification, and urbanization, the degradation of freshwater and the rise in water demand have become major concerns, particularly in areas already experiencing water stress [58,59].

Variable	n	%
Rising temperatures, floods, and droughts typically impact agricultural activities		
Agree	38	67.8
Disagree	10	17.9
Neutral	8	14.3
Total	56	100.0
Climate change not only damages agriculture but also livestock production		
Agree	40	71.4
Disagree	8	14.3
Neutral	8	14.3
Total	56	100.0
Agricultural instability in Somalia is largely caused by land degradation, deforestation, and drought, which climate change makes more severe		
Agree	34	60.7
Disagree	12	21.4
Neutral	10	17.9
Total	56	100.0
Using organic farming techniques in Somalia can improve soil health and resilience to climate change		
Agree	36	64.2
Disagree	10	17.9
Neutral	10	17.9
Total	56	100.0

Table 2: Distribution of Perceptual Statements of Climate Change Impacts

Climate change can cause soil degradation, deforestation, salinization, pollution from fertilizers and pesticides, and the reduction of pollinators, which in turn impact agricultural activities and production [60-63]. Additionally, as 67.9% of participants in the survey agreed, rising temperatures, floods, and droughts typically impact agricultural activities. Livestock not only provides us with essential food sources like meat, milk, and eggs, but also gives us valuable resources like wool, leather, and manure, and even helps with tasks like plowing and transportation [64,65]. However, climate change is a major threat to this century and damages it worldwide. In Somalia, 71.4% of respondents agreed it's a problem. The remaining respondents had differing views, with 14.3%

disagreeing and 14.3% remaining neutral. A study conducted in 2022 also emphasized that climatic effects hinder the production of livestock in Somalia [66]. Over half of the participants (60.7%) agreed that land degradation, deforestation, and drought, all of which are made severe by climate change, are major contributors to agricultural instability in Somalia. The remaining participants were divided, with 21.4% disagreeing and 17.9% offering a neutral response. Previous studies have highlighted how deforestation, drought, floods, agricultural land expansion, and land degradation contribute to agricultural instability in developed and developing countries [67-72].

Variable	n	%
What is the most common consequence of climate change in Somalia?		
Crop failure	34	60.7
Livestock death	14	25.0
Increased pest problems	8	14.3
Total	56	100.0
What factors contribute to soil erosion and food insecurity in Somalia?		
Deforestation	26	46.4
Drought	22	39.3
Overgrazing	8	14.3
Total	56	100.0
What is the best solution to climate change to achieve agricultural sustainability and food security in Somalia?		
Expanding climate-smart agriculture	26	46.4

Enhancing market access for sustainable agriculture	16	28.6
Investing in Early Warning Systems	14	25.0
Total	56	100.0

Table 3: Climate Change Challenges and Solutions in Somalia

Climate change is the primary factor affecting agricultural sustainability in Somalia. More than half of the participants (60.7%) identified crop failure as the most common consequence of climate change in Somalia, followed by livestock death (25.0%) and increased pest problems (14.3%). The USA and China, the largest agricultural crop producers, have seen increased crop failures because of climate change [73,74]. Sub-Saharan countries, including Somalia, Ethiopia, Kenya, and South Sudan, are also experiencing the impacts of climate change on their agricultural production [75-79]. Soil erosion is a global concern caused by climate change. It contributes to food insecurity and agricultural instability in many areas. Many factors accelerate soil erosion, such as deforestation, recurrent droughts, and overgrazing. Our study found that 46.4% of respondents declared deforestation as the most significant contributor to soil erosion. Drought (39.3%) and overgrazing (14.3%) were also recognized as major factors.

In this survey, solutions to climate change for achieving agricultural sustainability and food security in Somalia found that 46.4% of respondents recommended expanding climate-smart agriculture as the best solution. Enhancing market access for sustainable agriculture and investing in early warning systems were also identified as important measures, suggested by 28.6% and 25.0% of participants, respectively. As shown in Table 2, more than half of the participants (64.3%) agreed that adopting organic farming techniques in Somalia can improve soil health and strengthen resilience to climate change. According to Ali. I. I. [80], agroecology represents one of the key approaches to achieving food security by reducing dependence on chemical inputs, preserving biodiversity, promoting diverse cropping systems, improving soil health, and ensuring better water management. This approach is increasingly being adopted in developing countries, including Somalia, to promote food security and agricultural sustainability.

4. Conclusion

Somali agriculture and livestock production are heavily affected by climate change. Rising temperatures, recurrent floods, and increased frequency of droughts pose a significant threat to food security and rural livelihoods. This study combines qualitative and quantitative research methods to explain the severe effects of climate change on agricultural sustainability in Somalia. Our study highlighted a concerning pattern of rising temperatures and decreasing precipitation. This combination leads to increased evaporation, reducing soil moisture. Consequently, less water is available for irrigation, potentially causing significant reductions in crop yields and livestock production. Solving all these issues takes more time, but it is mandatory to do so rapidly through organic practices like composting and cover cropping, which increase organic matter in the soil. This acts like a sponge, holding more water and reducing evaporation during dry periods, which

is crucial in Somalia's arid climate. Additionally, it reduces reliance on chemical fertilizers and improves soil structure, promoting healthy microbial populations that contribute to long-term soil fertility. Implementing and expanding climate-smart agriculture is crucial in adapting to climate change problems, as agreed by nearly half (46.4%) of respondents in this survey. Enhancing market access for sustainable agriculture can facilitate adaptation to climate change challenges while investing in early warning systems can strengthen resilience. Promoting sustainable land management practices, sowing drought-resistant crop varieties, investing in water-efficient irrigation systems, and encouraging diversification of agricultural activities can also mitigate major climate change issues. Finally, we recommend that future researchers conduct comprehensive studies related to flood and drought solutions, which are the most exacerbated factors of agricultural sustainability and food security in Somalia.

Author Contributions

Each author contributed to different aspects of the study, such as conceptualization, design, data collection, investigation, analysis, reviewing, and editing. All authors have reviewed the results and approved the final version of the manuscript.

Data Availability

Data used to support the findings of this study are available from the corresponding author upon request.

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