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ANALYSIS OF CLIMATE SMART AGRICULTURAL PRACTICES UTILIZATION AND PRODUCTIVITY AMONG RICE FARMERS IN SOUTHERN AGRICULTURAL ZONE OF NASARAWA STATE, NIGERIA.

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ABSTRACT

This study examined Climate-Smart Agricultural (CSA) practices Utilization and productivity among rice farmers in the Southern Agricultural Zone of Nasarawa State, Nigeria. The sample size used for the study was 180 farmers. The results showed that rice farming is dominated by males (75.0%) with a mean age of 49 years, mean household size of 8 persons, and mean farm size of 2 ha. About 63.9% had access to extension services, while 91.7% had formal education. Major CSA practices utilized included organic fertilizer (97.2%; WMS = 4.46), and improved seeds (81.7%; WMS = 4.00). The results on the multiple linear regression model showed that improved crop variety (β = 440.619), mulching (β = 10.106), organic manure (β = 0.750), and use of weather information (β = 180.941) were all positively related to rice output and statistically significant at the 1 percent level. However, major constraints included high input cost (WMS = 4.00), limited credit access (WMS = 3.68), and poor infrastructure (WMS = 3.43). The study recommends input subsidies, improved credit access, and better rural infrastructure to enhance CSA adoption.

Keywords: Climate-Smart Agriculture, Rice Farmers, Productivity, Utilization.

INTRODUCTION

Agriculture remains an important sector supporting food security, employment, and livelihoods in developing economies. In Nigeria, rice production plays a vital role as both a staple food crop and income-generating activity for rural households (FAO, 2019). However, rice production is increasingly threatened by climate variability, including irregular rainfall patterns, rising temperatures, flooding, drought, and increased pest infestation. These challenges have contributed to declining productivity and increased production risks among smallholder farmers (FAO, 2021).

Climate-smart agriculture (CSA) provides an integrated approach for addressing climate-related challenges through practices that improve productivity, enhance resilience, and promote sustainable resource management. Practices such as improved crop varieties, organic manure application, mulching, conservation agriculture, efficient water management, and weather information utilization have been identified as strategies for improving agricultural performance under changing climatic conditions (UNFCCC, 2021).

Nasarawa State is one of Nigeria's major rice-producing areas, but farmers continue to face challenges associated with climate change impacts and limited access to production resources (Olufemi and Akinola, 2023). Although CSA practices have the potential to improve rice productivity, information on the extent of utilization and their effects on production outcomes among rice farmers in the Southern Agricultural Zone remains limited. Therefore, this study analyzed climate-smart agricultural practices utilization and productivity among rice farmers in the study area.

The specific objectives were to:

i. describe the socioeconomic characteristics of rice farmers; in the study area.
ii. identify available CSA practices and their utilization levels; in the study area.
iii. determine the level of utilization of CSA practices among respondents; in the study area.
iv. determine the effects of CSA practices on rice productivity; in the study area.
v. identify constraints affecting CSA utilization in the study area

MATERIALS AND METHODS

Study Area

The study was conducted in the Southern Agricultural Zone of Nasarawa State, Nigeria. The zone comprises five Local Government Areas (LGAs), namely Awe, Doma, Keana, Lafia, and Obi. The area is predominantly agrarian, with farming serving as the major source of livelihood and food security for households. The zone experiences a tropical climate with a rainy season that extends from May to October and annual rainfall ranging from approximately 1,200 mm to 2,000 mm. Temperature ranges between 22.7°C and 36.8°C. Major crops cultivated in the area include rice, maize, yam, cassava, cowpea, groundnut, sesame, millet, and soybean, while livestock production involving cattle, goats, sheep, and poultry is also practiced. Rice production is an important agricultural activity among farmers in the zone.

Sampling Procedure and Sample Size

A multi-stage sampling procedure was employed for the study. In the first stage, three Local Government Areas (LGA) namely Lafia, Doma, and Awe were purposively selected based on their prominence in rice production. In the second stage, two rice-producing communities were purposively selected from each selected LGA, resulting in six communities. The selected communities were Assakio, Kwandere, Doma, Agbashi, Jangwa, and Ribi.

The sampling frame obtained from the Nasarawa Agricultural Development Programme (NADP) indicated a total population of 1,525 registered rice farmers in the selected communities. A sample size of 180 respondents was determined using the Taro Yamane formula at 7% precision level. Proportionate sampling was then used to allocate respondents across the selected communities.

Table 1: Sample Size among Selected Rice-Producing Communities in Study Area

Selected LGA	Selected Community	Number of Registered Rice Farmers (Population)	Proportion (%)	Sample Allocated
Lafia	Assakio	285	18.7	34
Lafia	Kwandere	240	15.7	28
Subtotal		**525**	**34.4**	**62**
Doma	Doma	320	21.0	38
Doma	Agbashi	245	16.1	29
Subtotal		**565**	**37.1**	**67**
Awe	Jangwa	230	15.1	27
Awe	Ribi	205	13.4	24
Subtotal		**435**	**28.5**	**51**
Total		**1,525**	**100.0**	**180**

Source: Nasarawa Agricultural Development Programme (NADP) Farmers' Register, 2025.

Data Collection

Primary data were collected through the administration of structured questionnaires to sampled rice farmers. Information obtained included socioeconomic characteristics of respondents, availability and utilization of climate-smart agricultural practices, inputs and output used in rice production, profitability indicators, and constraints affecting CSA utilization.

Data Analysis

Data collected were analyzed using descriptive and inferential statistical techniques. Descriptive statistics such as frequency, percentages, and mean were used to summarize socioeconomic characteristics, available CSA practices, and constraints affecting utilization.

A Weighted Mean Score (WMS) was used to determine the level of utilization of CSA practices. The utilization scale was categorized as: very low utilization = 1, low utilization = 2, moderate utilization = 3, high utilization = 4, and very high utilization = 5. A mean value of 3.0 and above was considered utilized, while values below 3.0 indicated non-utilization.

Multiple Linear Regression Analysis was used to determine the effects of CSA practices utilization on rice productivity. The model was specified as:

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \ldots\ldots\ldots\ldots\ \beta_7X_7 + u$$

Where;

$E(Y)$ =Rice productivity (kg/ha)
β_0 = Intercept (Constant term)
X_1 = Area planted with improved crop varieties (hectares)
X_2 = Fertilizer used (kg)
X_3 = Labour Input (man-day)
X_4 = Mulching (Percentage of farm under mulch)
X_5 = Crop rotation (Number of different crops rotated per seasons)
X_6 = Organic manure application (kg/hectare)
X_7 = Weather information use =number of times in a week
β_1 - β_7 = Regression Coefficients
u = error term

RESULTS AND DISCUSSION

Socioeconomic Characteristics of Rice Farmers in the Study Area

Table 2: Socioeconomic Characteristics of Rice Farmers in the Study Area

Variable	Frequency	Percentage (%)
Sex		
Male	135	75.0
Female	45	25.0
Age (years)		
27–36	18	10.0
37–46	42	23.3
47–57	85	47.2
Above 57	35	19.5
Marital Status		
Single	35	19.4
Married	130	72.2
Others	15	8.4
Educational Level		
No formal education	15	8.3
Primary education	45	25.0
Secondary education	85	47.2
Tertiary education	35	19.5
Farming Experience (years)		
≤10	40	22.2
11–20	83	46.1
21–30	42	23.3
Above 30	15	8.4

Source: Field Survey, 2025

The result in Table 2 shows that rice production in the study area was dominated by male farmers (75.0%), while females constituted 25.0% of the respondents. This suggests that rice farming remains largely male-dominated, possibly due to differences in access to resources such as land, credit, labour, and agricultural information. The majority (47.2%) of respondents were within 47–57 years, with a mean age of 49 years, indicating that farmers were within the productive age group with considerable farming experience. This agrees with FAO (2023) and World Bank (2024), who reported that age and gender influence farmers' access to resources, decision-making, and capacity to adopt climate-smart agricultural practices. They further noted that experienced farmers possess better knowledge for managing climate-related production risks. Most respondents were married (72.2%) with an average household size of 8 persons, suggesting the availability of family labour for rice production activities. The high level of formal education among farmers (91.7%) indicates their ability to access information, understand extension messages, and adopt improved technologies. This supports IFPRI (2021) and UNDP (2022), who emphasized that education and household characteristics enhance agricultural technology adoption by improving farmers' understanding and application of innovations that increase productivity and climate resilience.

Furthermore, the majority (46.1%) of respondents had 11–20 years of farming experience, indicating that rice farmers possessed considerable practical knowledge of production activities and climate-related challenges. Experienced farmers are more likely to recognize environmental changes and adjust their farming decisions accordingly. This finding is consistent with CGIAR (2024) and African Development Bank (2021), who reported that farming experience improves farmers' adaptive capacity by strengthening their knowledge of local production conditions, risk management strategies, and sustainable agricultural practices. They also highlighted that experienced farmers are more likely to combine traditional knowledge with improved climate-smart technologies. Regarding farm size, 40.6% of farmers cultivated between 1–2 hectares, showing that rice production in the study area was mainly smallholder-based. The dominance of small farm holdings may limit access to mechanization and reduce farmers' ability to invest in some capital-intensive CSA practices. However, smallholders are more likely to adopt affordable practices such as improved seeds and organic manure application. This finding agrees with Goni *et al.* (2024), who observed that farm size influences the type and intensity of CSA practices adopted by farmers, with small-scale farmers often depending on low-cost and easily accessible climate adaptation strategies.

Availability of Climate Smart Agricultural Practices among Rice Farmers

Table 3: Availability of Climate Smart Agricultural Practices among Rice Farmers

CSA Practice	Frequency	Percentage (%)
Organic fertilizer application	175	97.2
Improved seed varieties	147	81.7
CSA training	136	75.6
Drought tolerant varieties	106	58.9
Crop diversification	104	57.8
Crop rotation	97	53.9
Weather information	91	50.6
Mulching	87	48.3
Water conservation	63	35.0
Agroforestry	49	27.2

Source: Field Survey, 2025

The findings in Table 3 revealed that several climate-smart agricultural (CSA) practices were available to rice farmers in the study area. Organic fertilizer application (97.2%) was the most available practice, followed by improved seed varieties (81.7%) and CSA training (75.6%). The high availability of organic fertilizer indicates farmers' reliance on accessible soil fertility management practices to improve productivity. This agrees with Sadiq *et al.* (2023), which identified organic soil management practices as important CSA strategies for enhancing resilience and productivity among smallholder farmers. The availability of improved seed varieties and drought-tolerant varieties suggests increased awareness of climate-resilient crop technologies. These practices enable farmers to cope with climate-related challenges such as irregular rainfall and declining yields. This supports CGIAR (2024), which emphasized the role of improved varieties in strengthening farmers' adaptive capacity under changing climatic conditions. Furthermore, crop diversification (57.8%), crop rotation (53.9%), CSA training (75.6%), and weather information (50.6%) were available among respondents, indicating the contribution of extension and information services to CSA awareness. This agrees with Ayinde *et al.* (2022), who reported that access to agricultural information and extension support enhances farmers' adoption of climate adaptation practices.

Level of Utilization of Climate Smart Agricultural Practices

Table 3: Level of Utilization of Climate Smart Agricultural Practices

Practice	Mean Score	Decision
Organic fertilizer application	4.46	Utilized
Improved seeds	4.00	Utilized
Inorganic fertilizer	3.82	Utilized
CSA training	3.78	Utilized
Crop diversification	3.43	Utilized
Drought tolerant varieties	3.33	Utilized
Crop rotation	3.21	Utilized
Weather information	3.10	Utilized
Mulching	2.95	Not utilized
Water conservation	2.71	Not utilized

Source: Field Survey, 2025

Decision Rule: Mean ≥ 3.0 = Utilized

The result in Table 3 shows that organic fertilizer application had the highest utilization level among the climate-smart agricultural (CSA) practices with a weighted mean score (WMS) of 4.46, followed by improved seeds (WMS = 4.00), inorganic fertilizer (WMS = 3.82), and CSA training (WMS = 3.78). This indicates that rice farmers in the study area highly utilized practices that directly improve soil fertility, crop performance, and productivity. The high utilization of organic fertilizer may be attributed to its availability, affordability, and contribution to soil nutrient improvement, while the use of improved seeds suggests farmers' efforts to enhance yield and adapt to changing climatic conditions. The utilization of crop diversification (WMS = 3.43), drought-tolerant varieties (WMS = 3.33), crop rotation (WMS = 3.21), and weather information (WMS = 3.10) indicates that farmers were also adopting practices that improve resilience to climate variability. Access to climate information and training may have enhanced farmers' awareness and encouraged the application of adaptive practices. This finding agrees with Ogunniyi et al. (2023), who emphasized that climate-smart practices such as improved varieties, soil fertility management, and climate information services improve farmers' productivity and resilience under changing climatic conditions.

Effect of Utilization of Climate Smart Agricultural Practices on Rice Productivity

Table 4: Multiple Linear Regression Estimates on the Effect of Utilization of Climate Smart Agricultural Practices on Rice Productivity

Variable	Coefficient (β)	Std. Error	t-Statistic	p-value
(Constant)	1174.526	164.955	7.120	0.000***
Improved_varieties_area_ha	440.619	39.593	11.129	0.000***
Mulching_percent	10.106	1.303	7.753	0.000***
Organic_manure_kg_ha	0.750	0.033	22.419	0.000***
Weather_information_score	180.941	12.838	14.094	0.000***
Fertilizer Use (kg)	0.834	1.024	0.814	0.417 NS
Farm Size (ha)	22.618	23.819	0.950	0.344 NS
Labour Input (man-day)	1.661	1.490	1.115	0.266 NS
R-square = 0.893				
F-value = 205.310 (.000 b)				

Source: Field Survey, 2025 *** = Significant at 1%, NS = Not Significant

The result in Table 4 shows that the regression model was significant (F = 205.310; $p < 0.01$) and explained 89.3% ($R^2 = 0.893$) of the variation in rice productivity among farmers in the study area. This indicates that the selected climate-smart agricultural (CSA) practices jointly influenced rice productivity. The high explanatory power of the model suggests that utilization of CSA practices plays an important role in improving rice output among smallholder farmers.

The coefficient of improved varieties was positive and statistically significant at 1% level (β = 440.619; $p < 0.01$), indicating that a unit increase in the use of improved climate-resilient rice varieties increased productivity by 440.619 kg/ha. This implies that farmers using improved varieties achieved higher output due to better adaptability to climate variability, improved yield potential, and resistance to production challenges. This finding agrees with Wooldridge, (2020); and Cameron and Trivedi, (2022)., who emphasized that improved crop varieties are important CSA strategies for enhancing productivity and building farmers' resilience to climate change.

Mulching was also positive and significant at 1% level (β = 10.106; $p < 0.01$), suggesting that increased utilization of mulching practices contributed to improved rice productivity. This may be attributed to the ability of mulch to conserve soil moisture, reduce temperature stress, and improve soil conditions. The finding supports the position of CGIAR (2024) that soil and water management practices improve the capacity of farming systems to withstand climate-related production risks. Organic manure application had a positive and significant influence on productivity (β = 0.750; $p < 0.01$), indicating that increased application of organic manure enhanced rice yield. This may be due to improved soil fertility, better soil structure, and increased nutrient availability. The result agrees with Goni et al. (2024**)** who reported that soil fertility management practices contribute significantly to sustainable productivity among smallholder farmers. The coefficient of weather information utilization was also positive and significant (β = 180.941; $p < 0.01$). This implies that access to and use of climate information improved farmers' productivity by enabling better decisions on planting time, farm management, and response to climatic risks. This finding is consistent with Issahaku and Abdulai (2020), who identified access to timely climate information as a key factor influencing farmers' adaptation decisions and adoption of climate-smart practices.

Table 5: Constraints to the Utilization of Climate-Smart Agricultural Practices

Constraints	VL(1)	L(2)	M(3)	H(4)	VH(5)	WMS	Decision	Rank
High cost of inputs	8	15	30	67	60	4.00	High	1st
Limited access to credit	12	18	38	60	52	3.68	High	2nd
Unavailability of CSA inputs	10	23	38	60	49	3.64	High	3rd
Poor infrastructure	14	27	45	57	37	3.43	High	4th
Lack of technical knowledge	15	27	45	53	40	3.42	High	5th
Limited irrigation access	15	30	42	55	38	3.39	High	6th
Poor extension services	18	30	42	53	37	3.34	High	7th
Lack of market	27	42	48	38	25	2.96	Low	8th
Cultural beliefs	38	45	42	33	22	2.77	Low	9th

Source: Field Survey, 2025

The result in Table 5 shows that the major constraints affecting the utilization of climate-smart agricultural (CSA) practices among rice farmers were high cost of inputs (WMS = 4.00), limited access to credit (WMS = 3.68), unavailability of CSA inputs (WMS = 3.64), poor infrastructure (WMS = 3.43), lack of technical knowledge (WMS = 3.42), limited irrigation access (WMS = 3.39), and poor extension services (WMS = 3.34). This indicates that financial, institutional, and infrastructural challenges remain major barriers limiting farmers' effective utilization of CSA practices.

The high cost of inputs ranked first among the constraints, suggesting that the increasing cost of improved seeds, fertilizers, and other agricultural inputs reduces farmers' ability to adopt climate-smart technologies. Limited access to credit was also identified as a major challenge, indicating that inadequate financial support restricts farmers' investment in improved production practices. This finding agrees with Omonona *et al*. (2021), who reported that access to finance and affordable inputs are critical factors influencing farmers' ability to adopt climate adaptation strategies.

The unavailability of CSA inputs and poor infrastructure were also important constraints. This suggests that even where farmers are aware of CSA practices, limited availability of improved seeds, fertilizers, irrigation facilities, storage systems, and rural infrastructure may prevent effective utilization. This supports the findings of Adamu *et al*. (2022), which emphasized that inadequate infrastructure and weak support systems constrain agricultural productivity and climate resilience among smallholder farmers. Furthermore, lack of technical knowledge and poor extension services were identified as constraints affecting CSA utilization. This implies that farmers require continuous training, advisory services, and access to reliable climate information to properly implement CSA practices. The finding agrees with Oduntan *et al*. (2022), which highlighted that extension support and capacity building enhance farmers' understanding and adoption of climate-smart innovations.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The utilization of Climate-Smart Agricultural (CSA) practices significantly enhances rice productivity and profitability in the Southern Agricultural Zone of Nasarawa State, as evidenced by the strong statistical relationships. Key inputs such as improved crop variety, mulching, organic manure (kg/ha), weather info use were found to positively influence output, confirming the effectiveness of climate-resilient technologies in boosting production. Despite the high level of awareness and adoption of some CSA practices, the study identified critical constraints such as high input costs, limited access to credit, inadequate infrastructue, and weak extension services as major barriers to optimal utilization.

Recommendations

i. Government and relevant agencies should provide targeted subsidies on critical inputs such as improved seeds, organic fertilizers to reduce the high cost burden and encourage wider adoption of CSA practices among farmers.
ii. Financial institutions should design and implement farmer-friendly credit schemes with low interest rates and flexible repayment plans to enable farmers invest in climate-smart technologies.
iii. Extension delivery systems should be enhanced through increased funding, training of extension agents, and use of digital platforms to improve farmers' technical knowledge and awareness of CSA practices.
iv. Government should invest in rural infrastructure such as roads, storage facilities, and irrigation

systems to support year-round farming and improve the efficiency of rice production.

v. There should be increased organization of training programs, workshops, and timely distribution of CSA inputs to ensure farmers have both the knowledge and resources needed for effective adoption.

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