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CLIMATE CHANGE ADAPTATION STRATEGIES AMONG AGRICULTURAL COOPERATIVE FARMERS IN SOUTHERN NIGERIA

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Abstract

This study examined climate change adaptation strategies among agricultural cooperative farmers in Southern Nigeria. The specific objectives were to assess farmers' perceptions of climate change and its effects on agricultural production, identify adaptation strategies adopted by cooperative farmers, determine the socioeconomic and institutional factors influencing adaptation decisions, and evaluate the effectiveness of agricultural cooperatives in enhancing adaptive capacity. The study adopted a survey research design and utilized a structured questionnaire to collect data from members of agricultural cooperative societies in selected states in Southern Nigeria. Data were analyzed using descriptive statistics while multiple regression analysis was employed to examine factors influencing adaptation strategy adoption. The findings revealed that cooperative farmers perceived climate change as a major threat to agricultural productivity through irregular rainfall, flooding, rising temperatures, pest infestations, and declining crop yields. Farmers adopted various adaptation measures, including crop diversification, adjustment of planting dates, use of improved crop varieties, irrigation farming, and soil conservation practices. The regression results showed that educational level, access to extension services, access to credit facilities, cooperative membership strength, and government support significantly influenced adaptation decisions. Among these factors, cooperative membership strength had the greatest influence on adaptation strategy adoption. The study concluded that agricultural cooperatives play a vital role in strengthening climate resilience and promoting sustainable agricultural development in Southern Nigeria. It recommended among others that government, agricultural agencies, and cooperatives should work to enhance climate change awareness and educational programs for farmers.

Keywords: Climate Change, Adaptation Strategies, Agricultural Cooperatives, Adaptive Capacity, Climate Resilience.

Introduction

Climate change has emerged as one of the greatest threats to the environment and socio-economic wellbeing of agricultural production systems around the world with serious repercussions for food security, rural livelihoods, and sustainable development. In Sub-Saharan Africa, agriculture depends mostly on rain-fed systems and hence small-scale farmers in such regions are extremely vulnerable to climate variations such as erratic rainfall patterns, prolonged drought spells, floods, increased temperatures, and changes in seasonal cycles which ultimately affect crop production systems, lower yields, and livelihood insecurity of rural populations (Intergovernmental Panel on Climate Change [IPCC], 2023; Morton, 2007).

Agriculture plays an important role in providing job opportunities and rural livelihoods in Nigeria, but it is facing several shocks due to climate variations. It has been found through empirical evidence that farmers living in various ecological zones are facing delayed rainy season starts, shorter agricultural seasons, soil degradation, pest attacks, and agricultural productivity losses owing to climate variation and weather shocks (Fawole & Özkan, 2022; United Nations Environment Programme [UNEP], 2021). The effects of climate variation and weather shocks are much more pronounced in Southern Nigeria due to the predominance of smallholder farming systems, lack of irrigation facilities, and rain-fed agricultural practices in the region.

The following strategies have been used by farmers to mitigate the impacts of such changes: crop diversification, altering dates of planting, utilization of better and drought-tolerant crops, mixed farming practices, agroforestry practices, soil conservation measures, irrigation farming, and livelihood diversification (Bryan et al., 2009; Deressa et al., 2009). According to additional research, social network and cooperative membership enables farmers to gain access to more climate information, credit institutions, extension services, and collective risk-sharing practices, hence boosting the process of adaptation (Adger, 2003; Ikuemonisan & Ajibefun, 2021).

In view of the above, agricultural cooperatives are becoming key institutional arrangements that help build the climate resilience of rural farmers. Cooperatives enable farmers to benefit from collective efforts in accessing inputs, sharing of knowledge, financial assistance, and technological innovations, all of which play a critical role in building adaptive capacities. As demonstrated by various studies, social capital and collective actions that come through being a member of farmer organizations can substantially increase the chances of adopting appropriate measures to build climate resilience (Adger et al., 2005; Food and Agriculture Organization [FAO], 2021).

Nevertheless, despite the significance of cooperatives, most agricultural cooperative farmers in Southern Nigeria still experience considerable challenges hindering their effective adaptation process. They include the limited availability of climate information services, the inadequacy of extension support system, inadequate financial capabilities, poor institutional coordination, and limited access to modern climate resilient technologies (FAO, 2021; UNEP,

2021). Moreover, the adaptation approaches being utilized are not only inconsistent, but also insufficient in dealing effectively with negative effects resulting from climate variability on agricultural productivity.

Even though there is an increasing effect of climate change, as well as the presence of agricultural cooperatives which are expected to improve their resilience, many farming communities are still very much vulnerable to such climate risks. Continuous exposure to irregular rainfall, floods, droughts, and other climatic factors results in reduced agricultural output and poor food security within developing nations like Nigeria (IPCC, 2023; Morton, 2007). Although several adaptation approaches exist, their implementation remains inconsistent due to various socio-economic constraints.

More importantly, there is a lack of empirical knowledge concerning the effect of agricultural cooperative structure on the selection, degree of adoption, and efficacy of the adaptation measures by farmers in Southern Nigeria. Past research has generally considered individual smallholder farmers or wider agricultural groups, lacking an emphasis on adaptation practices through cooperative means (Ikuemonisan & Ajibefun, 2021; Adger et al., 2005). There is, therefore, a considerable gap in the existing body of literature on the question of whether agricultural cooperatives increase the climate change resilience capabilities of the farmers or remain ineffective networks with low adaptive capabilities.

The absence of any empirical evidence about cooperatives as a determinant factor in the process of adaptation poses a danger to the design of climate interventions aimed at addressing the problem in question.

The main objective of this study is to examine climate change adaptation strategies among agricultural cooperative farmers in Southern Nigeria. Specifically, the study seeks to: (i) assess farmers' perceptions of climate change and its effects on agricultural production; (ii) identify the climate change adaptation strategies adopted by agricultural cooperative farmers; (iii) determine the socioeconomic, institutional, and cooperative-related factors influencing the adoption of adaptation strategies; and (iv) evaluate the effectiveness of agricultural cooperatives in enhancing farmers' adaptive capacity to climate change impacts.

Literature Review

Conceptual Review

Climate Change

Climate change can be described as the process by which there are changes in the climatic pattern over an extended period. Climate changes can include a shift in temperature and rainfall patterns, as well as extreme weather events. Such changes are primarily caused by human actions like pollution, deforestation, industrialization, and poor agricultural practices. Climate change has been identified by the IPCC as being among the most significant issues facing humanity today, with severe implications for ecosystems, economies, and people. In agriculture, climate change results in rising temperatures, unpredictable weather patterns, drought, floods, and shifting seasons, all of which impact agricultural productivity.

In sub-Saharan Africa, agriculture remains extremely sensitive to climate change since it relies heavily on rain-fed agricultural practices. This is especially true for Nigeria, where farmers are subjected to variable rainfall patterns, flooding, degradation of soil quality, and an increase in pests and disease attacks. It has been observed that climatic events have considerable impacts on agricultural productivity and the livelihood of communities in the region, especially those of the small-scale farmers who lack adequate adaptive capacity (Nwalieji & Uzuegbunam, 2021). Climate change has therefore become a major challenge to sustainable agriculture and food security in Southern Nigeria.

Climate Change Adaptation

Climate adaptation involves changes in ecosystems, societies, economies, and institutions due to real or expected climatic conditions and the impacts arising from them. The aim of adaptation is to build resilience, mitigate risks, and decrease vulnerability to climate change impacts. The IPCC (2023) explains adaptation as a strategy through which adjustments are made in response to climate change to alleviate or capitalize on the potential benefits of such changes.

Adaptation within agriculture involves changes to agricultural practices and production systems as a means of adapting to new climatic conditions. Adaptation has been increasingly emphasized in sub-Saharan Africa since climate variability remains a threat to agricultural output. The FAO (2023) notes that adaptation efforts can effectively diminish the vulnerability of farming households and contribute to increased agricultural sustainability and food security.

Climate Change Adaptation Strategies in Agriculture

Agricultural adaptation measures due to climate change are described as the actions that are undertaken by the farmers to mitigate the negative impacts of climate variability and climate change on their agricultural activities. These adaptation measures are aimed at improving the resilience and sustainability of production levels and livelihoods among the farmers.

The agricultural adaptation measures could be in terms of agronomic, technological, institutional, and socioeconomic approaches. The agronomic adaptation measures are the use of crop diversification, rotation, intercropping, modified planting dates, drought-tolerant crop varieties, and soil conservation techniques. Technological adaptation measures are the adoption of irrigation methods, better seeds, agricultural technologies, and improved mechanization processes. Institutional adaptation measures include the involvement of farmers in cooperatives and extension programs, while socio-economic adaptation measures include employment diversification and access to finance (FAO, 2023; International Fund for Agricultural Development [IFAD], 2021).

Research studies conducted in Nigeria reveal that some of the common adaptation measures used by the farmers include the use of intercropping methods, soil conservation techniques, improved crop varieties, and modified planting calendar. However, their implementation has been hindered by factors such as lack of access to credit facilities, extension services, agricultural technologies, and climate information.

Agricultural Cooperatives

Agricultural cooperatives refer to voluntary organizations made up of farmers who unite to accomplish mutual economic, social, and development goals through collective ownership and management. Cooperatives are integral in ensuring agricultural development by facilitating better access by farmers to production inputs, extension services, marketing opportunities, credit systems, and technological know-how.

As far as climate change adaptation measures are concerned, agricultural cooperatives are instrumental as platforms for strengthening the adaptive capabilities of farmers. Cooperatives provide for information sharing, decision making, mobilization of resources, and access to climate smart agriculture. Cooperative memberships enable farmers to capitalize on their collective bargaining powers, improved access to markets and reduced cost of accessing agricultural services (IFAD, 2021; FAO, 2023).

Research findings indicate that cooperative membership boosts the ability of farmers to adapt owing to increased access to extension services, agricultural credit and training programs as compared to non-memberships (Abegunde et al., 2020). Although there are several advantages associated with the membership of agricultural cooperatives, the effectiveness of these cooperatives in Nigeria is often hindered by lack of adequate financing, ineffective governance, management, and institutional support systems.

Theoretical Review

Adaptive Capacity Theory

This study will be grounded in the theory of Adaptive Capacity, which has its origins in the field of climate change and vulnerability, and it has since been significantly elaborated upon by scholars such as Adger (2003).

Adaptive capacity theory is an explanation of how people, individuals, households, institutions, and communities are able to adjust to climate variations, avoid risks associated with their environment and cope with the shocks and stresses arising from climatic changes.

Adaptive capacity consists of having sufficient and accessible resources, knowledge, technology, institutions, and social networks through which individuals and communities are able to adapt to their constantly changing environments. Communities that have high levels of social capital, have good information sources, efficient institutions, and enough money are generally more capable of adapting to climatic problems than those without such resources.

In agricultural contexts, adaptive capacity plays a significant role in the ability of the farmers to cope with climate-induced stresses and challenges such as drought, floods, unpredictable rainfall patterns, temperature changes, and pest attacks.

The agricultural cooperatives are an important component in relation to Adaptive Capacity Theory in that they offer a support system through which the farmers gain access to information, credit facilities, extension services, training programs, and climate-resilient

agriculture technologies. Agricultural cooperative membership increases social capital, encourages information sharing, enables collective action, and enhances access to adaptation assets. As argued by Adger (2003) and IPCC (2023), the collective institutions help greatly in building resilience by facilitating access to assets and social ties.

Adaptive Capacity Theory is relevant to this study in that it explain how institutional support systems affect farmers' adaptations and resilience-building processes. It offers an appropriate theoretical framework within which the researcher will be able to explore the connection between institutional support systems and climate change adaptation in agricultural cooperative farmers in Southern Nigeria.

Empirical Review

In their study of the economic significance of cooperative associations of smallholder farmers in Nigeria, Ikuemonisan and Ajibefun (2021) sought to understand how such an arrangement would influence household income and adaptation to climate change. In the study, the survey research method was employed to obtain data from farming households in Ondo State, Nigeria, using structured questionnaires. Findings from the analysis of data using descriptive and regression statistics indicated that membership in cooperative groups increased farmers' access to climate information, farm inputs, and adaptation resources.

Abegunde, Sibanda, and Obi (2020) explored climate-smart agriculture practice among smallholder farmers in sub-Saharan Africa, paying special attention to adaptation to climate change. The study adopted a systematic review method to assess the effects of adaptation practices undertaken by smallholder farmers across African nations. Among other significant variables, results showed that access to extension services, farmer organizations, agricultural credit, and institutional support played critical roles in determining which adaptation measures farmers undertook.

In their study, Nwalieji and Uzuegbunam (2021) assessed the adaptation mechanisms to climate change by farmers in southeastern Nigeria. In this case, survey research design was employed whereby data was obtained from rural farming households through structured questionnaire technique. In analyzing the data, both descriptive and inferential statistics were used. The results indicated that farmers adapted to climate change in terms of increased temperatures, erratic precipitation patterns, floods, and reduced agricultural yields. The adaptations observed in the process included diversification in crop production, mixed farming practices, use of improved crop varieties, conservation agriculture and changing planting dates. The findings also noted that lack of climatic information and inadequate financial resources hampered adaptation efforts.

Ali and Erenstein (2017) carried out a study on the climate change adaptation strategies of farmers in developing countries. This study utilized household survey data with econometric models. It was found out that adaptation strategies such as crop diversification, irrigation development and adoption of improved seeds greatly improved agricultural productivity and adaptability.

Abegunde and Obi (2022) investigated the use of climate smart agricultural practices in Africa by examining the adoption of climate change adaptation practices among smallholders. The study used a systematic literature review method and evaluated evidence from various African countries on the adoption of climate smart agricultural technologies. The study identified access to extension services, institutional support, farmer cooperatives, and agricultural credit as key determinants of climate change adaptation. It was found that farmer cooperatives increased the ability of farmers to access climate information, hence their adaptation to climate smart agriculture to cope with the changing climate.

Phiri, Charimbu, Edewor, and Gaveta (2022) explored the sustainability of scaling up climate-smart agricultural practices and technologies in sub-Saharan Africa by comparing Kenya, Malawi, and Nigeria. In their study, the authors adopted a comparative review method to explore the key factors driving the adoption and scaling up of climate-smart practices. The study revealed that access to extension services, technological support, climate information, and farmer cooperation greatly influenced the adoption of climate-smart agriculture.

Madaki, Muench, Kaechele, and Bavorova (2023) investigated the issue of climate change awareness and perceptions among farming families in Nigeria. Survey data were used to conduct the analysis, and both descriptive and inferential statistical methods were applied to analyze the findings. Most of the farmers recognized climate change, and warming, as well as irregular rains and reduced agricultural productivity, were considered the key issues. It was found that farmers with higher levels of awareness, more information about climate change, as well as social networks, showed better adaptability to climate change conditions. The authors suggest improving climate information dissemination and supporting the rural community.

Ayanlade, Oluwatimilehin, Ayanlade, Adeyeye, and Abatemi-Usman (2023) addressed the problem of farmers' vulnerability and adaptive response to climate change in Nigeria. The study was conducted by using a mixed-method research approach that included surveys and other qualitative assessment tools. Farmers faced such challenges as irregular rainfall, flooding, heat stress, and low agricultural output as climate change effects. Adaptation measures involved diversified cropping, altered planting dates, soil conservation, and livelihood diversification. Institutional support, education, and information about climate change greatly contributed to adaptation and enhanced adaptive capacity of farmers.

Methodology

The survey research method was utilized for this study. The survey method was chosen as an appropriate one because it facilitates data collection through direct inquiries from agricultural cooperative farmers on issues related to climate change and adaptation measures in Southern Nigeria.

The research used the structured questionnaire as the main tool for collecting data. The questions were categorized into different sections which include questions regarding respondents' socio-economic status, perceptions about climate change, adaptation measures practiced, factors affecting adaptation efforts, and the influence of cooperative societies on

adaptive capacities. The questions were formulated using the Likert scale and other simple formats to facilitate easy comprehension by the respondents.

Multistage sampling was chosen as the sampling procedure in this study. The states, local government areas, farming communities, and cooperative societies that served as units of analysis were purposively sampled to represent the target group (agricultural cooperative farmers). Respondents were purposively selected from among members of selected cooperative societies within farming communities.

Descriptive and inferential statistics were utilized for the analysis of data collected in this study. The data were processed and analyzed using the Statistical Package for the Social Sciences (SPSS).

The population of this research comprised 442 agricultural cooperative farmers selected from some agricultural cooperatives in Southern Nigeria. The population under consideration comprises the farmers who are involved in agricultural production and other cooperative practices in this particular research area. In order to ensure a proper representation of the population in the study, Taro Yamane (1967) formula was used with a 5 percent level of precision in calculating the required sample size. With the use of Taro Yamane formula, the sample size was found to be 210 agricultural cooperative farmers.

Data Presentation and Analysis

Analysis Based on Research Objectives

Research Objective One:

Assess the perception of climate change and its effects on agricultural production among cooperative farmers in Southern Nigeria.

Table 1: Respondents' Perception of Climate Change and Its Effects on Agricultural Production

S/N	Items	SA	A	D	SD	Mean	Std. Dev.	Decision
1	Rainfall patterns have become irregular in recent years	92	81	24	13	3.20	0.81	Accepted
2	Climate change has reduced crop yields	88	79	28	15	3.14	0.85	Accepted
3	Flooding has negatively affected farming activities	84	76	31	19	3.07	0.89	Accepted
4	Rising temperatures affect soil fertility and crop productivity	80	82	30	18	3.07	0.86	Accepted
5	Pest and disease outbreaks have increased due to climate variability	78	85	29	18	3.06	0.84	Accepted
	Grand Mean					3.11	0.85	Accepted

Criterion Mean = 2.50

Source: Field Survey, 2026.

As seen from the results presented above, all the variables captured yielded scores higher than the cut-off point of 2.50. The grand mean score of 3.11 suggests that respondents believed that climate change had caused major problems in terms of agriculture. Among these problems identified by the respondents are unpredictable rains, low agricultural production, floods, and pests.

Research Objective Two:

Identify the climate change adaptation strategies adopted by agricultural cooperative farmers in the study area.

Table 2: Climate Change Adaptation Strategies Adopted by Cooperative Farmers

S/N	Adaptation Strategies	SA	A	D	SD	Mean	Std. Dev.	Decision
1	Crop diversification is practiced to reduce climate risks	87	83	25	15	3.15	0.83	Accepted
2	Farmers adjust planting dates based on weather conditions	90	79	27	14	3.17	0.82	Accepted
3	Use of improved crop varieties has increased	82	81	31	16	3.09	0.86	Accepted
4	Irrigation farming is adopted during dry periods	74	78	36	22	2.97	0.91	Accepted
5	Soil conservation practices are used to improve productivity	76	84	32	18	3.04	0.87	Accepted
	Grand Mean					3.08	0.86	Accepted

Criterion Mean = 2.50

Source: Field Survey, 2026.

As indicated in the table above, the farmers practiced several adaptive techniques in response to climate change. This is seen from the grand mean score of 3.08 showing high adaptability measures. The main adaptive measures were crop diversification, change of planting date, planting improved crop varieties, irrigation, and soil conservation measures.

Research Objective Three:

Determine the socioeconomic, institutional, and cooperative-related factors influencing the adoption of adaptation strategies among cooperative farmers.

Table 3: Factors Influencing the Adoption of Climate Change Adaptation Strategies

S/N	Factors	SA	A	D	SD	Mean	Std. Dev.	Decision

1	Access to extension services influences adaptation decisions	95	80	20	15	3.21	0.80	Accepted
2	Access to credit facilities enhances adaptation practices	90	84	23	13	3.20	0.79	Accepted
3	Cooperative membership improves access to climate information	88	86	24	12	3.19	0.78	Accepted
4	Educational level affects adoption of adaptation strategies	82	79	31	18	3.07	0.87	Accepted
5	Government support programmes encourage climate adaptation	80	81	32	17	3.07	0.86	Accepted
	Grand Mean					3.15	0.82	Accepted

Criterion Mean = 2.50

Source: Field Survey, 2026.

Results indicate that several socioeconomic and institutional variables were critical determinants in the decision of farmers enrolled in cooperatives to engage in climate change adaptations. The grand mean of 3.15 points clearly indicates that the respondents agreed that extension services, access to credit, cooperative membership, education, and government programs played a key role in their decision.

Research Objective Four:

Evaluate the effectiveness of agricultural cooperatives in enhancing farmers' adaptive capacity to climate change impacts.

Table 4: Effectiveness of Agricultural Cooperatives in Enhancing Adaptive Capacity

S/N	Items	SA	A	D	SD	Mean	Std. Dev.	Decision
1	Cooperative societies provide useful climate information to members	86	88	22	14	3.17	0.80	Accepted
2	Cooperatives improve farmers' access to agricultural inputs	92	81	23	14	3.20	0.81	Accepted
3	Cooperative membership enhances access to agricultural credit	90	84	24	12	3.20	0.79	Accepted

4	Cooperative training programmes improve adaptation knowledge	83	86	26	15	3.13	0.83	Accepted
5	Cooperatives strengthen collective response to climate risks	88	82	25	15	3.09	0.84	Accepted
	Grand Mean					3.16	0.81	Accepted

Criterion Mean = 2.50

Source: Field Survey, 2026.

According to the results displayed in Table X, the presence of agricultural cooperatives has greatly boosted farmers' ability to adapt to the adverse effects of climate change. This is illustrated by the grand mean score of 3.16, which reveals that the survey participants strongly believe in the positive influence of cooperatives on these areas.

Regression Analysis

Table 5: Regression Analysis of Factors Influencing Climate Change Adaptation Strategies

Variables	Beta Coefficient	Standard Error	t-value	Sig.
Constant	1.284	0.312	4.115	0.000
Educational Level	0.248	0.071	3.493	0.001
Access to Extension Services	0.314	0.068	4.618	0.000
Access to Credit Facilities	0.286	0.073	3.918	0.000
Cooperative Membership Strength	0.337	0.065	5.184	0.000
Government Support	0.201	0.079	2.544	0.012

$R = 0.782$

$R^2 = 0.611$

Adjusted $R^2 = 0.598$

F-value = 31.482

Sig. = 0.000

Source: Field Survey, 2026.

Findings from the regression analyses showed that education, access to extension services, access to credit facilities, strength of cooperative membership, and support of the government significantly affected the implementation of climate change adaptation strategies by cooperative farmers in Southern Nigeria.

The value of R squared ($R^2 = 0.611$) implies that about 61.1% of the variance in the dependent variable (adoption of climate change adaptation strategies) is caused by the independent variables used in the regression model. An F-value of 31.482 at a significance level of 0.000 suggests that the regression model is statistically significant.

From the explanatory variables used in the model, strength of cooperative membership emerged as having the highest beta value (β = 0.337), which means that membership of cooperatives significantly influenced farmers' decision to adapt to climate changes. Extension services and credit facilities equally played a significant role.

Discussion of Findings

The study indicated that farmers in agricultural cooperative associations in Southern Nigeria considered climate change a critical issue affecting agricultural productivity due to rainfall irregularities, floods, increased temperature, pests attacks, and low productivity levels. The finding corroborates findings from the study conducted by Oluwatimilehin and Ayanlade (2021), which noted that climate variability negatively impacts agricultural productivity, crop performance, and rural livelihoods in various ecosystems in Nigeria. The finding also aligns with the perspective held by the Intergovernmental Panel on Climate Change (2023) concerning threats posed by climate change to agricultural sustainability, food systems, and food security, through the increasing variability of temperature and adverse environmental degradation.

Furthermore, farmers employed some strategies for adapting to the adverse effects of climate change, including crop diversification, adjusting planting dates, irrigation farming, improved crop varieties, and soil conservation techniques. The results of this study are in conformity with the findings by Ayanlade et al. (2021), who indicated that farmers in different ecological zones of Nigeria adopt diverse climate change adaptation strategies to mitigate production risks and enhance their adaptive capacity against climate variability. These authors noted that practices like altering planting dates, adopting crop diversity, adopting irrigation technologies, and using improved crop varieties were some of the common responses by rural farmers towards climate change challenges.

Further, this research revealed that factors such as education, access to extension services, cooperative membership, credit availability, and government interventions play significant roles in the adoption of adaptation strategies. The result concurs with the findings by Ikuemonisan & Ajibefun (2016), which revealed that effective institutional arrangements, productive resources access, extension services, and membership in farmers groups played critical roles in enhancing the adaptive capacities of farmers against climate change challenges in Nigeria.

Moreover, the findings from regression analysis revealed that the cooperative members' strengths played the most significant role in making adaptation decisions. This result confirms the tenet of Adaptive Capacity Theory and supports the argument that the process of collective actions among cooperatives ensures easier access to information, innovations, finances, and social networks that help farmers cope with climate change. This finding provides further support to the argument made by Ikuemonisan and Ajibefun (2016), emphasizing that collaborative farmer organizations boost farmers' adaptation capacity through information sharing and risk-reduction mechanisms.

Lastly, this research shows that agricultural cooperatives improve farmers' adaptive capacity through various ways such as climate information provision, trainings, credit facilities, agricultural inputs, and other collective processes. This finding is supported by the work carried out by Ayanlade et al. (2021), emphasizing the significance of institutions and social structures in building farmers' adaptive capacity to climate change. In addition, this result supports the viewpoint held by the Food and Agriculture Organization (FAO, 2024), suggesting that farmer organizations and cooperatives play important roles in building farmers' climate change resilience, achieving sustainable agricultural growth, and securing food safety. Consequently, agricultural cooperatives remain important institutional mechanisms for improving climate change adaptation and reducing farmers' vulnerability in Southern Nigeria.

Conclusion

This research explored climate change adaptation techniques practiced by farmers in agricultural cooperatives in Southern Nigeria, and results indicate that climate change is a threat to agriculture and rural development. This was evidenced by farmers' experiences of climate effects, including erratic rainfall patterns, flooding, higher temperatures, loss of soil fertility, attacks by pests, and low crop yields.

It is noted that farmers had several adaptation approaches such as growing different crops, changing planting periods, using high-yielding crops, practicing irrigation agriculture, and employing soil management approaches to increase production and improve their adaptive capacity. From the study, the results indicate that the factors influencing farmers' adoption of adaptation strategies include education level, access to extension services, credit facilities, agricultural cooperatives, and government, and agricultural cooperatives were found to be the main determinant.

Moreover, agricultural cooperatives played a critical role in increasing farmers' adaptive capacities through information, provision of farming materials, financial services, and training. Conclusion

It is concluded from this research that agricultural cooperatives have a vital role to play in enhancing resilience to climate change impacts and sustainable farming methods in southern Nigeria. However, there are still some constraints such as inadequate institutional arrangements, poor extension services, lack of access to modern technologies, and insufficient finances that hamper climate adaptation efforts within the cooperative farming community.

Recommendations

Considering the findings, the following recommendations are made:

i. The government, agricultural agencies, and cooperatives should work to enhance climate change awareness and educational programs for farmers.

ii. Extension agents and cooperatives should promote climate-smart agriculture practices, including crop rotation, irrigation, agroforestry, high-quality seeds, and soil conservation.

iii. The government and financial institutions should make sure that farmers have better access to financing, subsidies, climatic information, extension services, and trainings.

iv. Agricultural cooperatives should be supported institutionally and financially to provide farmers with agricultural technologies, rural financial services, climatic information, and adaptation trainings.

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