EDUCATIONAL MANAGEMENT AND POLICY INTERVENTIONS TO ENHANCE CLIMATE-SMART AGRICULTURAL (CSA) TRAINING IN HIGHER INSTITUTIONS

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Abstract
The study was to explore the role of educational management and policy interventions to enhance the integration of Climate-Smart Agriculture (CSA) into higher education curricula. The study was conducted in the Faculty of Education, University of Nigeria. Three research questions and specific purposes were formulated to guide the study. The population of the study consisted of 682 academic lecturers, and due to the manageable size of the population, no sampling was applied. A self-structured questionnaire was developed and used as the instrument for data collection, which was face-validated by three experts from the Faculty of Education, University of Nigeria. The reliability test yielded a Cranach's Alpha coefficient of 0.85, indicating high reliability. Data was collected through a survey, with a 4-point Likert scale used for the decision rule. Mean and Standard Deviation were used to answered the research questions. The findings of the study revealed that the integration of CSA in higher education institutions enhances students' understanding of climate change impacts and encourages innovation in farming techniques. The findings of the study revealed that significant challenges to implementing CSA programmes include the lack of qualified faculty and limited financial resources. Based on the findings, it was recommended among others that higher education institutions revise and integrate CSA principles into existing agricultural curricula to improve the effectiveness of CSA education. This study contributes to knowledge by providing insights into the integration of CSA into higher education, particularly highlighting the importance of curriculum reform, and policy support in fostering climate-resilient agricultural education.

Keywords: Climate-smart agriculture, educational management, agricultural education, curriculum reform

Introduction

Climate change is increasingly recognized as one of the most pressing challenges facing the global agricultural sector. Rising global temperatures, altered precipitation patterns, and more frequent extreme weather events, such as droughts and floods, have significant consequences for crop productivity, food security, and farming livelihoods (Intergovernmental Panel on Climate Change [IPCC], 2021). These shifts in climate patterns threaten the very foundation of agricultural systems, particularly in regions that rely on rain-fed agriculture. For example, severe droughts can lead to crop failure, reduced water availability, and compromised irrigation systems, while flooding destroys crops and disrupts food supply chains. The unpredictability of these extreme events further complicates farming practices, making it difficult for farmers to plan and adapt. As a result, these changes not only affect crop production but also have long-term repercussions for food security, particularly in developing countries where agriculture remains the primary source of income (Sarkar & Dutta, 2021). In response to these challenges, climate-smart agriculture (CSA) has emerged as a critical strategy aimed at transforming agricultural practices to be more resilient to climate change. CSA addresses three core objectives: increasing agricultural productivity and incomes, adapting to the impacts of climate change, and mitigating its adverse effects (Lipper et al., 2014). CSA promotes practices that improve soil health, optimize water usage, and reduce crop losses, thus enhancing overall productivity even in adverse climatic conditions. Adaptation strategies within CSA include using drought-resistant crops, improving irrigation systems, and developing early warning systems to help farmers anticipate extreme weather events (Thornton et al., 2018). Additionally, CSA encourages mitigation through sustainable farming practices such as agroforestry and conservation tillage, which reduce emissions and help sequester carbon (Vermeulen et al., 2012). By focusing on these three objectives, CSA not only helps farmers adapt to changing climatic conditions but also contributes to environmental sustainability by reducing the carbon footprint of agricultural practices.

The significance of CSA extends beyond climate resilience; it also plays a vital role in ensuring food security and promoting economic development, particularly in low-income regions. In areas where farming is the backbone of the economy, CSA practices enable farmers to boost yields and maintain sustainable livelihoods despite the challenges posed by climate change (Howden et al., 2007). These practices are particularly important in sub-Saharan Africa, South Asia, and Latin America, where the agricultural sector is highly vulnerable to the impacts of climate change (Pretty et al., 2018). However, for CSA to be fully effective, it is crucial that farmers have access to the knowledge and tools required to implement these practices. This highlights the importance of

education and training in climate-smart agricultural techniques, especially within higher education institutions. Hence, to address these needs, educational institutions must integrate CSA principles into their curricula and training programs, thereby equipping future agricultural professionals with the skills to manage the evolving challenges of the agricultural sector. Educational management strategies are essential in ensuring that CSA is incorporated into agricultural education. This includes revising existing curricula to include CSA-related topics, promoting interdisciplinary teaching that integrates environmental science, agronomy, and climate studies, and offering hands-on learning opportunities such as fieldwork and internships (Dinesh et al., 2021). Additionally, policy interventions at both the national and institutional levels are necessary to support the development and implementation of CSA education. Government policies that provide funding and infrastructure for CSA-related programs in universities can help foster innovation and ensure that students are well-prepared to meet the demands of climate-resilient agricultural systems (Kassam et al., 2014). Educational management and policy interventions are crucial in ensuring that future agricultural professionals are equipped with the knowledge and skills necessary to implement climate-smart practices. This research explores how educational management and policy interventions can enhance climate-smart agricultural training in higher education institutions globally, preparing future agricultural professionals to address the challenges of a climate-resilient agricultural future.

Climate-smart agriculture (CSA) is a transformative approach designed to address the challenges posed by climate change to global agricultural systems. It aims to sustainably increase agricultural productivity, enhance adaptation to climate change, and mitigate its effects by reducing greenhouse gas emissions. CSA integrates a wide range of practices and strategies that contribute to achieving these objectives, including agroforestry, conservation tillage, integrated pest management, and the cultivation of drought-resistant crops (Food and Agriculture Organization [FAO], 2022). The core idea behind CSA is to create farming systems that are not only resilient to the unpredictable impacts of climate change but also capable of maintaining or improving food production levels. CSA is grounded in the principle that agricultural practices must evolve in response to the changing climate, ensuring that food security is achieved while minimizing environmental damage. Key practices within CSA include promoting the use of climate-resilient crop varieties, implementing water-efficient irrigation techniques, enhancing soil health through sustainable practices, and reducing carbon emissions through improved land management strategies (Lipper et al., 2014). By focusing on both adaptation and mitigation, CSA seeks to reduce the vulnerability of agricultural systems to climate-related shocks, such as floods, droughts, and heatwaves, while also fostering long-term sustainability (Vermeulen et al., 2012).

In terms of productivity, CSA emphasizes increasing crop yields under climate stress conditions. For instance, the adoption of drought-resistant crop varieties allows farmers to maintain production levels even in areas where water resources are scarce (Thornton et al., 2018). Similarly, conservation tillage, which minimizes soil disturbance, helps to preserve soil moisture and improve soil structure, making agricultural systems more resilient to droughts (Kassam et al., 2014). Integrated pest management, which reduces reliance on chemical pesticides, not only helps in pest control but also promotes biodiversity and reduces the environmental impact of farming practices (Pretty et al., 2018). Furthermore, CSA emphasizes the importance of ensuring that agricultural systems can cope with the adverse effects of climate change. It integrates strategies that allow farmers to adapt to these changes, such as adopting early warning systems for extreme weather events and diversifying crop production to reduce the risks associated with mono-cropping. By improving farmers' capacity to respond to climatic changes, CSA plays a crucial role in safeguarding agricultural productivity and ensuring food security in the face of growing climate variability (Sarkar & Dutta, 2021). CSA also offers potential environmental benefits, particularly in reducing greenhouse gas emissions from agriculture. Practices such as agroforestry, where trees are planted alongside crops, not only improve soil fertility and water retention but also help sequester carbon, contributing to global climate change mitigation efforts (Lipper et al., 2014). Similarly, reducing tillage and enhancing soil organic carbon storage through sustainable practices can play a significant role in lowering emissions and contributing to global carbon sequestration efforts (Vermeulen et al., 2012). Importantly, the concept of CSA represents a holistic approach to climate-resilient agriculture that integrates sustainability, productivity, and climate change mitigation. It is an essential strategy for achieving food security in the context of a changing climate and offers numerous opportunities to improve the resilience of agricultural systems while contributing to environmental sustainability.

Educational management in agricultural training encompasses the strategic and organizational decisions made by institutions to ensure that educational outcomes meet the evolving needs of the agricultural sector, particularly in the context of climate change. In this context, educational management involves integrating climate-smart agriculture (CSA) into agricultural curricula and adopting innovative teaching methods to better prepare students for the challenges posed by climate change. Effective management practices are essential to ensure that agricultural education remains relevant, practical, and capable of equipping students with the skills needed to address global agricultural challenges (Vigoda-Gadot, 2021). However, one of the central aspects of educational management in agricultural training is curriculum development. It is critical for educational institutions to revise and update curricula to include CSA principles and practices, ensuring that students are exposed to the most current knowledge and skills related to climate-resilient farming. This could involve integrating topics such as agroecology, sustainable farming techniques, and the use of digital tools in agriculture to enable students to adapt to a rapidly changing agricultural landscape (FAO, 2022). Furthermore, curriculum development must be responsive to regional and local agricultural challenges, ensuring that students are trained to address specific climatic and environmental conditions that affect agriculture in their areas (Sarkar & Dutta, 2021). Faculty training is another key component of educational management in agricultural training. In order to teach CSA effectively, instructors must themselves be well-versed in climate-smart practices and have the capacity to implement them in the classroom. This requires ongoing professional development and training in CSA technologies, climate change adaptation strategies, and new teaching methodologies that emphasize hands-on, experiential learning. Faculty members must also be supported in adopting interdisciplinary teaching approaches that combine agriculture with environmental science, technology, and social sciences to foster a holistic understanding of the challenges posed by climate change (Sarkar & Dutta, 2021).

Practical exposure to CSA technologies and techniques is essential for preparing students for real-world agricultural challenges. Educational institutions must facilitate access to CSA practices through field trips, internships, and partnerships with agricultural research centers and farms. These practical experiences enable students to learn how to implement CSA techniques in real-world settings, such as using drought-resistant crop varieties, applying conservation tillage, and managing integrated pest systems (Lipper et al., 2014). Hands-on training also helps students understand the economic, social, and environmental implications of CSA, equipping them to make informed decisions when they enter the workforce. Incorporating CSA into agricultural training requires effective management of resources, including funding for research, infrastructure development, and the purchase of CSA technologies. The collaboration between universities, government agencies, and the private sector can provide the financial and technical support needed to implement these changes. Universities can also play a key role in creating a climate of innovation, where students and faculty can experiment with new CSA technologies and contribute to the development of more effective solutions for sustainable agriculture (Thornton et al., 2018). Policy interventions are crucial for creating an enabling environment that facilitates the integration of climate-smart agriculture (CSA) into agricultural education. Governments at various levels local, national, and international—play an essential role in establishing policies that encourage sustainable farming practices, climate adaptation strategies, and the inclusion of CSA in educational curricula. These policy frameworks guide the development of institutional programs, ensuring that agricultural education aligns with climate change mitigation and adaptation goals. A supportive policy environment ensures that CSA education is integrated into the broader agricultural development strategies of nations, particularly in the context of addressing the challenges posed by climate change (Kassie et al., 2021). National policies that support CSA education typically include provisions for curriculum reform, funding for research, and the development of educational strategies that integrate CSA principles into agricultural training programs. These policies often emphasize the need for higher education institutions to adopt CSA practices and train the next generation of agricultural professionals to address climate-related challenges. Governments may incentivize universities and colleges to offer courses and training programs that incorporate CSA technologies, such as drought-resistant crops, soil conservation, and sustainable water management practices. Policy frameworks may also encourage the establishment of research centers within universities that focus on CSA, enabling academic institutions to contribute to the development and dissemination of innovative solutions for climate-resilient agriculture (Lipper et al., 2014).

Additionally, governments may provide funding to support the development of CSA-focused educational resources, research initiatives, and practical training opportunities for students. Financial support can enable universities to invest in infrastructure, technologies, and faculty training, thereby ensuring that educational institutions can deliver high-quality CSA programs. Funding may also be used to facilitate partnerships between academic institutions, government agencies, and the private sector, fostering collaboration in the design and delivery of CSA education programs (Kassie et al., 2021). International organizations and donor agencies can also play a vital role by offering financial and technical assistance to countries in need of developing or scaling up CSA education. Policy frameworks at the international level, such as those developed by the United Nations and the World Bank, provide guidance on climate change adaptation and sustainable agricultural practices. These global frameworks set the agenda for national governments to develop policies that align with international climate goals, such as the Paris Agreement, which emphasizes the need for climate-resilient agriculture. By aligning national policies with global climate goals, countries can ensure that their agricultural education systems are responsive to the global demand for climate-smart agricultural practices (FAO, 2022). The successful implementation of CSA education policies requires effective governance structures and institutional coordination. Government ministries, educational authorities, and agricultural organizations must work together to design and implement policies that support the integration of CSA into agricultural education. Additionally, policymakers must engage with stakeholders, including farmers, educators, and students, to ensure that policies reflect the needs of the agricultural community and address local environmental and climate challenges. Monitoring and evaluation of policy implementation are also essential to assess the effectiveness of CSA education programs and identify areas for improvement (Sarkar & Dutta, 2021).

Several studies have investigated the integration of climate-smart agriculture (CSA) into educational programs, highlighting both the potential benefits and the challenges involved. Research conducted in Kenya and Uganda has shown that incorporating CSA principles into agricultural curricula significantly improves farmers' ability to adapt to climate change by providing them with knowledge and skills in sustainable farming practices. For example, Bryan et al. (2020) found that CSA education in these countries helped farmers adopt new techniques such as drought-resistant crops and soil conservation methods, which in turn improved agricultural resilience to climate variability. These findings emphasize the importance of incorporating CSA into educational programs as a means to equip future farmers with the tools needed to manage climate-related challenges effectively. Nevertheless, the uptake of CSA education in higher institutions has been relatively slow, with several barriers hindering its widespread adoption. A major challenge is the existing gaps in educational policy, which often fail to prioritize the integration of CSA into agricultural training curricula. Tegbaru et al. (2022) identified that the slow adoption of CSA education can be attributed to a lack of coherent policies and insufficient interdisciplinary collaboration between agricultural faculties, environmental science departments, and policymakers. This fragmented approach has resulted in missed opportunities for developing a holistic educational framework that addresses the complex nature of climate change and its impact on agriculture.

In addition to policy barriers, the lack of adequate resources and faculty training has also been identified as a major constraint in integrating CSA into higher education. Many educational institutions face difficulties in developing the necessary infrastructure, such as laboratories, field stations, and access to CSA technologies, to effectively teach students about climate-smart agricultural practices. This limits the capacity of universities to provide hands-on learning experiences that are crucial for understanding the practical applications of CSA techniques (Ndlovu & Asfaw, 2021). Furthermore, research by Ndlovu and Asfaw (2021) found that many agricultural education programs lack a clear focus on climate change adaptation, with curricula often centered around traditional agricultural practices that do not fully address the urgent need for climate-smart approaches. As a result, there is a need for significant curriculum reform to incorporate CSA principles and ensure that students are well-prepared to tackle climate-related agricultural challenges. Addressing these challenges will require coordinated efforts from educational institutions, government agencies, and international organizations to develop policies and strategies that promote the widespread integration of CSA into higher education systems globally.

The integration of climate-smart agriculture (CSA) into higher education faces several challenges, which can slow down or hinder the effective implementation of CSA curricula. One of the most significant challenges is the lack of skilled educators who possess the necessary expertise to deliver CSA training

effectively. Many educators in agricultural faculties may not be well-versed in CSA techniques and strategies, as these concepts are relatively new in many regions. Consequently, the development of targeted educator training programs is essential to equip faculty members with the knowledge and skills required to teach CSA effectively (Kassie et al., 2021). In addition to the shortage of qualified educators, many higher education institutions, particularly in developing countries, face limited resources, which can restrict the implementation of CSA education. Financial constraints prevent universities from procuring advanced technologies, setting up practical training facilities, and organizing field trips or hands-on learning experiences that are crucial for CSA education. Without adequate funding, institutions may also struggle to update their curricula to reflect the latest climate change research and CSA techniques, further hindering the integration of CSA into agricultural programs (Fischer et al., 2020).

Another challenge to the adoption of CSA education is resistance to change. Traditional agricultural faculties, which have historically focused on conventional farming methods, may be reluctant to adopt new concepts such as CSA. This resistance can stem from a lack of familiarity with the benefits of CSA or from concerns about the practicality of implementing such approaches in local contexts. Overcoming this resistance requires concerted efforts to demonstrate the advantages of CSA, such as its potential to enhance agricultural productivity, reduce environmental degradation, and ensure food security in the face of climate change (Bryan et al., 2020). Lastly, insufficient awareness of CSA among both students and faculty in certain regions can delay its integration into academic curricula. In many developing countries, awareness of the links between climate change and agriculture remains limited, and as a result, CSA is not always recognized as a priority. Increasing awareness through workshops, seminars, and outreach activities is critical to fostering a deeper understanding of CSA's importance and ensuring that all stakeholders are on board with its inclusion in educational programs (Tegbaru et al., 2022). Through addressing these challenges, educational institutions can create a more conducive environment for the integration of CSA into higher education and better prepare future agricultural professionals to manage the impacts of climate change.

Hence, to address the challenges of integrating climate-smart agriculture (CSA) into higher education, several strategies can be employed to enhance the effectiveness of CSA training. One of the primary strategies is curriculum reform. Educational institutions should redesign agricultural curricula to incorporate a strong emphasis on climate change, sustainability, and CSA principles. This can be achieved by introducing dedicated CSA courses, seminars, and practical field trips that provide students with hands-on experience. By embedding CSA into the core curriculum, students will gain a deeper understanding of the practical applications of these techniques and be better equipped to address the climate challenges facing agriculture (FAO, 2022). Another important strategy is promoting research and innovation within the academic community. Encouraging students and faculty to engage in CSA-related research projects will foster innovation and the development of new solutions to climate change in agriculture. This research can include the development of drought-resistant crops, sustainable farming methods, and climate adaptation strategies tailored to local contexts. By fostering a culture of research and knowledge exchange, institutions can contribute to advancing CSA practices and create a pool of experts who can drive the sector forward (Kassie et al., 2021).

Public-private partnerships also play a crucial role in enhancing CSA training. Collaboration between universities and the private sector can help secure funding for CSA programs and facilitate the development of practical training opportunities for students. Private sector partners can provide valuable insights into the real-world challenges and innovations in the agricultural industry, while also offering internship and job opportunities for students. These partnerships can bridge the gap between academic knowledge and practical experience, ensuring that students are better prepared for the job market (Bryan et al., 2020). Furthermore, international collaboration is essential for strengthening CSA education. Partnerships with international organizations and universities can provide access to global best practices in CSA education and offer students and faculty the opportunity to participate in research and exchange programs. Through such collaborations, institutions can share knowledge and resources, enhance the quality of CSA training, and adopt innovative approaches to address the challenges posed by climate change in agriculture (Tegbaru et al., 2022). By implementing these strategies, educational institutions can enhance the quality of climate-smart agricultural training and equip future agricultural professionals with the necessary skills to tackle climate change.

Despite the growing recognition of climate-smart agriculture (CSA) as a critical strategy for addressing the impacts of climate change on agriculture, there remains a lack of comprehensive integration of CSA principles into the curricula of higher education institutions globally. While existing research has explored the technical aspects of CSA, such as its implementation on farms and its role in mitigating climate change, limited attention has been given to the role of educational management and policy in embedding CSA into agricultural training programs. Furthermore, while some studies have examined CSA adoption in specific regions or among farmers, there is a paucity of empirical evidence on how higher education institutions can effectively develop and deliver CSA-focused training to equip future professionals with the necessary skills and knowledge. Challenges such as outdated curricula, insufficient policy support, and inadequate resources have been identified in passing, but these issues have not been systematically addressed in the context of educational management and policy frameworks. Therefore, this study seeks to fill this gap by investigating the barriers to integrating CSA into agricultural education and identifying strategies that can enhance its adoption. By focusing on educational management practices and policy interventions, the research aims to provide actionable insights for improving CSA training in higher education institutions worldwide. This focus will contribute to bridging the existing knowledge gap and ensuring that agricultural education aligns with the demands of a changing climate.

Statement of the Problem

Agriculture is a vital sector that supports global food security, livelihoods, and economic growth. Ideally, agricultural systems should adapt to environmental changes while ensuring sustainable productivity to meet the demands of a growing population. Higher education institutions play a crucial role in equipping future agricultural professionals with the knowledge and skills needed to address emerging challenges, including the impacts of climate change. The integration of climate-smart agriculture (CSA) into agricultural education is essential for preparing students to develop and implement sustainable farming practices that enhance resilience and reduce environmental impact. However, the current reality indicates significant gaps in the integration of CSA into higher education curricula. Many institutions lack comprehensive policies, frameworks, and resources to effectively deliver CSA training. Limited faculty expertise, insufficient funding, and outdated curricula often hinder the inclusion of CSA principles, leaving graduates ill-prepared to address the challenges posed by climate change in the agricultural sector. Additionally, the lack of interdisciplinary collaboration between academia, industry, and government has further slowed the progress of CSA education. This study aims to investigate how educational management and policy interventions can enhance climate-smart agricultural training in higher education institutions. The research seeks to identify barriers to CSA integration, examine effective strategies for curriculum development and capacity building, and propose actionable recommendations for fostering the adoption of CSA principles in agricultural education globally.

Purpose of the Study

The main purpose of this study is to examine how educational management and policy interventions can enhance the integration of climate-smart agriculture (CSA) into higher education curricula. Specifically, the study seeks to:

1. examine the role of Climate-Smart Agricultural (CSA) integration in higher education institutions on a global scale.
2. Identify the challenges faced by higher education institutions in implementing CSA-focused training programs.
3. determine strategies to improve the effectiveness of CSA education in higher education institutions.

Research Questions

The following research questions guided the study

1. What is the role of Climate-Smart Agricultural (CSA) integration in higher education institutions globally?
2. What challenges do higher education institutions face in implementing CSA-focused training programs?
3. What strategies can improve the effectiveness of CSA education in higher education institutions?

Methods

This study adopted a descriptive survey design. The study was conducted in the Faculty of Education, University of Nigeria. The target population comprised 682 academic lecturers across various departments within the Faculty. Due to the manageable population size, no sampling was applied, and a census approach was used to include all 682 academic lecturers. This method eliminates sampling bias and ensures comprehensive, accurate representation. Empirical studies, such as Babbie (2017), confirm that using a census for populations under 1,000 enhances precision and avoids extrapolation errors. A structured questionnaire was used as the primary instrument for data collection. The questionnaire was designed to address the research questions, focusing on the role of CSA integration, the challenges faced by higher education institutions, and strategies for improving CSA education. The instrument was face-validated by three experts from the Faculty of Education, University of Nigeria, ensuring its relevance and appropriateness for the study objectives. The reliability of the instrument was tested using the Cronbach's Alpha method, yielding a reliability coefficient of 0.85, which indicates a high level of internal consistency. Data were collected through direct administration of the questionnaire to the respondents. A total of 682 questionnaires were distributed, and a high response rate was achieved, enabling comprehensive analysis. The collected data were analyzed using mean scores and standard deviations. A decision benchmark of 2.50 was adopted to determine the acceptance or rejection of each item on the questionnaire. Responses with mean scores equal to or greater than 2.50 were considered agreed upon, while those below 2.50 were considered disagreed upon. The analysis also included ranking the mean scores to identify priority areas. Findings were presented in tables to provide a clear overview of the responses and were discussed in relation to the research questions.

Results

Table 1: Mean Score and Standard Deviation of Responses on the Role of Climate-Smart Agricultural (CSA) Integration in Higher Education Institutions Globally

S/N	Item Statement	Mean	SD	$\bar{X}$ Set	Rank	Decision
1	Enhances students' understanding of climate change impacts on agriculture.	4.25	0.72	4.0	1	A
2	Prepares students for climate-resilient agricultural practices.	4.18	0.79	4.0	2	A
3	Encourages innovation in farming techniques through research and development.	4.20	0.73	4.0	3	A
4	Integrates interdisciplinary approaches, blending agriculture, climate science, and policy.	4.14	0.80	4.0	4	A
5	Facilitates the development of new agricultural technologies and techniques.	4.17	0.77	4.0	5	A
6	Encourages the adoption of climate adaptation and mitigation strategies in agriculture.	4.22	0.75	4.0	6	A
7	Supports the creation of environmentally sustainable farming systems.	4.19	0.74	4.0	7	A
8	Provides students with hands-on experience in CSA technologies and practices.	4.12	0.81	4.0	8	A
9	Strengthens global collaboration in addressing climate-related agricultural challenges.	4.19	0.76	4.0	7	A
10	Increases awareness and advocacy for climate-smart farming at local, national, and global levels.	4.18	0.79	4.0	6	A
	Aggregate Score	**4.18**	**0.78**	**4.0**		

Table 1 shows the mean scores, standard deviations, mean sets, and ranks of responses on the role of Climate-Smart Agricultural (CSA) integration in higher education institutions globally. The overall mean score of 4.18 indicates a strong level of agreement with the role of CSA in educational settings, with a standard deviation of 0.78, suggesting relatively consistent responses among participants. The mean set of 4.0 signifies strong agreement with the statements on CSA integration. The highest-ranked item is "Enhances students' understanding of climate change impacts on agriculture" (mean = 4.25), which reflects strong support for the idea that CSA education plays a critical role in helping students understand the impacts of climate change on agriculture. Other high-ranking items include "Prepares students for climate-resilient agricultural practices" (mean = 4.18) and "Encourages the adoption of climate adaptation and mitigation strategies in agriculture" (mean = 4.22). These results emphasize the belief that CSA education equips students with the skills necessary for resilient and adaptive agricultural practices. The item "Provides students with hands-on experience in CSA technologies and practices" received the lowest mean of 4.12, suggesting that while the importance of hands-on experience in CSA education is recognized, there may be some challenges in providing such opportunities. This indicates an area for improvement in educational strategies and curriculum development. Generally, the study highlights the strong support for CSA integration in higher education and its perceived importance in enhancing students' understanding of climate change, preparing them for resilient agricultural practices, and promoting innovation. However, there is a slight gap in providing hands-on experience, indicating an area for improvement in educational strategies and curriculum development.

Table 2: **Mean Score and Standard Deviation of Responses on the Challenges Higher Education Institutions Face in Implementing CSA-Focused Training Programmes**

S/N	Item Statement	Mean	SD	$\bar{X}$ Set	Rank	Decision
1	Lack of qualified faculty with expertise in CSA principles.	3.87	0.85	4.0	1	A
2	Limited financial resources to support CSA curriculum development and infrastructure.	3.83	0.88	4.0	2	A
3	Resistance from traditional agricultural faculties to adopt new CSA methods.	3.79	0.89	4.0	3	A
4	Insufficient integration of CSA topics into existing curricula.	3.75	0.86	4.0	4	A
5	Limited access to CSA-related research and technological resources.	3.83	0.84	4.0	2	A
6	Inadequate awareness and understanding of CSA among students and faculty.	3.79	0.88	4.0	3	A
7	Institutional inertia and reluctance to change established teaching practices.	3.70	0.85	4.0	5	A
8	Gaps in policy frameworks to support CSA education within academic institutions.	3.76	0.82	4.0	6	A
9	Challenges in providing practical, hands-on training opportunities for students.	3.81	0.80	4.0	7	A
10	Lack of interdisciplinary collaboration between agricultural, environmental, and climate science departments.	3.72	0.87	4.0	8	A
11	Difficulty in aligning CSA education with local agricultural practices and regional climate conditions.	3.77	0.83	4.0	9	A

Aggregate Score	**3.78**	**0.85**	**4.0**	

Table 2 shows the mean scores, standard deviations, mean sets, and ranks of responses on the challenges higher education institutions face in implementing CSA-focused training programs. The overall mean score of 3.78 with a standard deviation of 0.85 indicates a strong agreement among respondents on the presence of significant challenges. The mean set of 4.0, which is classified as "Agree," reveals that respondents acknowledge the importance of these challenges in the context of integrating CSA into higher education curricula. The highest-ranked challenge is "Lack of qualified faculty with expertise in CSA principles" (mean = 3.87), which underscores the critical shortage of skilled instructors to effectively teach CSA-related topics. This issue is vital for ensuring that CSA education is taught with the necessary depth and expertise, emphasizing the need for faculty training and development. "Limited financial resources to support CSA curriculum development and infrastructure" (mean = 3.83) and "Limited access to CSA-related research and technological resources" (mean = 3.83) are also significant challenges. These results highlight financial constraints and the need for adequate resources to support CSA-focused educational programs. Similarly, "Resistance from traditional agricultural faculties to adopt new CSA methods" (mean = 3.79) indicates the reluctance to embrace new approaches, further complicating the implementation of CSA education. The lowest-ranked challenge is "Institutional inertia and reluctance to change established teaching practices" (mean = 3.70), which suggests that higher education institutions are often slow to adapt to new educational paradigms, including CSA integration. This points to the need for institutional leadership and policy changes to foster a more flexible approach to curriculum reform. Largely, the findings reflect that significant challenges exist in higher education institutions regarding CSA-focused training programs. These include faculty shortages, financial constraints, resistance to change, and the need for enhanced resources. Addressing these challenges will require comprehensive strategies that incorporate faculty development, financial support, and institutional policy reform to ensure effective integration of CSA education.

Table 3: Mean Score and Standard Deviation of Responses on the Strategies That Can Improve the Effectiveness of CSA Education in Higher Education Institutions

S/N	Item Statement	Mean	SD	$\bar{X}$ Set	Rank	Decision
1	Revise and integrate CSA principles into existing agricultural curricula.	4.11	0.75	4.0	1	A
2	Provide faculty development programs to enhance expertise in CSA topics.	4.07	0.80	4.0	2	A
3	Encourage interdisciplinary collaboration between agricultural, climate, and environmental sciences.	4.06	0.78	4.0	3	A
4	Establish partnerships with industry stakeholders to provide practical training and resources.	4.10	0.77	4.0	4	A
5	Foster student involvement in CSA-related research projects and fieldwork.	4.08	0.79	4.0	5	A
6	Promote public-private partnerships to fund CSA initiatives and provide learning opportunities.	4.05	0.81	4.0	6	A
7	Organize workshops, seminars, and conferences to raise awareness of CSA and its importance.	4.04	0.82	4.0	7	A
8	Develop innovative teaching methods, such as experiential learning and virtual simulations, to enhance engagement.	4.03	0.83	4.0	8	A
9	Strengthen international collaborations to share best practices and improve CSA education.	4.02	0.80	4.0	9	A
10	Secure funding for the development of CSA-focused research centers within institutions.	4.00	0.84	4.0	10	A

11	Advocate for policy changes that support the integration of CSA into higher education frameworks.	4.09	0.76	4.0	5	A
	Aggregate Score	**4.06**	**0.79**	**4.0**		

Table 3 shows the mean scores, standard deviations, mean sets, ranks, and decisions on the strategies to improve the effectiveness of CSA education in higher education institutions. The overall mean score of 4.06 with a standard deviation of 0.79 indicates strong agreement on the importance of these strategies, with the mean set classified as "Agree" (4.0). The highest-ranked strategy is "Revise and integrate CSA principles into existing agricultural curricula" (mean = 4.11), suggesting that updating the curricula to include CSA principles is seen as a critical step for improving CSA education. This strategy emphasizes the importance of curriculum reform as a foundational step in the integration of CSA into academic programs. Closely following is "Provide faculty development programs to enhance expertise in CSA topics" (mean = 4.07), which highlights the need for ongoing professional development to ensure that faculty members have the necessary skills and knowledge to teach CSA-related content. "Encourage interdisciplinary collaboration between agricultural, climate, and environmental sciences" (mean = 4.06) also ranks highly, pointing to the need for a holistic approach to CSA education that combines knowledge from multiple fields. Other significant strategies include "Establish partnerships with industry stakeholders to provide practical training and resources" (mean = 4.10) and "Foster student involvement in CSA-related research projects and fieldwork" (mean = 4.08). These strategies reflect the importance of real-world experience and industry collaboration in providing students with the practical skills necessary for CSA implementation. "Promote public-private partnerships to fund CSA initiatives and provide learning opportunities" (mean = 4.05) and "Organize workshops, seminars, and conferences to raise awareness of CSA and its importance" (mean = 4.04) both emphasize the importance of external funding and community engagement to promote CSA education and increase awareness of its significance. The lowest-ranked strategy, though still within the "Agree" range, is "Secure funding for the development of CSA-focused research centers within institutions" (mean = 4.00), indicating that while funding is critical, it may be perceived as a more long-term goal compared to other immediate strategies such as curriculum reform and faculty development. Taken as a whole, the findings suggest that higher education institutions strongly support strategies that focus on curriculum integration, faculty development, industry collaboration, and student involvement in CSA-related activities. These strategies are seen as essential to enhancing the effectiveness of CSA education and ensuring that future generations of agricultural professionals are well-equipped to address the challenges posed by climate change.

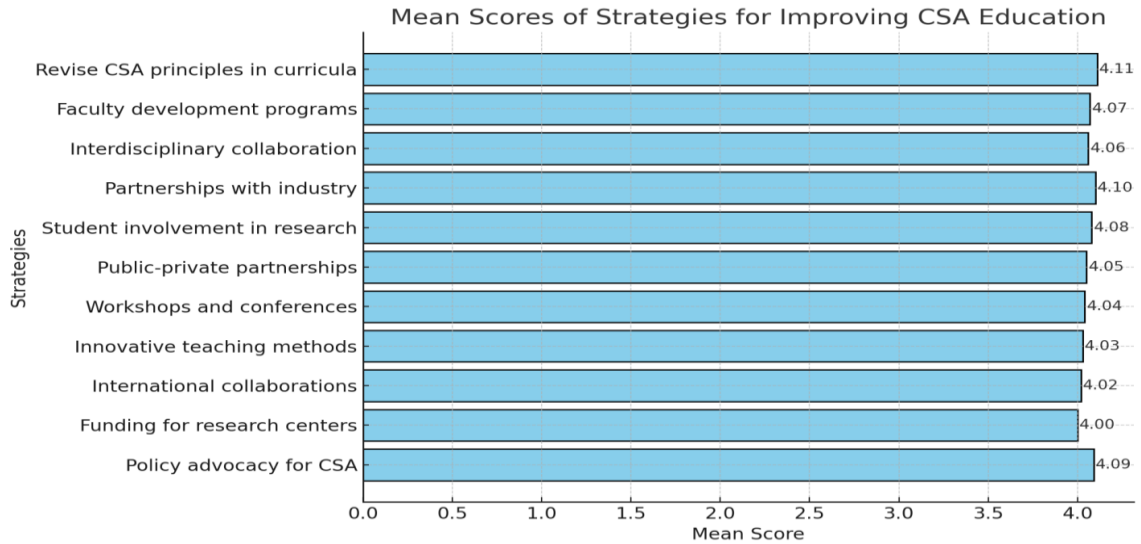

Figure 1: The bar chart illustrates the mean scores for various strategies aimed at improving the effectiveness of Climate-Smart Agriculture (CSA) education in higher education institutions. Among the strategies, "Revise and integrate CSA principles into existing agricultural curricula" received the highest mean score of 4.11, reflecting its critical importance. Other strategies such as "Provide faculty development programs" (4.07),

"Encourage interdisciplinary collaboration" (4.06), and "Establish partnerships with industry stakeholders" (4.10) also garnered strong support, highlighting the necessity of investing in both curriculum development and collaborative efforts. While "Secure funding for the development of CSA-focused research centers" was rated lowest with a mean score of 4.00, it still reflects a high level of agreement on its significance. The overall mean score of 4.06 demonstrates consistent agreement on the value of these strategies, emphasizing the importance of a comprehensive and collaborative approach to enhancing CSA education in higher education institutions.

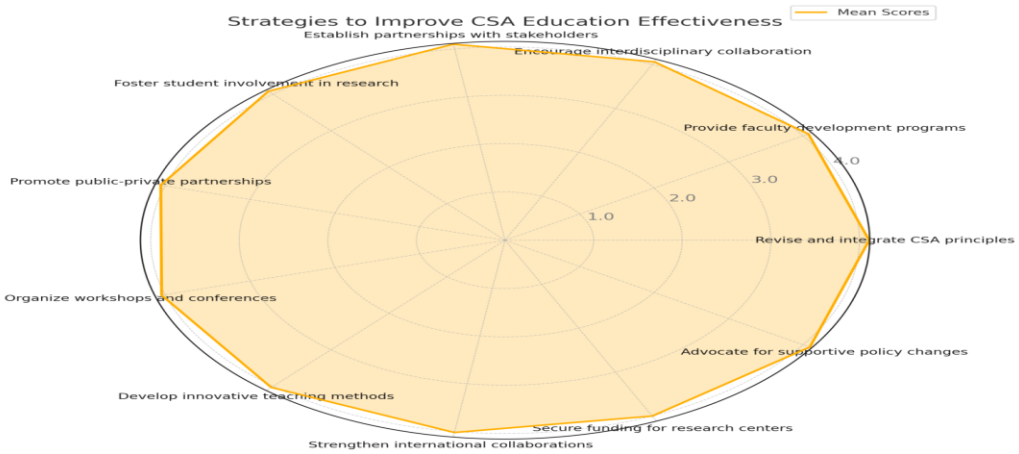

Figure 3: The radar chart above visually represents the effectiveness of various strategies to improve CSA education in higher education institutions. Each axis corresponds to a specific strategy, and the mean scores reflect their perceived importance or success. This visualization allows for quick identification of strategies with the highest ratings, such as revising CSA curricula, establishing partnerships, and advocating for policy changes, all of which scored above 4.0. The chart highlights areas for strategic emphasis in implementing CSA-focused education programs.

Discussion

The findings of the study revealed that integrating climate-smart agriculture (CSA) into higher education institutions globally plays a significant role in equipping students with the knowledge and skills required to address climate-related challenges in agriculture. This integration enhances students' understanding of sustainable practices, promotes climate-resilient agricultural techniques, and fosters innovation for global food security. These findings align with the work of Food and Agriculture Organization (2022), which highlighted the importance of embedding CSA principles in educational curricula to prepare professionals capable of addressing the multifaceted impacts of climate change. Similarly, Vigoda-Gadot (2021) emphasized that higher education institutions serve as key platforms for advancing sustainability in agriculture by providing students with hands-on training and exposure to adaptive methodologies. These results underscore the necessity of incorporating CSA education as a core component of agricultural training to align with global sustainability initiatives. The findings of the study identified several challenges hindering the implementation of CSA-focused training programs in higher education institutions. These challenges include insufficient financial resources, a lack of faculty expertise, inadequate infrastructure, and resistance to change from stakeholders. These results are in consonance with the findings of Bryan (2020), who identified limited institutional funding and faculty capacity as critical barriers to CSA integration in East African higher education systems. Similarly, Tegbaru (2022) found that resistance to curriculum innovation and insufficient collaboration among departments significantly impede the adoption of CSA-focused programs. These findings highlight the urgent need for increased investment in capacity building, policy interventions, and stakeholder engagement to overcome these obstacles and facilitate the effective integration of CSA into academic curricula.

The findings of the study revealed that strategies such as curriculum reform, faculty development, public-private partnerships, and international collaborations are effective in enhancing CSA education in higher education institutions. Curriculum reform was emphasized as a pivotal strategy, involving the redesign of academic programs to incorporate CSA principles, practical sessions, and experiential learning opportunities. Faculty training initiatives were also highlighted as critical in ensuring educators has the necessary expertise to teach CSA concepts effectively. Kassie and Teklewold (2021) emphasized the importance of curriculum

innovation and capacity building for educators as foundational elements for improving CSA education. Furthermore, Vigoda-Gadot (2021) underscored the role of public-private partnerships and international collaborations in addressing resource gaps, facilitating global knowledge exchange, and providing students with exposure to industry practices. These strategies collectively create a robust framework for the successful implementation of CSA education, preparing future professionals for climate-resilient agricultural practices.

Implications for Educational Policy

The study highlights the need for educational policy reforms to integrate climate-smart agriculture (CSA) into higher education curricula. Policies should prioritize the inclusion of CSA as a core part of agricultural programs, equipping students with relevant skills to tackle climate-related challenges in farming. There is also a need to address the shortage of qualified faculty through targeted training in climate change, sustainable agriculture, and CSA techniques. Enhancing teaching quality through continuous professional development is essential. Furthermore, collaboration between universities, government agencies, and private organizations should be encouraged to support CSA training through funding, internships, and innovation in teaching and research. These steps will help prepare future professionals for climate-resilient agriculture.

Contributions to Knowledge

This study contributes to knowledge through a comprehensive analysis of how educational management and policy interventions enhance the integration of climate-smart agriculture (CSA) into higher education curricula. The findings illuminate the critical role CSA plays in preparing agricultural professionals to tackle climate change challenges and promote sustainable agricultural practices. The identification of challenges such as resource gaps, faculty expertise shortages, and institutional resistance provides valuable insights into the barriers that hinder the effective implementation of CSA education. Additionally, the research underscores the importance of strategic policy frameworks and collaborations among educational institutions, government bodies, and the private sector to advance CSA education. Practical strategies, including curriculum reform and faculty development programs, are highlighted as essential for improving the quality and effectiveness of CSA education in higher institutions globally. The study further emphasizes the need for targeted interventions to ensure students acquire the necessary skills and knowledge to adopt climate-resilient agricultural practices, ultimately contributing to global sustainability and food security goals.

Conclusion

The study underscores the vital role of educational management and policy in promoting the integration of climate-smart agriculture (CSA) into higher education. CSA inclusion in agricultural curricula is key to preparing future professionals for climate-resilient and sustainable farming. However, challenges such as limited resources, lack of skilled educators, and institutional resistance remain. Overcoming these issues requires curriculum reform, faculty training, and partnerships among universities, government, and the private sector. Strengthening CSA in higher education will better equip students to address climate change in agriculture and support global sustainability efforts.

Recommendations

Based on the findings of this study, the following recommendations are made to enhance the integration of climate-smart agriculture (CSA) into higher education institutions:

1. Higher education institutions should revise and integrate CSA principles into agricultural curricula, including specialized courses, workshops, and field training.
2. Institutions should provide ongoing faculty development programs focused on CSA principles, through exchange programs, partnerships with experts, and research opportunities.
3. Institutions should allocate adequate resources and invest in infrastructure, research facilities, and access to CSA technologies to support effective training.
4. Governments and policymakers should create supportive frameworks and policies for CSA education, including funding and incentives for universities.
5. Institutions should raise awareness about CSA among students, faculty, and policymakers through campaigns, seminars, and public forums.

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