Climate-smart agriculture as a possible solution to mitigate climate change impact on food security in Sub-Saharan Africa

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REVIEW

Climate-smart agriculture as a possible solution to mitigate climate change impact on food security in Sub-Saharan Africa

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Abstract

Climate change is a constant threat to global food security. In Sub-Saharan Africa (SSA), extended dry spells, heavy rainfall, flooding, and tropical storms have driven a large percentage of the population to a severe food crisis. Climate-smart agriculture (CSA) is a potential comprehensive solution whose adoption can mitigate climate change and its ramifications on the state of food security in the region. CSA combines innovation, the use of technology, extensive research, stakeholder involvement, and data to increase food production, optimize resource allocation and utilization, and enhance the region's ability to feed its population. The adoption of CSA has succeeded in increasing agricultural productivity in several parts of SSA and will help towards the building of resilience food systems across the region amid constant and unpredictable climate change and its far-reaching impacts in the region. For the sustained and universal adoption of CSA within the region, there is a need for more stakeholder involvement in its development and adaptation to the needs of specific communities. Furthermore, it is necessary to leverage the positive impact of the approach by expanding its scope beyond climate change mitigation to prevention and control, and ultimately help in achieving the United Nations SDG 2 and 13.

KEYWORDS

climate-smart agriculture, food security, mitigate, solution, Sub-Saharan Africa

1 | INTRODUCTION

Climate change is a major threat to global food security. In Sub-Saharan Africa, climate change manifests through extended periods of drought, lack of rainfall, floods, and high temperatures. These weather changes have significantly reduced agricultural productivity, and are expected to lead to the loss of two-thirds of the continent's arable land by 2025 (Masipa, 2017). As a result, crop yields have fallen to alarming levels, with the limited output of staple grains such as maize, rice, sorghum, and wheat rendering the region incapable of feeding its population. Consequently, Sub-Saharan Africa is facing a food security crisis that will worsen if solutions to mitigate climate change and its impact on the region's food security are not implemented.

Efforts to increase crop yield, restore the region's ability to sustain its growing population, and mitigate the impact of climate change on food production have led to the adoption of Climate-smart agriculture (CSA). CSA is a combination of approaches that target the transformation of agricultural systems to establish, restore, and maintain food security amid unfavorable climate change (Westermann et al., 2018). The approaches leverage technology for data collection, communication with stakeholders, and coordinating regional efforts to boost food security through sustainable agricultural practices.

The approaches that make up CSA include resource-use efficiency and conservation. As a promising solution to Sub-Saharan Africa's climate change-driven food security problem, CSA has the potential to restore the region's lost soil fertility, optimize water storage and usage and boost crop yield (Branca et al., 2021). However, the adoption and implementation of CSA across Sub-Saharan Africa face three debilitating challenges despite the solution's positive implications for the future of food security in the region. Fortunately, increased investment, the inclusion of all stakeholders in decision-making, and partnerships with African governments can help overcome the challenges of limited knowledge among farmers and other stakeholders, inadequate funding, and political interference.

2 | THE SITUATION OF FOOD SAFETY AND CLIMATE CHANGE IN SSA

The current food security and climate change situation in Sub-Saharan Africa is critical. Changes in weather patterns and extreme weather conditions have driven parts of Eastern, West, Central, and Southern Africa into extreme food insecurity. According to humanitarian organizations, the Greater Horn of Africa is experiencing its most devastating drought in over 40 years. Experts attribute the drought to the raised temperatures of the Western Pacific Ocean, which have led to significant rainfall deficits in Somalia, Ethiopia, Kenya, and other countries in Eastern Africa. Since the region relies heavily on rain-fed agriculture, the extended dry spell has taken human lives, led to massive crop failure, and caused the death of livestock (Haile et al., 2019). The crop failure and livestock deaths have left millions of people in Somalia, Ethiopia, Kenya, and Djibouti without enough food and water to meet their daily caloric and nutritional needs. The situation is replicated across all other parts of Sub-Saharan Africa (Baptista et al., 2022). In addition, changes in weather patterns have subjected West and Central Africa to heavy rainfall since July, according to the World Food Program (Madjiangar, 2022). The extended periods of heavy rain have led to the worst floods in the region in decades. The floods have destroyed crops, limited the region's capacity to grow food, displaced people, and swept their property, leaving millions of people in West and Central Africa food insecure. In Southern Africa, extended periods of drought, deadly tropical storms, and heavy flooding in 2022 have led to poor harvests leaving several countries, including Malawi, Madagascar, Zimbabwe, Mozambique, and Malawi, severely food insecure. Figure 1 shows the selected effects of climate change on food security in Sub-Saharan Africa.

3 | THE BURDEN AND CURRENT STATUS OF THE IMPACT OF CLIMATE CHANGE ON FOOD SECURITY IN SSA

The burden of the impact of climate change on food security in Sub-Saharan Africa falls on the residents and governments of the respective countries in SSA, farmers in the region, and humanitarian organizations. The residents of SSA bear the heaviest burden of the impact of climate change on their food security. For instance, the World Bank estimates that more than 656 million people in Eastern and Southern African countries such as Ethiopia and Madagascar are food insecure and report significant challenges in their access to food that is safe, nutritious, and enough to meet their daily caloric needs (Kray et al., 2022). Equally, large numbers of people in Central and West African countries such as Senegal, Niger, Mauritania, Mali, Chad, Burkina Faso, and other Sahelian countries are food insecure and do not consume enough nutrients and calories for sustenance (UN Office for the Coordination of Humanitarian Affairs, 2021). Consequently, they battle malnutrition, starvation, and death in extreme circumstances. Figure 2 summarises food insecurity in Sub-Saharan Africa by Country.

In addition, communities are sometimes forced to abandon their homes and ancestral lands in search of food and water. The government is the second stakeholder on whom the burden of food insecurity in SSA falls. The governing authorities of the countries in the region are responsible for the rampant food insecurity due to their inability to feed their people by solving the primary challenge of the vulnerability of the region's food systems to climate change. The burden of adopting solutions such as CSA to reduce the negative impact of climate change on their region falls on them. The governments share the burden with humanitarian organizations that provide food and water to the food-insecure population and work with other stakeholders, such as farmers in efforts to boost food production sustainably.

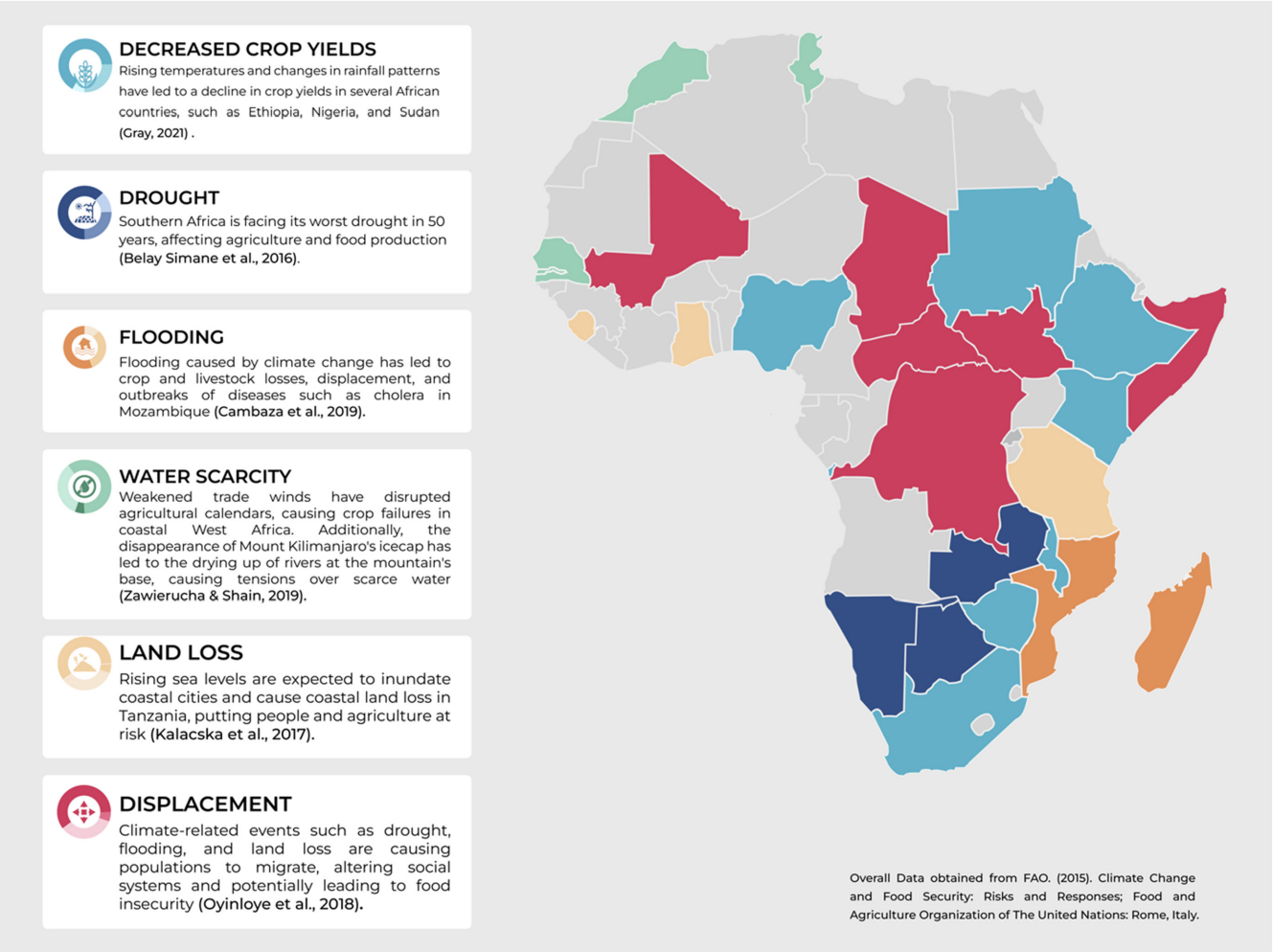

FIGURE 1 Selected effects of climate change on food security in Sub-Saharan Africa.

4 | CURRENT EFFORTS AND CHALLENGES FACING THE MITIGATION OF THE IMPACT OF CLIMATE CHANGE ON FOOD SECURITY

In recent years, stakeholders have made numerous efforts to mitigate the impact of climate change on the production of safe, nutritious, and adequate food globally. In Sub-Saharan Africa, the most promising efforts to this end are the mass adoption of CSA across the region, the deployment of appropriate technology such as push–pull technology, and the establishment of collaborative partnerships among key stakeholders in agriculture. Although SSA continues to grapple with mass food insecurity, the three efforts have improved food production, albeit marginally, and promise to address some of the effects of climate change on agricultural productivity. Collaboration among stakeholders streamlines the adoption and implementation of appropriate policies such as CSA, which solves the problem of water scarcity and drought through irrigation and farming methods that retain soil moisture (Branca et al., 2021).

The desired outcomes of the adoption of CSA across Sub-Saharan Africa align with two of the 17 Sustainable Development Goals that were adopted by the United Nations in 2015. SDG 2 targets the elimination of world hunger to create a hunger-free world by 2030, while SDG 13 focuses on climate action and recognizes the need for prompt action to address climate change and its effects (FAO, 2015). CSA has the potential to eliminate food insecurity and address climate change by transforming agriculture through increased agricultural productivity, improving the resilience of SSA's food systems, and reducing agriculture-related emissions of greenhouse gases and other pollutants (Makate, 2019). All three outcomes of the solution will drive Sub-Saharan Africa toward the fulfillment of SDG 2 and 13 by improving the continent's food security and driving the universal adoption of sustainable agricultural practices that reduce the emission of greenhouse gases across Sub-Saharan Africa.

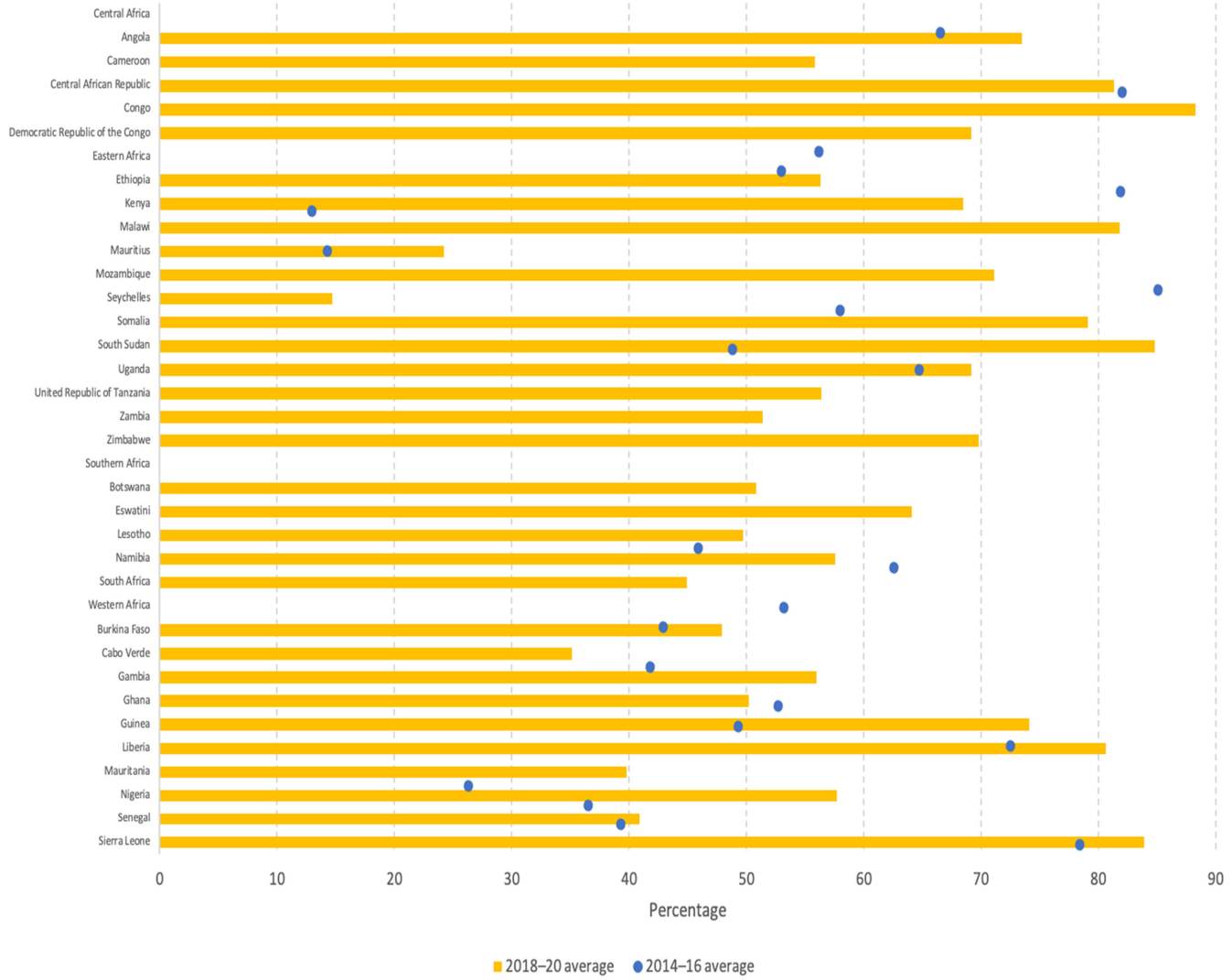

FIGURE 2 Food Insecurity in Sub-Saharan Africa by Country. Adapted from the Food and Agriculture Organization of the United Nations (2021).

One of the main challenges facing the above efforts to mitigate the impact of climate change on food security is the unpredictability of weather conditions, which raises the need for enhancing the adaptability and resilience of the region's food systems. Agriculture in SSA is primarily rain-fed. In the past, farmers planned planting activities around the rainy season to maximize output. However, the rapid deterioration of the environment has made it impossible to predict seasons in the region. To address this challenge, CSA and other efforts to boost food security in SSA must account for the unpredictable weather patterns by providing a contingency for limited rainfall, prolonged drought, and floods. The contingencies will guarantee constant food production and address the current vulnerability of Africa's food systems to climate change.

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Other challenges include the need for sustainability, limited consultation among stakeholders, and lack of funding for promising solutions. The agricultural industry causes climate change through the emission of greenhouse gases, the use of unsustainable agricultural methods that cause soil deterioration and erosion, and the misuse of crucial resources such as water (Lynch et al., 2021). The reduction of emissions, efficient use of water, and maintenance of the integrity of soil must

accompany other efforts to mitigate the role of climate change on the availability of adequate, safe, and nutritious food in Sub-Saharan Africa (Anita et al., 2010; Venkateswarlu & Shanker, 2009).

5 | FUTURE DIRECTIONS

To mitigate the impact of climate change on food security in Sub-Saharan Africa, it is crucial to promote the adoption of CSA practices and technologies. CSA is a holistic approach for improving food production and addressing the challenges of climate change and it has the potential to increase the resilience and sustainability of the region's food systems. To support the adoption of CSA in Sub-Saharan Africa, the following recommendations should be considered:

First, CSA has proven to be effective in diversifying agricultural activities, increasing crop and livestock yields, and enhancing environmental conservation (Branca et al., 2021; Makate, 2019). However, for these benefits to be realized, CSA must be adopted on a universal scale and adapted to the needs of different communities. This will require the involvement of farmers and communities in the decision-making process and the provision of necessary resources and support, including technical assistance, education, and training to drive the implementation of CSA practices by farmers.

Second, CSA approaches need to be adapted to the needs of different communities through community involvement and investment in research and development to support the mainstreaming and adaptation of new CSA technologies and practices to agriculture in SSA. For instance, one of the components of CSA is the creation of a dataset on soil fertility and management and the use of the data to plot the distribution of drought-resistant crops (Brandt et al., 2017). Involving communities and farmers will fortify knowledge gained through research and development and aid in the determination of the crop varieties that thrive in different locations and earn the commitment of the communities towards the adoption of CSA. Biotechnologists can use the information to breed seeds that thrive in extreme weather conditions to enhance the food system's adaptability to climate change.

Third, CSA approaches must be fortified with active steps to address and reverse climate change (Saj et al., 2017). This will require collaboration, partnerships between the private and public sectors, and consultation among key stakeholders, including farmers, governments, research institutions, and international organizations. With the right support and investment, CSA and other efforts can help to improve the adaptability and resilience of Sub-Saharan Africa's food systems and ensure the availability of adequate, safe, and nutritious food in the face of a changing climate.

Finally, investments in infrastructure, capacity building, and sustainability initiatives are necessary to support the transition to more resilient and sustainable food systems in Sub-Saharan Africa. This will enable the widespread adoption of CSA and other efforts to boost food security in the face of climate change. By implementing these recommendations, we can help promote the adoption of CSA in Sub-Saharan Africa and contribute to the creation of a more sustainable and secure food system in the region.

6 | CONCLUSION

The Sub-Saharan Africa is experiencing its worst food crisis in over 40 years. The main driver of the crisis is climate change, which has led to periods of extended drought, floods, and tropical storms in different parts of the continent. As a result, a significant percentage of Sub-Saharan Africa's population is food insecure. CSA presents a holistic solution to the negative impact of climate change on food security in SSA. The solution features a comprehensive set of approaches that reinforce the adaptability of the food system against climate change through resource conservation, the development of resilient crop varieties, and the adoption of farming methods that protect soil integrity. Over the past few years, stakeholders have laid the groundwork for the implementation of CSA in several parts of Sub-Saharan Africa. Ultimately, CSA will effectively mitigate the effects of climate change on agriculture and enhance food security in Sub-Saharan Africa if adopted universally with the participation of all stakeholders.

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DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available from the corresponding author upon reasonable request.

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