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The Importance Of Climate Smart Agriculture (CSA) In Tackling Climate Change Issues

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Abstract

Climate Smart Agriculture (CSA) is a strategic approach that addresses the challenges posed by climate change. CSA aims to incorporate these concerns and highlight their significance through fostering resilience to climate change and variability, and reducing greenhouse gas emissions for a more climate-smart world. It underpins sustainable intensification, adaptation, greenhouse gas (GHG) mitigation, and resilience. CSA faces constraint including policy and institutions, funding and technical gaps as well as social conditions. Solving these will require cooperation among government, policy-makers, scientists, and others with an interest at stake. In the face of these challenges. It is imperative to combine technologies with traditional practices and to have a sound policy support for successful up-scaling of CSA universally.

Definitions of Climate Smart Agriculture:

The Food and Agriculture Organization (FAO) describes Climate Smart Agriculture (CSA) as an approach aimed at guiding efforts to change agri-food systems into practices that are more environmentally sustainable and resilient to climate change (FAO, 2018). Its main objectives include: adapting to and enhancing resilience against climate change; decreasing and/or eliminating greenhouse gas emissions where possible; and sustainably boosting agricultural productivity and farmer incomes (Kabato, W. et al., 2025).

According to the United Nations, CSA is "agriculture that strengthens resilience (adaptation), reduces/removes greenhouse gases (mitigation) where possible, increases productivity in a sustainable manner, and promotes attainment of national food security and development goals" (Manyike, J. Z. et al., 2025).

To tackle the interrelated challenges of food security and climate change, the World Bank defines Climate Smart Agriculture as "a holistic strategy for managing landscapes - including cropland, livestock, forests, and fisheries" (FAO, 2019; Singh, P., 2024).

Climate Smart Agriculture is defined by the European Common Agricultural Policy Network as One strategy that can assist farmers and foresters in raising incomes and production in a sustainable manner is climate aware agriculture. By lowering or eliminating greenhouse gas emissions, it also aids in climate change mitigation and helps people become more resilient and adapt to its impacts (European, 2021). Reducing emissions from animal production, lowering farm inputs (such fuels, electricity, pesticides, and mineral fertilizers) for greater resource efficiency, or preserving carbon deposited in the soil are some examples of climate-smart activities. Increasing the diversity of farming systems can also help them become more climate change resilient (Addorisio, R., 2025).

Climate smart agriculture is "a comprehensive strategy which aims tackling food security, climate change, and sustainable development at the same time", according to the African Union (AU). In order to increase agricultural output, strengthen food systems' resistance to climate change, and lower greenhouse gas emissions, this entails combining current knowledge with sustainable practices and emerging technology (UN.ECA, 2022).

"A method that reforms and redirects agricultural system in order to promote development and guarantee food security under climate change" is how the Economic Community of West African States (ECOWAS) describes climate-smart agriculture (Paul Jr, M., et al., 2023).

Importance of addressing climate change: Climate change is a serious issue. In order to sequester carbon, protect the environment, lower greenhouse gas emissions and increase awareness of preventive measures for CSA, CSA has emerged as a crucial solution to climate change.

Overview of climate change and its impacts on agriculture: The important effects of climate change worldwide. Science, agriculture, climate migration, crop production, management systems, livestock, fisheries and aquaculture, and soil and water resource management have all been significantly influenced by the global climate crisis. Fossil fuel combustion is the main cause of pollution linked to global warming. Problems brought on by the changing climate include dwindling output of food and fodder, more frequent droughts, wildfires, and the spread of diseases and pests. The globally surface air temperature has risen, and more warming is predicted, according to the Fourth U.S. National Climate Assessment. Generating stress-resistant crop varieties, adapting to changing weather, and cutting greenhouse gas emissions through adjustments to land use and production methods are all examples of climate change mitigation efforts in agriculture (Bennett, B., 2021). According to the U.S. Fifth National Climate Assessment, adaptation and mitigation efforts are shaped by the long-term effects of extreme weather, adaptation to climate change is driven by ocean and coastal impacts, disproportionate impacts underscore the significance of equitable policy choices, and the implementation of climate plans depends on sufficient funding (Crimmins, A. R., et al., 2023; Katner, A., 2024). The World Bank emphasizes the importance of Climate-Smart Agriculture (CSA) to enhance resilience, lower emissions, and align financial aid with sustainable agricultural production and management systems. As a result, the negative impacts of climate change on food security, which include rising global food prices, declining crop yields and outputs, climate-induced migration, the development of effective adaptive strategies, and the execution of sustainable agricultural practices and policies, can be mitigated to lessen the effects of global changes.

Importance of adapting agricultural practices to mitigatethese challenges: The damage would escalate exponentially with further temperature increases. Temperature risk factors are increased by more erratic rainfall, and famines may result from the resulting droughts. Agriculture and land use practices significantly contribute to the climate crisis, accounting for twenty-five percent of global greenhouse gas emissions (GHG). However, agriculture can also play a role in addressing this issue. If we fail to change our approach to planning and investing in agricultural growth and development, we risk misallocating financial resources, creating agricultural systems that jeopardize food security, exacerbating land degradation and the vulnerability of impoverished communities, and accelerating climate change. To effectively promote Climate-Smart Agriculture (CSA), immediate action is needed from public, private, and civil society stakeholders at all levels to coordinate policymaking, strengthen institutions, base planning and decision-making on solid evidence, and ensure dedicated financing while assessing its impact (Lipper et al. 2014).

Components and Principles of Climate-Smart Agriculture (CSA): CSA does not refer to a particular, universally applicable farming system or method. Identifying appropriate agricultural production technology and methods necessitates site-specific assessments. Rooted in sustainability and innovation, Climate Smart Agriculture (CSA) aims to strengthen food security, help communities adapt to climate change, and reduce climate impacts through the adoption of appropriate practices. These practices, which can be employed individually or together, shield farmers from climate change repercussions like droughts, floods, and the emission of greenhouse gases that contribute to global warming. They focus on enhancing both the quality and quantity of farm yields and profitability while protecting the ecosystem. CSA's objective is to create agricultural systems that are environmentally sustainable and resilient to climate fluctuations by connecting climate-responsive policies with sustainable development objectives. As noted by Verhagen et al. (2014), the successful implementation of these strategies requires cooperation among all levels and stakeholders to foster innovation and improve adaptability towards climate resilience within a more productive agricultural sector.

Adaptation to climate change: In order to increase agricultural productivity, increase resilience to climate change, and lower greenhouse gas emissions, Climate Smart Agriculture must include adaptation to climate change. Diverse adaptation strategies at various scales are incorporated into CSA, which focuses on reducing agricultural exposure to climate change. Afforestation, climate-smart agriculture, resistant crop varieties, and other recognized methods to lessen the effects of climate change are some of these tactics (Okoronkwo, D. J., et al., 2024).

Rising temperatures and irregular rainfall patterns are already effects of climate change and drought in Morocco, situated in North Africa. These changes impact the agricultural industry, which plays a vital role in the nation's demographic and socioeconomic landscape, providing 40% of all employment, mainly in rural areas where a significant portion of the impoverished population lives. While the sector includes dynamic and successful large-scale farmers who utilize advanced technologies and engage effectively in both domestic and international markets, it is predominantly composed of small subsistence farmers. The Plan Maroc Vert (PMV), an extensive agricultural strategy initiated by Morocco in 2008, seeks to double the sectors value-added and create 1.5 million jobs by 2020. Its goal is to transform the agri-food sector into a dependable engine for growth,

competitiveness, and inclusive economic development in rural regions (Jassogne et al., 2013).

Smallholder farmers in sub-Saharan Africa are modifying their traditional farming practices to adapt to the changing climate. However, more comprehensive strategies are needed to mitigate climate change effects. Farmers have indicated that they can effectively reduce these impacts by implementing afforestation, climate-smart agriculture, resilient crop varieties, and other recognized methods (Okoronkwo, D. J. et al., 2024).

The negative impacts of climate change on agricultural output have prompted Nigeria to transition from a net exporter of food to a food importer. To enhance the sustainability and resilience of agriculture against climate change, it is crucial to embrace climate-smart farming practices (Bank, A. D., 2023). The Agricultural Productivity Program for Southern Africa (APPSA) promotes cooperation among southern African countries by bolstering regional collaboration and strengthening national research and development capabilities. Its goal is to enhance the generation and distribution of technology while mitigating the effects of global change in the area (Jassogne et al., 2013).

Through its climate-smart practices and sustainable strategies for adapting to climate variability, Climate-Smart Agriculture (CSA) has demonstrated its effectiveness in addressing the challenges posed by climate change in the agricultural sector. However, decision-makers often underestimate the value of traditional knowledge in adapting to climate change within agriculture. This potential is frequently ignored during international climate negotiations, where the focus shifts towards enhancing production with modern agricultural techniques. The transition from traditional to modern agriculture in rural communities has led to a loss of crop diversity, further intensifying the impacts of climate change. Therefore, it is crucial to rediscover and reintegrate traditional agricultural practices alongside modern approaches. (E. A. Grigorieva et al., 2023b).

Mitigation of greenhouse gas emissions: A crucial aspect of Climate Smart Agriculture (CSA) is the reduction of greenhouse gas emissions, as agricultural practices are significant sources of emissions such as carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O), all of which greatly contribute to global warming. To address these emissions and enhance carbon storage within agricultural systems, CSA encourages the implementation of methods that lower emissions (Zaman, M. et al., 2021). To decrease nitrification rates and N2O emissions, using urease inhibitors and controlling nitrification are vital strategies in CSA's approach to greenhouse gas reduction. Additionally, research indicates that practices like conservation tillage, cover cropping, and the careful use of both synthetic and organic fertilizers can effectively reduce emissions and boost soil carbon storage in agricultural systems. These approaches not only promote agricultural sustainability and productivity but also play a role in diminishing greenhouse gas emissions (USDA, 2021). In order to boost crop absorption of nitrogen and reduce the loss of nitrogen to the atmosphere, CSA also pushes for better fertilizer management, which is crucial for reducing greenhouse gas emissions from agriculture. Farmers may lower emissions while maintaining or growing output and adapting to climatic changes by employing climate-smart techniques like conservation tillage and cover crops, as well as by enhancing the efficiency of fertilizer consumption. Christ G. (2025).

The scientific significance of climate-smart agriculture: The adoption of decarbonization strategies to combat climate change alongside the development of climate-resilient approaches for enhancing agricultural adaptation is a necessary choice for sustainable agricultural growth. As such, climate-smart agriculture must encompass both decarbonization efforts and climate resilience. Additionally, food security is essential for human survival, and with climate change continually undermining food production capabilities, the global population is expected to exceed 9 billion by 2050 (Lam, D., 2025). This growth poses substantial challenges to the United Nations' "Zero Hunger" objective as part of the 2030 Sustainable Development Goals (SDGs). Therefore, food security should be regarded as a core principle of climate-smart agriculture. It can be argued that climate-smart agriculture serves as a modern production approach aimed at collaboratively enhancing food security, promoting climate mitigation benefits, and improving agricultural resilience to climate change in pursuit of the Sustainable Development Goals. Food production across various land and ocean ecosystems is expected to decrease due to the gradual negative impact of global warming on soil quality, the increase in pest and disease threats, and the reduction of marine animal populations. To address climate change and ensure food security, it is crucial to quickly implement climate-smart agriculture practices. Developing CSA while maintaining sustainable human health is a complex task. For effective implementation, future research must be more comprehensive and systematic to bridge the knowledge gaps, improve scientific understanding, refine the theoretical framework, and create new varieties, innovations, products, tools, systems, approaches, and policies.

Resilience building: One important way to reduce the problems agriculture faces due to global climate change is by building resilience through Climate-Smart Agriculture (CSA). CSA aims to grow more food, improve people's incomes and food supply, protect the environment, help farms cope better with climate change, and reduce harmful emissions. A major part of CSA is making agriculture more resilient to climate impacts. This means using new ideas and farming methods that both adapt to and reduce the effects of climate change, while also increasing productivity over time (UNDP). CSA promotes the use of climate-resilient techniques among participants in the value chain and small household farmers. This includes the establishment or strengthening of farmers' cooperatives, improved microfinance options, and the provision of tools and strategic plans to support the adoption of climate-resilient agriculture. Additionally,

it emphasizes the improvement of agricultural land use plans, crop calendars, advice on crop varieties, agricultural practices tailored for those varieties, and opportunities for micro-entrepreneurship. These efforts aim to further reduce the vulnerability of small household farmers. By adopting CSA practices, farmers can enhance the resilience of their agricultural systems to climate change, resulting in better management of crop residues, improved soil health, and increased overall farming system resilience (Dougill, A. J. et al., 2021).

Challenges Hindering the Implementation of CSAPractices in Nigeria: Despite significant endeavors to integrate climate change adaptation into its development policies and initiatives, Nigeria still faces obstacles in reaching its objectives. These challenges include factors like insufficient funding, a pressing need for skill development, and an inadequacy of technical expertise. Additionally, the lack of synergy, coordination, and collaboration among stakeholders, along with the failure to set targets and carry out monitoring and evaluation, has resulted in overlapping efforts, redundancy, and increased costs. Ineffective communication further hampers the success of adaptation programs in the nation. The limited involvement of sub-national governments, especially local authorities and indigenous communities, stands as a major barrier to the effective and inclusive implementation of the National Adaptation Plan (NAP). Furthermore, Nigeria has a scarcity of domestic resources to support climate change adaptation efforts, as the national budget predominantly prioritizes urgent development needs, providing little opportunity for long-term adaptation strategies. Nonetheless, the government is dedicated to enhancing its financial backing for adaptation and has formulated various approaches to attract additional funding (UNFCCC, 2021).

Conclusion: Climate Smart Agriculture promotes sustainable intensification, adaptation, mitigation of greenhouse gases, and the enhancement of resilience. By tackling the associated challenges and harnessing the advantages of CSA. Overcoming CSA challenges calls for collaboration among governments, policymakers, researchers, farmers, and various other stakeholders.

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