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Climate Change Education and the Enhancement of Sustainable Agriculture among Rural Farmers in Rivers State

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ABSTRACT

This study examined climate change education and the enhancement of sustainable agriculture among rural farmers in Rivers State. Three research questions and three null hypotheses guided the study. The study adopted the analytic descriptive survey research design. The population of the study was 3,498 farmers and agricultural extension officers in rural areas who are registered with the Rivers State Agricultural Development Programme (RSADP) and have attended climate Change awareness programmes organized by RSADP. The sample size of this study was 348 respondents consisting of 330 Farmers and 18 Agricultural Experts in Rivers State. The study used a self- designed questionnaire and a Key Informant interview guide for data collection. The instruments were validated by the researcher's supervisor, one expert in Community Development and one in Measurement and Evaluation from Rivers State University. A test of internal consistency was carried out using the Chronbach Alpha method to determine the reliability of the instrument. Reliability coefficients of 0.79, 0.96 and 0.97 were obtained for the three sections of the instrument respectively. The key informant data were analysed using thematic content analysis, which involved initial coding, categorization, and theme development. From the analysed qualitative and quantitative data, the findings of the study among others revealed that to a high extent, climate change education enhances water conservation methods for sustainable agriculture in Rivers State. Based on the findings of the study, it was recommended among other things that the Rivers State Ministry of Water Resources should implement demonstration projects for rainwater harvesting systems in strategic farming communities and provide technical training for local adoption.

Keywords: *Climate Change, Agriculture, Sustainable, Farming*

INTRODUCTION

Climate change represents one of the most formidable challenges facing humanity in the 21st century, with far-reaching implications for agricultural systems worldwide. In Nigeria's Rivers State, where agriculture constitutes a huge portion of rural livelihoods, the intersection of climate change awareness, educational interventions, and sustainable agricultural practices has become increasingly crucial. Rivers State, located in the Niger Delta region of Nigeria, is characterized by its rich biodiversity, extensive waterways, and significant agricultural potential. However, the region faces unique vulnerability to climate change impacts due to its coastal geography, dependence on rain-fed agriculture, and socioeconomic challenges (Nzeadibe, Egbule, Chukwuone, and Agu, 2021). The agricultural sector in Rivers State employs approximately 65% of the rural population and contributes substantially to the state's food security and economic development (Adewale and Adhuze, 2020). Despite this importance, rural agricultural systems in the region remain highly susceptible to climate-

induced stressors such as unpredictable rainfall patterns, increased flooding, soil degradation, and new pest and disease pressures (Akpodiogaga-a and Odjugo, 2019).

Climate change awareness is defined as the understanding and recognition of climate change processes, causes, and impacts constitutes a fundamental prerequisite for effective adaptation and mitigation strategies. According to Olorunfemi, Oloukoi, Adetunji, and Oladipo (2023) there exixt significant disparities in climate change awareness among rural farmers in Nigeria, with factors such as education level, access to information, and socioeconomic status influencing knowledge acquisition and perception. In Rivers State specifically, Ogbonna, Onyeneke, Mbanasor, Enwereuzor, and Nwankwo (2022) found that while many farmers observe changes in weather patterns, their understanding of the underlying causes and long-term implications of climate change remains limited. This knowledge gap underscores the critical need for targeted educational interventions that can bridge the divide between scientific understanding and local agricultural practices. Climate change education represents a transformative approach to building adaptive capacity among vulnerable communities. Effective climate change education transcends mere information dissemination, encompassing participatory learning processes that integrate indigenous knowledge systems with scientific insights (Bamidele, Johnson, and Tola, 2018).

The relationship between climate change education and sustainable agriculture is multifaceted and dynamic. Sustainable agriculture encompasses a range of practices designed to maintain ecological balance, conserve natural resources, and ensure long-term productivity while minimizing environmental degradation (Nnaji, Uzokwe, and Chukwu, 2021). Water conservation methods, soil conservation practices, income diversification strategies, post-harvest management techniques, climate-resilient crop selection, and agroforestry systems represent key components of sustainable agriculture that can be enhanced through targeted educational interventions (Anabaraonye, Okafor, and Hope, 2018). Water conservation methods have gained increasing significance in the context of climate change-induced alterations in precipitation patterns. In Rivers State, where rainfall variability has become more pronounced, innovative water management techniques such as rainwater harvesting, micro-irrigation systems, and water-efficient crop selection can significantly enhance agricultural resilience (Nwankwoala and Tariah, 2022).

Soil conservation practices represent another critical dimension of sustainable agriculture that can be enhanced through climate change education. In Rivers State, where soil degradation through erosion, nutrient depletion, and salinization poses significant challenges to agricultural productivity, soil conservation techniques such as contour farming, cover cropping, and conservation tillage can help maintain soil health and fertility (Nwagbara, Onyekwere, Nwankwo, and Nnaji, 2023). Educational programmes that emphasize the relationship between soil health and climate resilience can motivate farmers to adopt practices that enhance soil organic matter, improve water infiltration, and reduce erosion (Mmom and Aifesehi, 2019). A study conducted by Egwuogu, Olorunfemi, Adelekan, and Nwilo (2021) found that participatory learning approaches that combine theoretical knowledge with practical demonstrations significantly increased adoption rates of soil conservation practices among rural farmers in southeastern Nigeria. Diversification of income sources represents a crucial adaptation strategy that can help rural farmers manage climate-related risks and uncertainties. Climate change education can play a transformative role in broadening farmers' awareness of alternative livelihood options and equipping them with the skills necessary to pursue diverse income streams (Anabaraonye, Okafor, and Hope, 2018).

Gender dynamics play a significant role in shaping access to and benefits from climate change education. Research by Chikezie, Ibeawuchi, Ohajianya, Onyeagocha, and Henri-Ukoha (2019) found that women farmers in Rivers State often face barriers to participation in educational programmes due to time constraints, cultural norms, and limited mobility. Given women's substantial contribution to agricultural production and their specific vulnerabilities to climate change impacts, gender-sensitive educational approaches that address these barriers are essential for achieving equitable and effective outcomes (Ozor, Umunnakwe, and Acheampong, 2018). Youth engagement represents another critical dimension of climate change education for sustainable agriculture. With increasing rural-urban

migration and aging farmer populations in Rivers State, involving young people in agricultural innovation and climate adaptation is crucial for long-term sustainability (Adebayo, Oladele, and Ajayi, 2019). Educational initiatives that incorporate digital technologies, entrepreneurship training, and peer-to-peer learning can help attract and retain youth in agricultural sectors while fostering innovation and adaptation (Eze, Onwubuya, and Onyekuru, 2021).

In Rivers State, policies related to agricultural extension, land tenure, water resource management, and climate change adaptation can significantly influence farmers' access to information, resources, and incentives for sustainable practices (Nzeadibe, Egbule, Chukwuone, and Agu, 2021). Research by Adewale and Adhuze (2020) highlights the need for integrated policy approaches that align agricultural development, environmental conservation, and climate change adaptation objectives while ensuring meaningful participation of rural farming communities in decision-making processes. Institutional partnerships between government agencies, research institutions, non-governmental organizations, and community-based organizations can enhance the effectiveness and sustainability of climate change education initiatives. In Rivers State, collaborative approaches that leverage the strengths and resources of diverse stakeholders have shown promise in addressing complex challenges at the intersection of climate change and agriculture (Anabaraonye, Okafor, and Hope, 2018). Mmom and Aifesehi (2019) emphasize that such partnerships should be built on principles of mutual respect, shared learning, and long-term commitment to supporting farmers' adaptive capacity.

The relationship between climate change education and sustainable agriculture among rural farmers in Rivers State is characterized by complex interactions between knowledge systems, technological innovations, socioeconomic factors, and ecological processes. Effective educational interventions must address not only technical aspects of sustainable agricultural practices but also the broader contextual factors that influence farmers' adaptive capacity and decision-making. By fostering climate change awareness and promoting sustainable practices in water conservation and soil management, educational initiatives can play a transformative role in building resilient agricultural systems in Rivers State. It is against this background that this study intends to investigate climate change education as a strategy for enhancing sustainable agriculture among rural farmers in Rivers State.

Statement of the Problem

Climate change poses a significant threat to global food security, particularly in rural communities where agriculture remains the primary source of livelihood. In Rivers State, rural farmers are increasingly vulnerable to soil degradation and declining crop yields, all of which threaten agricultural sustainability. These challenges highlight the urgent need for climate change education as a tool for enhancing adaptive farming strategies. However, the extent to which rural farmers in Rivers State are aware of climate change and its impact on their agricultural practices remains largely unknown. Despite various governmental and non-governmental interventions, many farmers continue to rely on traditional farming techniques that may not be well-suited for coping with climate variability. The limited integration of climate change education in rural agricultural training programmes have hindered the adoption of sustainable practices such as water conservation, soil conservation, agroforestry, improved crop selection, post-harvest management, and diversification of income sources. Without adequate knowledge and skills, farmers may struggle to implement adaptive measures necessary for mitigating the adverse effects of climate change on their livelihoods.

Given the critical role of climate change education in promoting sustainable agriculture, it is essential to assess its impact on rural farmers in Rivers State. This study sought to examine the level of climate change awareness among these farmers and investigate how climate change education enhances water conservation methods, soil conservation practices, diversification of income sources, post-harvest management, crop selection practices, and agroforestry.

Purpose of the Study

The purpose of this study was to examine how climate change education enhances sustainable agriculture among rural farmers of Rivers State. The specific objectives of this research were to:

1. find out the extent to which rural farmers are aware of how climate change education enhances sustainable agriculture in Rivers State;
2. examine the extent to which climate change education enhances water conservation methods among rural farmers for sustainable agriculture in Rivers State;
3. determine the extent to which climate change education enhances soil conservation practices among rural farmers for sustainable agriculture in Rivers State;

Research Questions

The following research questions guided the study:

1. To what extent are rural farmers aware of how climate change education enhance sustainable agriculture in Rivers State?
2. To what extent does climate change education enhance water conservation methods among rural farmers in Rivers State?
3. To what extent does climate change education enhance soil conservation practices among rural farmers in Rivers State?

Hypotheses

The following null hypotheses were tested at a 0.05 significance level:

1. There is no significant difference in the mean responses of Farmers and Agricultural Extension Officers on the extent to which rural farmers are aware of how climate change education enhances sustainable agriculture in Rivers State.
2. There is no significant difference in the mean responses of Farmers and Agricultural Extension Officers on the extent to which climate change education enhances water conservation methods for sustainable agriculture in Rivers State.
3. There is no significant difference in the mean responses of Farmers and Agricultural Extension Officers on the extent to which climate change education enhances soil conservation practices for sustainable agriculture in Rivers State.

METHODOLOGY

The study adopted the analytic descriptive survey research design. The population of the study was 3,498 farmers and agricultural extension officers in rural areas who are registered with the Rivers State Agricultural Development Programme (RSADP) and have attended climate change awareness programmes organized by RSADP. The sample size of this study was 348 respondents consisting of 330 Farmers and 18 Agricultural Experts in Rivers State. The sample size was determined using the Krejcie and Morgan table of sample size determination. The multistage method was used to distribute the sample for the study. Firstly, the respondents were clustered into the three senatorial districts in Rivers State, which are Rivers East, Rivers West and Rivers Southeast senatorial districts. Secondly, simple random sampling technique was used to select three local governments areas each from the three senatorial districts, making a total of nine local government areas. Finally, 20% was selected from the sample of farmers and agricultural extension officers from the nine local government areas selected for the study.

The study used a self- designed questionnaire titled “Climate Change Education and Enhancement of Sustainable Agriculture among Rural Farmers in Rivers State” (CCEESAARFRS) and a Key Informant interview guide for data collection. The instruments were validated by three experts, two in Community Development and one in Measurement and Evaluation from Rivers State University. A test of internal consistency was conducted using the Cronbach's Alpha method to assess the reliability of the instrument. Reliability coefficients of 0.79, 0.96 and 0.97 were obtained for the three sections of the instrument, respectively. The key informant data were analysed using thematic content

analysis, which involved initial coding, categorization, and theme development. The quantitative data were analyzed using mean, standard deviation, and z-test statistics. The decision rule for the research questions were based on the following classification:

Classification	**Value Range**
Very High Extent (VHE) = 4	3.50 – 4.00
High Extent (HE) = 3	2.50 – 3.49
Low Extent (LE) = 2	1.50 – 2.49
Very Low Extent (VLE) =1	1.00 – 1.49

Results

Research Question 1: To what extent are rural farmers aware of how climate change education enhances sustainable agriculture in Rivers State?

Table1: Mean Response on the Extent to which Rural Farmers are Aware of how Climate Change Education Enhance Sustainable Agriculture in Rivers State

S/N	**Items**	**Farmers N = 330**			**Agric. Ext. Officers N=18**		
		Mean	**SD**	**Remark**	**Mean**	**SD**	**Remark**
1	To what extent are you aware of the concept of climate change and its potential impacts on agriculture?	3.26	0.90	HE	3.22	0.91	HE
2	to what extent can you identify specific climate change indicators in your local agricultural environment?	2.75	1.14	HE	3.41	1.53	HE
3	To what extent do you understand the potential long-term consequences of climate change on crop production in Rivers State?	3.98	0.89	VHE	3.61	1.00	VHE
4	To what extent are you aware of the relationship between climate change and local water resources?	3.29	0.89	HE	3.55	1.00	HE
5	To what extent do you know about adaptation strategies that can help mitigate the impacts of climate change on farming?	2.99	1.13	HE	2.94	1.15	HE
6	To what extent are you familiar with the sources of information about climate change in your community?	2.85	1.41	HE	3.66	1.43	VHE
7	To what extent do you believe climate change is currently affecting your agricultural practices?	3.10	0.95	HE	3.14	0.97	HE

8	To what extent do you understand the causes of climate change	3.32	1.10	HE	2.93	1.12	HE
	Grand Mean	**3.22**		**HE**	**3.34**		HE

Table 1 above on research question one shows the mean responses of farmers and agricultural extension officers on the extent to which rural farmers are aware of how climate change education enhances sustainable agriculture in Rivers State. The grand mean scores of 3.22 and 3.34 for farmers and agricultural extension officers respectively fall within the decision mean of 2.50 - 3.49. This indicates that both groups agreed that to a high extent farmers are aware of how climate change education enhances sustainable agriculture in Rivers State

Research Question 2: To what extent does climate change education enhance water conservation methods among rural farmers in Rivers State?

Table 2: Mean Response on the Extent Climate Change Education Enhance Water Conservation Methods Among Rural Farmers in Rivers State

S/N	Items	Farmers N = 330			Agric. Ext. Officers N=18		
		Mean	**SD**	**Remark**	**Mean**	**SD**	**Remark**
9	To what extent has climate change education increased your awareness of the importance of water conservation for sustainable agriculture	3.32	0.58	HE	3.56	0.60	VHE
10	To what extent has climate change education influenced your adoption of water-saving irrigation techniques for sustainable agriculture	2.23	0.97	HE	3.13	1.00	HE
11	To what extent has climate change education encouraged you to implement rainwater harvesting methods for sustainable agriculture?	3.26	1.22	HE	3.12	1.27	HE
12	To what extent has climate change education enhanced your understanding of the relationship between climate change and water resource availability for sustainable agriculture?	2.46	0.69	HE	3.51	0.72	VHE
13	To what extent has climate change education motivated you to schedule your planting and harvesting periods based on water availability and climate forecasts for sustainable agriculture?	3.34	0.86	HE	3.28	0.89	HE
14	To what extent has climate change education led you to adopt soil moisture retention practices, for sustainable agriculture?	3.77	0.54	VHE	3.45	0.66	HE
15	To what extent has climate change education influenced your participation in	3.37	0.55	HE	3.35	0.49	HE

	community-based water management initiatives for sustainable agriculture?						
16	To what extent has climate change education affected your use of drought-resistant crop varieties for sustainable agriculture?	2.29	0.46	HE	3.77	0.49	VHE
	Grand Mean	**3.09**		**HE**	**3.42**		**HE**

Table 2 above on research question two, shows the mean responses of farmers and agricultural extension officers on the extent to which climate change education enhance water conservation methods among rural farmers in Rivers State. The grand mean scores of 3.09 and 3.42 for farmers and agricultural extension officers respectively fall within the decision mean of 2.50 - 3.49. This indicates that both groups agreed that to a high extent climate change education enhance water conservation methods among rural farmers in Rivers State.

Research Question 3: To what extent does climate change education enhance soil conservation practices among rural farmers in Rivers State?

Table 3: Mean Response on the Extent Climate Change Education Enhance Soil Conservation Practices among Rural Farmers in Rivers State

S/N	Farmers N = 330				Agric. Ext. Officers		
	Items	Mean	SD	Remark	N=18 Mean	SD	Remark
17	To what extent has climate change education increased your understanding of soil conservation techniques?	3.35	1.41	HE	3.39	1.43	HE
18	To what extent have you implemented erosion control methods after receiving climate change education?	3.23	0.16	HE	2.87	1.06	HE
19	To what extent does your understanding of soil nutrient management improve after climate change educational interventions?	2.76	1.14	HE	2.57	1.12	HE
20	To what extent has climate change education helped you understand the importance of organic matter in soil conservation?	2.73	1.13	HE	2.97	1.03	HE
21	To what extent have you modified your tillage practices to minimize soil disturbance?	2.63	1.15	HE	2.56	1.12	VHE
22	To what extent has climate change education influenced your understanding of soil biodiversity and its role in agricultural sustainability?	2.84	1.16	HE	2.69	1.17	HE
23	To what extent do you now understand the connection between	3.55	1.41	VHE	3.38	1.43	HE

	soil conservation and climate change adaptation?							
24	To what extent has climate change education improved your knowledge about the role of organic matter in maintaining soil health and promoting sustainable agriculture?	2.62	0.16	HE		2.88	1.06	HE
	Grand Mean	**2.90**		**HE**		**2.99**		**HE**

Table 3 above on research question three, shows the mean responses of farmers and agricultural extension officers on the extent to which climate change education enhances soil conservation practices among rural farmers in Rivers State. The grand mean scores of 2.90 and 2.99 for farmers and agricultural extension officers respectively fall within the decision mean of 2.50 - 3.49. This indicates that both groups agreed that to a high extent climate change education enhance soil conservation practices among rural farmers in Rivers State.

Test of Hypotheses

H_{01}: There is no significant difference in the mean responses of Farmers and Agricultural Extension Officers on the extent to which rural farmers are aware of how climate change education enhances sustainable agriculture in Rivers State.

Table 4: Z-test Analysis on Significant Difference in the Mean Responses of Farmers and Agricultural Extension Officers on the Extent to Which Rural Farmers are Aware of How Climate Change Education Enhances Sustainable Agriculture in Rivers State

Respondents	N	$\bar{X}$	SD	Df	Z-cal	Z-crit	SL	Decision
Farmers	330	3.22	1.04	346	1.07	+1.96	0.05	Accepted
Agricultural Extension. Officers	18	3.47	1.06					

Table 4 above shows that z-calculated value of 1.07 is less than the z-critical value of +1.96 at 0.05 significant level for 346 degree of freedom indicating that, there is no significant difference in the mean responses of Farmers and Agricultural Extension Officers on the extent to which rural farmers are aware of how climate change education enhances sustainable agriculture in Rivers State. Therefore, the null hypothesis is accepted and the alternate hypothesis rejected.

H_{02}: There is no significant difference in the mean responses of Farmers and Agricultural Extension Officers on the extent to which climate change education enhances water conservation methods for sustainable agriculture in Rivers State.

Table 5: Z-test Analysis on significant difference in the mean responses of Farmers and Agricultural Extension Officers on the Extent to Which Climate Change Education Enhances Water Conservation Methods for Sustainable Agriculture in Rivers State

Respondents	N	$\bar{X}$	SD	Df	Z-cal	Z-crit	SL	Decision
Farmers	330	3.09	0.80	346	0.50	+1.96	0.05	Accepted
Agricultural Extension. Officers	18	3.42	0.81					

Table 5 above shows that Z-calculated value of 0.50 is less than the Z-critical value of +1.96 at 0.05 significant level for 346 degree of freedom indicating that, there is no significant difference in the mean responses of Farmers and Agricultural Extension Officers on the extent to which climate change education enhances water conservation methods for sustainable agriculture in Rivers State. Therefore, the null hypothesis is accepted and the alternate hypothesis rejected.

H_{03}: There is no significant difference in the mean responses of Farmers and Agricultural Extension Officers on the extent to which climate change education enhances soil conservation practices for sustainable agriculture in Rivers State.

Table 6: Z-test Analysis on significant difference in the mean responses of Farmers and Agricultural Extension Officers on the Extent to Which Climate Change Education Enhances Soil Conservation Practices Methods for Sustainable Agriculture in Rivers State

Respondents	N	$\bar{X}$	SD	Df	Z-cal	Z-crit	SL	Decision
Farmers	330	2.90	1.16	346	0.32	+1.96	0.05	Accepted
Agricultural Extension. Officers	18	`2.99	1.08					

Table 6 above shows that Z-calculated value of 0.32 is less than the Z-critical value of +1.96 at 0.05 significant level for 346 degree of freedom, indicating that, there is no significant difference in the mean responses of Farmers and Agricultural Extension Officers on the extent to which climate change education enhances soil conservation practices for sustainable agriculture in Rivers State. Therefore, the null hypothesis is accepted and the alternative hypothesis rejected.

Discussion of Findings

Extent to which Rural Farmers are Aware of How Climate Change Education Enhance Sustainable Agriculture in Rivers State

The results of the findings in research question one indicates that to a high extent, rural farmers are aware of how climate change education enhances sustainable agriculture in Rivers State. The corresponding hypothesis indicated that there is no significant difference in the mean responses of Farmers and Agricultural Extension Officers on the extent rural farmers are aware of how climate change education enhances sustainable agriculture in Rivers State. This finding is in agreement with the findings of Olawuyi and Ojo, (2019) who observed that awareness of climate change among rural farmers encompasses knowledge of the causes, impacts, and adaptation strategies necessary for mitigating agricultural losses. In their view most farmers have acquired more knowledge of climate change concepts, which enhances their readiness to adopt adaptive strategies for sustainable agriculture. In a related view, Nguyen, Pham, and Do (2023) opined that increasing climate change awareness enhances farmers' ability to understand climate patterns, utilize meteorological data, and make informed farming decisions. For example, knowledge of climate variability enables farmers to adjust planting calendars, adopt drought-resistant crop varieties, and improve water conservation techniques. According to Ibekwe, Opara, and Nduka (2021). climate change awareness is a key determinant of sustainable agriculture among rural farmers in Rivers State. By equipping farmers with knowledge on climate adaptation, soil and water conservation, agroforestry, income diversification, and post-harvest management, climate education enhances resilience and long-term agricultural sustainability. Strengthening climate education initiatives through policy support and community engagement is essential for improving adaptation outcomes and ensuring food security in the face of climate change.

Extent to which Climate Change Education Enhances Water Conservation Methods Among Rural Farmers for Sustainable Agriculture

The results of the findings in question two indicate that the respondents agrees that to a high extent, climate change education enhances water conservation methods for sustainable agriculture in Rivers State. The corresponding hypothesis indicates that there is no significant difference in the mean responses of Farmers and Agricultural Extension Officers on the extent to which climate change education enhances water conservation methods for sustainable agriculture in Rivers State. This agrees with the findings of Boretti and Rosa, (2019) who assert that water conservation methods are critical in mitigating the adverse effects of climate variability, ensuring that rural farmers can maintain crop yields and sustain their livelihoods despite changing weather patterns. In their views, the integration of climate change education into rural farming practices serves as a strategic intervention for promoting sustainable agricultural systems by enhancing farmers' understanding of climate-related risks and their ability to implement adaptive measures. According to Mukherjee, Molden, Alam, Singh, Huda and Clement, (2021), rural farmers, who are often constrained by limited access to formal education and training, benefit significantly from targeted climate education programmess that focus on water conservation techniques such as rainwater harvesting, irrigation management, and soil moisture retention. Similarly, research by Kogo, Kumar and Koech (2021) demonstrated that climate-smart agricultural training programmes significantly influenced farmers' willingness to invest in water-saving technologies. These findings underscore the importance of climate change education as a driver for behavior change among rural farmers, leading to the widespread adoption of water conservation measures that enhance sustainability. The effectiveness of climate change education in promoting water conservation is further supported by studies on indigenous knowledge systems and participatory learning approaches. Many rural communities possess traditional water management practices that align with sustainable agricultural principles (Nyong, Adesina & Elasha, 2019).

Extent to which Climate Change Education Enhances soil conservation practices Among Rural Farmers for Sustainable Agriculture

The results of the findings in question three indicate that the respondents agree that to a high extent, climate change education enhances soil conservation practices for sustainable agriculture in Rivers State. The corresponding hypothesis indicates that there is no significant difference in the mean responses of Farmers and Agricultural Extension Officers on the extent to which climate change education enhances soil conservation practices for sustainable agriculture in Rivers State. This finding is in line with the findings of Rockström et al (2019). Who observed that soil conservation practices are critical for sustainable agriculture, as they help preserve soil structure, enhance moisture retention, and prevent nutrient loss. Traditional farming methods such as slash-and-burn and continuous tillage contribute to soil degradation, making it imperative for farmers to adopt sustainable alternatives. In a relegated view, Kogo, Kumar and Koech (2021) asserts that farmers who participated in climate-smart agricultural training were more likely to adopt mulching, minimum tillage, and crop rotation techniques. Similarly, a study by Alemayehu, Bewket, Gebremariam, Eshetu, Melesse and Steenhuis (2022) demonstrated that extension programmes incorporating climate education significantly enhanced soil conservation awareness and practices among smallholder farmers. These findings underscore the transformative role of education in fostering behavioral change and promoting sustainable land management. However, addressing barriers such as access to training, resource availability, and institutional support is critical for maximizing the impact of climate education on soil conservation. Strengthening climate education initiatives through participatory approaches, digital innovations, and policy interventions will ensure that rural farmers can effectively conserve soil and sustain agricultural productivity in the face of climate change.

Analysis of Key Informant Interviews with Agricultural Extension Officers

Theme 1: Climate Change Awareness Among Rural Farmers

The analysis revealed consensus among extension officers that climate change awareness varies significantly across different farming communities in Rivers State. Seven out of nine officers reported that while most farmers recognize unusual weather patterns, they often lack understanding of the broader climate change phenomenon. According to one officer from Ikwerre LGA:

> *"Farmers in my area have noticed that rainfall is becoming increasingly unpredictable, but they typically attribute this to spiritual or cultural factors rather than global climate change."*

Extension officers serving upland areas reported higher levels of climate change awareness among farmers compared to those in riverine communities, which they attributed to differences in educational access and exposure to external information.

Multiple barriers to climate change awareness were identified, with low literacy levels being cited by all nine officers as a primary constraint. Other frequently mentioned barriers included:

1. Language limitations in translating climate science concepts (mentioned by 6 officers)
2. Limited access to information sources in remote areas (mentioned by 8 officers)
3. Cultural and traditional beliefs that provide alternative explanations for weather changes (mentioned by 5 officers)
4. Lack of locally relevant educational materials (mentioned by 7 officers)

An extension officer from Omuma LGA said:

> *"When we try to explain climate change, we struggle to find appropriate terms in local dialects that accurately convey scientific concepts without sounding abstract or disconnected from farmers' daily experiences."*

Theme 2: Effectiveness of Current Climate Change Education Approaches

The extension officers described various approaches currently used for climate change education, including farmer field schools, demonstration plots, community meetings, radio programmes, and printed materials. six officers reported that participatory approaches with practical demonstrations yielded the most positive responses from farmers. According to an officer from Etche LGA:

> *"When farmers can see with their own eyes how certain practices improve resilience to erratic rainfall, they become much more receptive to the underlying climate change message."*

All officers emphasized that one-off training sessions produced minimal lasting impact compared to continuous engagement strategies. Five officers specifically highlighted the effectiveness of farmer-to-farmer knowledge transfer approaches, where early adopters serve as community role models.

The analysis identified several critical gaps in current climate change education efforts they include:

1. Insufficient localization of climate information (mentioned by 8 officers)
2. Inadequate follow-up after initial training (mentioned by all 9 officers)
3. Limited resources for practical demonstrations (mentioned by 7 officers)
4. Poor coordination among different agencies providing climate information (mentioned by 6 officers)
5. Lack of evaluation mechanisms to assess educational outcomes (mentioned by 5 officers)

As one officer from Abua/Odual LGA expressed:

> *"We deliver training sessions as required by our programmess, but we rarely have resources to follow up and support farmers as they try to implement new practices. This creates a disconnect between knowledge transfer and actual behavior change."*

Theme 3: Water and Soil Conservation Practices

Seven extension officers reported observing increased interest in water conservation methods following educational interventions, particularly for techniques requiring minimal financial investment. However, all officers noted that sophisticated water management systems like drip irrigation showed low adoption rates due to cost barriers. Similarly, soil conservation practices that provided visible short-term benefits (such as mulching) were more readily adopted than those with primarily long-term benefits (such as contour bunding).

An officer from Tai LGA observed:

> *"Farmers quickly embrace mulching because they can immediately see how it helps retain soil moisture during dry spells. But convincing them to invest labor in creating drainage systems for heavy rainfall events is challenging when the benefits are less immediately apparent."*

Furthermore, the informants identified several factors influencing successful adoption:

1. Compatibility with existing farming systems (mentioned by 8 officers)
2. Observable benefits within one growing season (mentioned by all 9 officers)
3. Low implementation and maintenance costs (mentioned by 7 officers)
4. Technical simplicity (mentioned by 6 officers)
5. Community-wide coordination, especially for watershed management (mentioned by 5 officers)

CONCLUSION

This study examined the role of climate change education in enhancing sustainable agricultural practices among rural farmers in Rivers State. The findings of the study indicated that climate change education enhances the adoption of sustainable agricultural practices, including water conservation methods and soil conservation techniques. Notably, farmers who received structured climate change education demonstrated greater resilience to changing weather patterns and improved agricultural productivity. These findings underscore the critical importance of integrating climate change education into agricultural extension services in Rivers State. By enhancing farmers' understanding of climate change impacts and adaptation strategies, policy makers and agricultural stakeholders can significantly improve agricultural sustainability, food security, and rural livelihoods in the region.

RECOMMENDATIONS

Based on the findings of the study, it was recommended that:

1. The Rivers State Ministry of Agriculture should establish community-based climate information centers in each local government area, equipped with simplified educational materials in local languages to improve farmers' awareness of climate change phenomena and impacts.
2. The Rivers State Ministry of Water Resources should implement demonstration projects for rainwater harvesting systems in strategic farming communities and provide technical training for local adoption.
3. The Rivers State Ministry of Environment should develop and implement a comprehensive soil conservation policy with specific guidelines for different agroecological zones within the state.

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