Climate Change and Crop Adaptation in Sahelian Savana Region of Nigeria

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Abstract. The investigation into the consequences of climatic pressures on agricultural output has emerged as a central concern for agronomists and policymakers globally. This review specifically aims to fill in knowledge gaps regarding how certain climate changes affect agriculture in Nigeria, particularly in the Savanna region. Recent research has indicated that as temperatures rise, soil organic carbon (SOC) levels decrease, especially in areas with high initial SOC levels. Reduced crop yields in Sahelian agro-ecosystems are primarily a result of a shorter growing season, caused by higher atmospheric temperatures. Diminished agricultural residues contribute to lower levels of SOC and nitrogen, posing a threat to crop production globally. To counteract this risk, strategies like adjusting times for crop planting, developing climate-resilient crop varieties, using nitrogen fertilization, disease prevention and pest control should be put into place.

1 Introduction

The accelerated pace and magnitude of climate change have become a subject of concern globally. Climate change, defined as long-term alterations typically spanning over 30 years, exerts diverse impacts on human life. Currently, fluctuations of ecosystem temperature in line with climate change are influencing agricultural production and output harvesting. Concurrently, global population growth necessitates higher demand of food production. However, heightened global climate change over the past few decades [1] rising environmental temperatures, and the expected increased frequency of droughts and floods will complicate this demand [5] for new ways of farming in Saharan regions, which will reduce the crop yield of rural farmers. More importantly, acquiring knowledge in academic patterns for the negative impacts of climatic changing disasters on soil crop production has become a priority for agronomists and policymakers worldwide. Consequently, the escalating rate of climatic alteration may be destabilizing existing agricultural systems. Additionally, the Industrial Revolution has been instrumental in the augmented sequestration of thermal energy and global warming, alongside generating pronounced spatial and temporal fluctuations. This has a remarkable impact on the overall rainfall pattern in the Sahel region, changing the onset, amount, and intensity of precipitation. Forecasts of climate phenomena relevant to agriculture are generally made using statistical (empirical) models or process-based (mechanistic) models of crop simulation. Numerous scientific studies confirm that the latter model is more suitable for predicting future crop yields under dynamic climatic conditions. This advantage is due to their inherent capacity to integrate the multiple effects of environmental, pedological, agronomic, and horticultural changes on crop production.

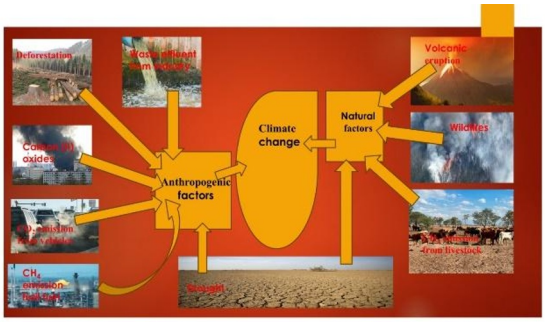

Fig. 1. Climate Change Forcing Factors and Environmental Responses in the Sahelian Zone of Nigeria. Source : Author's conceptualization (2026)

2 METHODOLY

This study employed a literature review approach, analysing existing research on climate change impacts in Nigeria's Savanna-Sahelian region. Secondary data from journals, articles, and online sources informed the examination of soil health, agricultural productivity, and climate change adaptation strategies in the region.

3 PECULIAR CHARACTERISTICS OF THE SAHELIAN REGION

Sahelian region stands out due to its distinctive characteristics that set it apart from other areas. It stretches along the southern edge of the Sahara Desert, spanning across multiple nations. Pierre et al. [2] explained that the Sahelian region features a predominantly arid landscape with sparse vegetation and experiences high temperatures during the day and cooler nights, along with minimal and erratic rainfall. The region is mostly semi-arid, with limited arable land due to poor, rocky soil that hampers plant growth [3].

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The environment and climate of the region greatly impact the daily lives and livelihoods of its inhabitants [3]. The dominant edaphic substrates in the Sahel are typically characterised by high sand content, pH < 7, and a lack of organic matter [2]. The decline in soil fertility on African savannas is linked to low levels of essential elements, which can be attributed to the level of organic carbon [4]. In addition, rural farmers have been using agricultural land without adding organic inputs, and this has led to a decrease in basic nutrients, soil organic carbon, and crop yields [6]

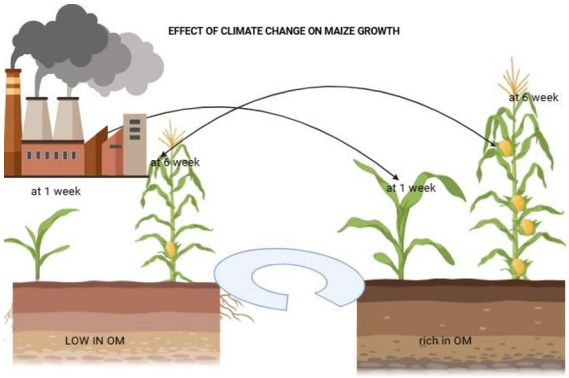

Fig. 2. Effect of Climate Change on Maize Growth. Source : Author's conceptualization (2026)

4 EFFECT OF CLIMATE CHANGE ON SOIL HEALTH

Climatic shifts are dramatically changing the physical condition and characteristics of soils, which in turn affects their fertility. [7] Reported that one of the most common impacts of climate change on ecosystems are changes in temperature, precipitation variations, and an increase in extreme weather events. [16] conducted an 11-year warming experiment in a wheat field to assess how continuous heat affected soil structure and organic carbon. Their findings showed that prolonged warming increased soil density while reducing overall pore space and larger pores. Shah et al. [9] found that maize production decreased by 30% as soil compaction intensified. Additionally, reported that the rise in global temperatures resulted in a 10.6% decrease in overall soil organic carbon content [6-10] Highlight that altered precipitation patterns and rising temperatures linked to climate change substantially impact soil moisture levels. [16] Note that intense rainfall leads to topsoil erosion, diminishing agricultural productivity, while climatic shifts significantly alter soil chemical properties. [6]. The swift depletion of soil organic matter, a reduction in soil salinity, and the loss of exchangeable cations are rapid occurrences, primarily stemming from shifts in climatic conditions and land management techniques [6]

In agricultural systems, a high concentration of one nutrient can diminish the availability of several other elements. For example, increased levels of CO_2 typically improve cropland by increasing soil organic carbon (SOC) and certain nutrients such as available potassium (K) and total nitrogen (N) [11]. It was discovered that elevated CO_2 levels in croplands boosted available potassium (K) and total nitrogen (N) [12]. Similar trends were noted by [13] These findings are corroborated by [14] who reported climate change-induced declines in crop quality.

5 Conclusion

Conclusively, this reviewed work indicated that rising temperatures lead to decreased soil organic carbon (SOC), especially in areas with high initial SOC, shortening growing seasons and reducing crop yields. Lower residues, depleted SOC, and reduced nitrogen availability threaten global food production. To counter this, strategies like adjusted planting schedules, crop breeding, optimized nitrogen use, and enhanced pest management are crucial.

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