KENYA'S APPROACH IN INTEGRATING CLIMATE-SMART AGRICULTURE (CSA) TO ATTAIN SUSTAINABLE DEVELOPMENT GOAL 2 "ZERO HUNGER"

Phelyster K. NAFULA[1], Elly NDIAO[2], R. PASCALAU[3], L. DANCEA [4]*,
[1]Africa International University, Nairobi, Kenya
[2]Africa International University, Kenya
[3]University of Life Sciences "King Michael I of Romania" from Timișoara, Romania
[4]University of Life Sciences "King Michael I of Romania" from Timișoara, Romania
Corresponding author: lucretiu_dancea@usvt.ro

Abstract. *Climate-smart agriculture (CSA) aims to meet the elevating global food demand during this time of immense climate variability. It is also considered an effective strategy in attaining the Sustainable Development Goals 2 and 13, and thus, securing a better future. The study offers an in-depth analysis of Kenya's efforts to address Sustainable Development Goal (SDG) 2, which focuses on "Zero Hunger" by integrating CSA practices. The research employed a desktop research methodology that examined various academic literature, government reports, and international organization publications. The aim was to analyze the approach by farmers in Kenya in integrating CSA techniques into the agricultural systems. According to the research findings, in their commitment to achieve SDG 2, farmers in Kenya have integrated a multifaceted approach that includes the implementation of initiatives, and innovative farming practices aimed at promoting CSA. However, there are significant challenges that have been encountered in adopting and scaling up of CSA practices. The challenges include limited access to resources and technology as well as institutional and policy constraints. Interesting aspects that require further research based on the information from various sources in the use of CSA include the importance of local knowledge, community involvement, and innovative financing mechanisms. In general, this study provides useful insights into Kenya's progress toward SDG 2 by harnessing climate-smart farming methods, impacting future policy decisions and sustainable development efforts across the region.*

Keywords*: Climate-Smart Agriculture, SDGs, Sustainable Development*

INTRODUCTION

The Sustainable Development Goals or SDGs were established in 2015 with the focus being on ascertaining improvement of the wellbeing of all people from various angles and the environment. A significant aspect to note is that the goals are interdependent and aim at establishing a balance between environmental, economic, and social sustainability. The SDG under analysis in this studt is SDG 2 which focuses on eliminating world hunger to zero by the year 2030. According to a 2022 report by the United Nations, "By 2022, approximately 735 million people – or 9.2% of the world's population – found themselves in a state of chronic hunger – a staggering rise compared to 2019. This data underscores the severity of the situation, revealing a growing crisis." It is also estimated that if the target will not be met, about 600 million individuals will be suffering from hunger by 2030. This puts into perspective the role of Climate-smart agriculture (CSA) in fighting hunger. CSA is aimed at meeting the increasing global food demand during this time of heightened climate variability.

The agricultural landscape of Kenya features both limited irrigation land and small landholdings. This makes the percentage of arable land very small, an aspect that presents a challenge in developing sustainable agricultural practices. The situation takes into consideration the integration of sustainable land management (SLM) practices to address the challenge. Due to changes in agricultural practices as a result of globalization which has elevated and technologically supported farming practices, various farmers in Kenya, particularly those in horticulture and dairy farming, have embraced innovative practices. According to an article by

the World Bank (2015), "These value chains have the potential to generate enough revenue to enable farmers to invest in promising CSA interventions, such as the use of forage (improved feeding systems) and irrigation (water management practices). The CSA concept depicts the drive of the agriculture sector in many countries to constantly focus on both agricultural progress and climate adaptation (Bongole, 2023). It focuses on attaining food security concerning the wider development goals in a world that faces a constant increase in demand for food and climate change. CSA is associated with enhanced resilience, reduction of the emission of greenhouse gases, and improved productivity (Bongole, 2023). The practices associated with CSA bring together the goals of various nations and other stakeholders to ensure a more equitable and efficient food systems, a move that assists in addressing social, economic, and environmental issues (Singh et al., 2022). A significant aspect to note is that CSA is actively being used in various nations across the globe to manage production risks. Also, for CSA to be part of a nation's agricultural system, it is important to ensure the mapping of ongoing and completed practices including the potential financial and institutional supporters (Singh et al., 2022).

Statement of Purpose

Research shows that in the past four decades, the agriculture industry has remained the pillar of Kenya's economy, contributing more than 30% of the nation's gross domestic product, covering about 70% of the earnings from exports (Nyang'au et al., 2021). This implies that the country largely relies on agriculture for its economic progress. It also shows the need and relevance of integrating sustainable agricultural practices that will not only benefit the current generation but also meet the needs of the future generations. CSA is not a new concept in Kenya's farming practices as various studies have demonstrated how the concept is applied in various agricultural sectors. Accordingly, the aim of the study is to examine Kenya's approach to integrating CSA techniques into the agricultural systems in diverse sectors.

Research Question

What are the approaches used in Kenya to Integrate Climate-Smart Agriculture (CSA) to attain Sustainable Development Goal 2 "Zero Hunger"?

Research Objectives

1. To identify the efforts by Kenyan farmers to address Sustainable Development Goal (SDG) 2 through CSA practices
2. To identify the challenges that have been encountered in adopting and scaling up of CSA practices in Kenya

MATERIAL AND METHODS

The research employed a desktop review, a qualitative approach, to explore recent studies on the approaches used in Kenya to integrate Climate-Smart Agriculture (CSA) to attain sustainable development Goal 2 "Zero Hunger." The method was useful in examining what has been done by other scholars regarding the topic and providing insight into the CSA practices applied by farmers in Kenya to ensure continuous supply of food. Thisresearch design is considered useful when time and costs are limited. The key terms used to access the articles were "Climate-Smart Agriculture", "SDGs", "Climate Change" and "Sustainability." The involved data analysis entailed examining the key factors highlighted in past studies regarding thr application of CSA farming practises in Kenya . The information was divided in terms of the efforts by Kenyan farmers to address Sustainable Development Goal (SDG) 2 through CSA

practices and the challenges that have been encountered in adopting and scaling up of CSA practices in Kenya.

Table 1.

A list of the articles used in the review

Article	**Author(s)**	**Findings**
Sustainable Development Efforts in Kenya	Macharia (2019)	- Kenya's focus on sustainable development since independence, emphasizing environmental considerations. - Alignment with Vision 2023 and efforts towards achieving MDGs and SDGs.
Strengthening Food Security Measures in Kenya	Bande (2021)	- Collaboration between UN World Food Programme and Kenyan government to enhance food security.
Perception of Smallholder Farmers on Climate Change in Kisii	Nyang'au et al. (2021)	- Climate change impact on food production in Kisii, Kenya. - Adoption of Climate-Smart Agriculture practices to manage moisture shortages and enhance resilience. - Strategies include crop diversification, changes in planting timing, and use of drought-resistant seeds.
Potato Production and Climate-Smart Agriculture in Kenya	Waaswa et al. (2020)	- Adaptation of planting timing to align with changing weather patterns in Kenya.
Agriculture Production Status in Hawzen and Irob, Kenya	Kahsay et al. (2019)	- Shift in planting patterns as an adaptation strategy to changing rainfall patterns in Kenya.
Factors Influencing Adoption of Climate-Smart Agriculture	Musafiri et al. (2022)	- Various factors including family size, age, education, and access to weather information influencing farmers' adoption of Climate -Smart Agriculture in Kenya.
Challenges in Integrating Climate-Smart Agriculture in Kenya	Akweya (2023)	- Challenges in integrating Climate-Smart Agriculture practices, including financial constraints and legal issues. - Importance of linkages between researchers, extension workers, and farmers for effective implementation.
Application of Climate-Smart Agriculture in Southeast Kenya	Autio et al. (2021)	- Localized and gender-responsive solutions needed for effective implementation of Climate -Smart Agriculture in sub-Saharan regions.
Climate Adaptation Strategies in Ghana	Antwi-Agyei & Nyantakyi-Frimpong (2021)	- Adoption of drought-tolerant crop species and diversification of crops as climate adaptation strategies in Ghana.
Changes in Farming Calendar Worldwide	Amir et al. (2020)	- Highlighting changes in farming calendars globally, including shifts in planting periods due to climate change.

RESULTS AND DISCUSSIONS

Kenya and the SDGs

Kenya is considered active in focusing on Sustainable Development from the time it attained independence in 1963, not only within its borders but across the African continent (Macharia, 2019). This is after the realization that in the process of meeting the needs of the current generation, it is critical to ensure that the environment and the wellbeing of the future generations is considered. In relation to Vision 2030, the Kenyan government is perceived to focus on ensuring that all citizens lead a high-quality life and in a clean environment. This is also associated with how the government embraced both the MDGs and the SDGs and is still making efforts to ensure that the SDGs are achieved as expected (Macharia, 2019). Nonetheless, issues such as the post-election violence that occurred between 2007 and 2008, the COVID-19 pandemic, locust infestation including climate change which has interfered with rainfall patterns, have weakened the food security system of Kenya. Despite persisting problems, the UN World Food Programme works with the Kenyan government to strengthen measures aimed at developing a sustainable food system, ensuring long-term food and nutrition security in Kenya (Bande, 2021). A number of UN agencies, that include the International Fund for Agricultural Development (IFAD), the World Food Program (IFP) and the Food and Agriculture Organization (FAO), have collaborated with the Kenyan government to identify ways of ensuring the achievement of SDG 2. The FAO, which was established in 1945, has been active on establishing platforms and committees to address food security (Bande, 2021).

The efforts by Kenyan farmers to address Sustainable Development Goal (SDG) 2 through CSA practices

Nyang'au et al. (2021) in their analysis of perception of smallholder farmers' view on climate change and integration of CSA practices in Kisii, Kenya, state that high temperatures and low rainfall over the years significantly lowered food production in the region. The CSA practices adopted in the region include changes in how land is used and management of water, changing the topography of land and farm production techniques (Nyang'au et al., 2021). The changes aimed at managing the moisture shortages and change the period of farming activities. Also, their research findings showed that the use of CSA strategies sought to enhance resilience to climate change and heighten agricultural productivity.

In relation to farm production techniques, some of the strategies employed by the farmers include crop diversification, application of manure, including changing the frequency of applying manure. Other farmers also plant retained maize to use as the planting seeds instead of buying hybrid seeds while others use drought resistant seeds such as the *Punda Millia 529* and *SC Simba* to assist with coping with climate change. The diversification of plant crops include introducing crops that never grew in the area before, crops such as finger millet, green grams, cow peas and even flowers. The authors state, "These findings are in line with findings reported among farmers in semi-arid and sub-humid regions of Kenya where they stopped growing some crops due to low yields associated with low rainfall and opted for early maturing and drought resistant crop varieties" (Nyang'au et al., 2021, 6). Farmers in Ghana have also been found to grow drought-tolerant crop species together with diverse crops to align with the changing climate (Antwi-Agyei and Nyantakyi-Frimpong, 2021). Manure was applied in farms to enhance the fertility and moisture of soil.

The other strategy entails changing of the planting period. As per the study by Waaswa et al. (2020) on potato production and CSA in Kenya, farmers in Kenya have adjusted the timing

of their planting activities to align with the changing weather patterns. Planting is mostly done after rains begin and when there is certainty of sufficient moisture in the soils to facilitate growth.

Planting in Kenya is mainly done before the long rainfall season begins, that is, from December to February. With the late onset of rains, planting has shifted to between March and May. For the short rains, the offset was always between July and August. However, the onset of short rains currently is from September. Thus, farmers are adjusting to make use of the new farming patterns.

A similar perspective is shared by Kahsay et al. (2019) in their research on the status of agriculture production in Hawzen and Irob. The farmers in the regions are considered to have also shifted planting patterns due to the changes in the onset of rains as adaptation strategies. Further studies also highlight the change in these patterns especially in highlighting the changes in the farming calendar in various parts of the world (Antwi-Agyei & Nyantakyi-Frimpong, 2021; Amir et al., 2020).

As per the research by Musafiri et al. (2022), aspects that include family size, age, gender, arable land, education, ownership of livestock, infertile soil including access to information about weather influence farmers in Kenya to adopt CSA in their farming practices.

Table 2.

Thematic Analysis of the efforts by Kenyan farmers to address Sustainable Development Goal (SDG) 2 through CSA practices

Themes	**Author(s)**	**Main Findings**
Impact of Climate Change on Food Production	Nyang'au et al. (2021)	- High temperatures and low rainfall have significantly lowered food production in Kisii, Kenya. - Adoption of Climate-Smart Agriculture (CSA) practices including changes in land use, water management, and farm production techniques to manage moisture shortages and adapt to changing farming conditions. - CSA strategies aim to enhance resilience to climate change and increase agricultural productivity.
Farm production techniques	Nyang'au et al. (2021)	- Farming strategies adopted by Kenyan farmers to cope with climate change include crop diversification, application of manure, and changing planting practices. - Adoption of drought-resistant seeds such as Punda Millia 529 and SC Simba to cope with climate change. - Introduction of new crops like finger millet, green grams, cowpeas, and flowers to diversify plant crops and adapt to changing conditions.
Adjustment of Planting Periods	Waaswa et al. (2020)	- Kenyan farmers have adjusted their planting timing to align with changing weather patterns. - Planting mainly occurs after the onset of rains to ensure sufficient soil moisture.

		- Shifts observed in planting periods due to changes in rainfall patterns, with adjustments made to adapt to the new farming conditions.
Adaptation Strategies	Kahsay et al. (2019)	- Kenyan farmers in regions such as Hawzen and Irob have shifted planting patterns as adaptation strategies to changing rainfall patterns. - Similar adaptations observed globally, highlighting the need for farmers to adjust planting calendars in response to climate change.
Factors Influencing CSA Adoption	Musafiri et al. (2022)	- Factors such as family size, age, gender, arable land, education, livestock ownership, soil fertility, and access to weather information influence the adoption of CSA practices among Kenyan farmers. - Understanding these factors is crucial for promoting the adoption of CSA and improving its effectiveness in addressing food security challenges in Kenya.

The challenges that have been encountered in adopting and scaling up of CSA practices in Kenya

Some of the challenges experienced by farmers in Kenya in integrating CSA practices include financial constraints especially during long drought spells, and legal challenges especially in how it takes a long time to approve a new variety of drought-resistant seeds (Nyang'au et al., 2021). Other challenges include land shortage, inadequate capital, poor technology and infrastructure, and lack of information regarding the weather and climate. The research by Akweya (2023) on problems faced by farmers in Kenya in the integration of CSA practices include inefficient political commitment and policies, financial challenges, institutional constraints, and smallholder farmers lack of awareness of the proper CSA technologies. However, aspects that include available resources, such as innovative farming practices and technologies functioned as opportunities for growth for farmers and even policymakers. As per the analysis, it is critical for linkages to exist between researchers, extension workers and farmers, and the need for integrating adequate CSA interventions which are tailored to the livelihood and specific contexts of communities (Akweya, 2023). Autio et al. (2021) also highlight human-wildlife conflicts and the development of new pests as other challenges that limit farmers from integrating CSA practices. In their analysis of the application of CSA practices in South East Kenya, the authors state, "adopting CSA practices and utilizing technologies, especially in sub-Saharan regions that are heavily based on subsistence agriculture with heterogenous agro-ecological zones, require localized and gender-responsive solutions in policy formulation and planning of both agricultural extension services and development interventions that take into account the agency of the farmers" (Autio et al., 2021, p.11). The study recommends that the government and other relevant non-governmental organizations should support the adaptive abilities of farmers using strategies such as offering training on sustainable practices and providing critical inputs like distributing certified seeds that can tolerate drought and diseases (Nyang'au et al., 2021). The other recommendation is for policymakers to establish guidelines that support farmers in the integration of diverse agricultural

methods that complement each other to manage the severe consequences of climate change (Musafiri et al., 2022). Also, governments and related stakeholders could facilitate agricultural training and provide extension services to enhance the capacity of smallholder farmers to increase productivity. Interesting aspects that require further research based on the information from various sources in the use of CSA include the importance of local knowledge, community involvement, and innovative financing mechanisms.

Table 3.

Thematic analysis of the challenges that have been encountered in adopting and scaling up of CSA practices in Kenya

Themes	Author(s)	Findings
Financial Constraints	Nyang'au et al. (2021), Akweya (2023)	Financial challenges, particularly during long drought spells, hinder the integration of CSA practices among Kenyan farmers
Legal Challenges Poor Technology and Infrastructure	Nyang'au et al. (2021)	Legal challenges, such as the lengthy process of producing new varieties of drought-resistant seeds, impede the scaling up of CSA practices. - Poor technology and infrastructure hinder the adoption and scaling up of CSA practices in Kenya.
Land Shortage Inadequate Capital Institutional Constraints	Akweya (2023)	- Land shortage poses a challenge to the adoption and scaling up of CSA practices in Kenya. - Inadequate capital is a barrier to integrating CSA practices among Kenyan farmers - Institutional constraints, such as the lack of awareness of proper CSA technologies among smallholder farmers, hinder the integration of CSA practices.
Human-Wildlife Conflicts Development of New Pests Gender-responsive solutions	Autio et al. (2021)	- Human-wildlife conflicts limit farmers from integrating CSA practices, particularly in Southeast Kenya. - The development of new pests is identified as a challenge that hampers the integration of CSA practices among Kenyan farmers, especially in Southeast Kenya. - Gender-responsive solutions are necessary for the successful adoption and utilization of CSA practices, particularly in sub-Saharan regions with heterogeneous agro-ecological zones. - Localized policy formation and planning of agricultural extension services and development interventions are vital to address the agency of farmers in adopting CSA practices.

Limitations of the Study

A limitation of this study is its sole reliance on secondary data. Therefore, further investigation utilizing primary data is necessary to enhance the study and deepen understanding of the approaches used in Kenya to Integrate Climate-Smart Agriculture (CSA) to attain Sustainable Development Goal 2 “Zero Hunger”.

CONCLUSIONS

The study focused on examining the approaches used in Kenya to integrate climate-smart agriculture (CSA) to attain sustainable development Goal 2 “Zero Hunger”. It involved examining the efforts by Kenyan farmers to address Sustainable Development Goal (SDG) 2 through CSA practices and the challenges that have been encountered in adopting and scaling up of CSA practices in Kenya. As per the research findings, some of the CSA practices integrated by farmers in Kenya to realize zero hunger include changes in how land is used and management of water, changing the topography of land and farm production techniques, crop diversification, application of manure, and changing the planting seasons. Some of the challenges faced include land shortage, inadequate capital, poor technology and infrastructure, lack of information regarding the weather and climate patterns and even human-wildlife conflict. Generally, the study provides useful insights into Kenya's progress toward SDG 2 by harnessing climate-smart farming methods, impacting future policy decisions and sustainable development efforts across the region.

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