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The Effects of Climate-Smart Agriculture on Rice Farmers' Food Security: Evidence from Nigeria

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Abstract

The study assessed the effects of climate-smart agriculture (CSA) practices on the household food security of smallholder rice farmers in Kwara State, Nigeria. It is a descriptive cross-sectional study. Multistage sampling procedure involving three stages was used to select 424 samples from a population of 3,727 smallholder rice farmers across three rice production zones in Kwara State. The study raised and answered four research questions and tested one null hypothesis at a 0.05 level of significance. The Household Food Insecurity Access Scale (HFIAS), designed by the United States Agency for International Development (USAID), was adapted to measure household food security. Data collected were analyzed using descriptive statistics, including frequency counts, percentages, mean, and standard deviation. Also, regression analysis was employed to establish the effect of CSA practices on household food security and livelihood indices. The results indicated that CSA practices have a significant positive effect on the household food security of smallholder rice farmers. Specifically, integrated soil fertility management (*P*=0.006) and integrated pest management (*P*=0.002) practices were found to significantly improve the livelihoods of these farmers by enhancing their household food security. Based on these findings, it is recommended that smallholder rice farmers maintain high adoption levels of CSA practices to mitigate the adverse effects of household food insecurity stemming from climate change.

Keywords: Agriculture, Climate Change, Climate-Smart, Food Insecurity, Nigeria.

1. Introduction

The uncertainty as to how the trend of climate change and greenhouse gas emission will continue in the future raises many questions related to food security, one of which is whether the aggregate productivity of global agriculture will be affected (Boone, *et al.* 2018). Agriculture in Nigeria will

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have to undergo a major transformation in the coming decades to meet the intertwined challenges of achieving food security, reducing poverty and responding to climate change without depletion of the natural resource base (World Bank, 2022). Climate-Smart Agriculture (CSA) is a technique to improve investment in an agricultural setting to attain sustainable agricultural progress and ensure food availability under climate change (Amin, *et al.* 2015). The CSA aims to attain sustainable developments of green economy goals, food availability and conservation of natural assets. Food and Agricultural Organization (FAO) develops CSA for crop yields by adopting sustainable land management practices that engage farmers in sustainable intensification measures such as agroforestry, conservation tillage, residue management, green manuring and improved water management to improve agricultural performance. The CSA packages enable farmers to use their knowledge and skills more effectively, share information, opt for more efficient pro-environmental technologies, and build stronger associations to effectively negotiate better market prices (Anuga, *et al.* 2019).

Direct seeding (no-tillage), improved protective soil cover through cover crops, crop residues or mulch and crop diversification through rotations (incorporating deep rooting plants and perennials pasture leys for integrated crop-livestock systems) are list of CSA agronomic practices. Water management practices for adapting to problems caused by poor water management include rainwater collection, effective irrigation, and integrated water resource management (Teweldebrihan & Dinka 2025). Residue management usually refers to maintaining the soil surface cover and protecting the soil from nutrient losses as well as erosion using farm waste (Gemeda, 2024). Integrated pest management entails the judicious use of crop rotations and beneficial plant substances as well as chemical pesticides, herbicides, and fungicides to control insect pest and disease problems. The CSA integrated soil fertility management involves precise management of nitrogen, that is planting of leguminous crops to enhance soil fertility through biological nitrogen fixation (International Atomic Energy Agency, 2025). Intercropping crops and trees, live fencing technologies are used as living contour hedges for erosion control, to conserve and enhance biodiversity, and to promote soil carbon sequestration.

According to Giri et al. (2022), two-third of world's population depend on rice for their calorie, as a result, there is hardly any country in the world where it is not being utilized in one form or the other. In Nigeria, rice seems to be one of the few foods crops whose consumption has no cultural, religious, ethnic or geographical boundary, making it an important staple food for all. To support the ever-increasing demand for higher grain yields in rice, farmers are increasing plant densities in their management schemes, which has resulted in an increased population of certain pests, poor water management, loss of soil nutrient and spoilage of farm produce as mitigation strategies (Jiang, *et al.,* 2021). It is estimated that rice production through various CSA technique will increase by 114 million tons by 2035, which farmers must achieve under significant threats from climate change (De Pinto, *et al.* 2020). Doing so will enhance the level of current food production and reduce food insecurity. It has been noted that increasing food production with minimal adverse impact on resources and the environment is the greatest challenge for food security (FAO, 2017). A central insight from the work of Lipper et al. (2014) is that when households adopt climate-smart agriculture (CSA) practices like improved water management, stress-tolerant crops, and conservation agriculture, they can significantly improve their food security. This is particularly important as climate variability increases.

United States Department of Agriculture (USDA, 2021) asserted that the Nigeria's estimated rice production is 5040 Metric tonnes in the year 2020 with a growth rate of 0.00% from 2019 estimated production. Moreover, there is a wide gap between available knowledge of improved technologies and actual practices and which would have a considerable effect on an attempt to increase rice production in Kwara State, being one of the states in Nigeria with high potential of rice production ability of an annual production rate of 49.6 metric tonnes and estimated rate of 128.3 metric tonnes (Kwara Agricultural Development Project (Kwara ADP), 2016). Total rice production in Kwara State was 102,332 metric tonnes in 2021 being the highest ever recorded (Saba, 2021). The impacts of climate change have not been fully understood by these small-holder rice farmers, resulting to being averse to adapt new technologies which may likely affect their food security. Smallholder rice farmers may adopt several CSA practices in combinations and it is not clear which of these give the highest payoffs in terms of improved household food security. Studies have been conducted on food security in Nigeria and Kwara State but no study was found to have been conducted on smallholder rice farmers food security in Kwara State.

This study specifically focused on assessing the effects of CSA on household food security among smallholder rice farmers in Kwara State, an area with high rice production potential but limited adoption of improved technologies. Unlike past studies that broadly addressed food security, this study fills a critical gap by providing baseline data linking CSA adoption to food security outcomes for this specific group. This study will therefore strengthen future planning and policy formulation that concerns CSA and smallholder rice farmers' food security in Kwara, Nigeria and the world at large.

The specific objectives are to:

i. determine the level of adoption of CSA practices among small-holder rice farmers in Kwara State;
ii. assess level of household food security of small-holder rice farmers involved in CSA practices in Kwara State;
iii. categorize small-holder rice farmers by level of household food security in Kwara State; and
iv. determine the effect of CSA adopted practices on smallholder rice farmers' household food security in Kwara State.

Null Hypothesis: Climate-Smart agriculture adopted practices have no significant effect on small-holder rice farmers' household food security in Kwara State.

2. Theoretical Framework

The theoretical framework introduces and describes the theory which explains why the research problem under study exists. Theoretical framework is the 'blueprint' or guide for research (Brondizo, *et. al.* 2014). Brondizo, et. al. (2014) concur that the theoretical framework is the specific theory or theories about aspects of human endeavour that can be useful to the study of events. Fulton and Krainovich-Miller (2010) compare the role of the theoretical framework to that of a map or travel plan. Neisi et al. (2020) stated that theoretical framework can be used as bases for understanding human behaviour.

Herbert Spencer (1820–1903) propounded the social change theory which states that the only thing constant in existence is change, including all changes in the physical world, biological universe, social universe, and the bewildering variety of phenomena that make up these universes. When such changes occur in interaction, it is referred to as social change (Olson, *et al.,* 2019). According to de la Sablonnière (2017) social change is the mechanism by which a social system's structure and purpose change. The adoption of CSA is not just a change in farming technique; it is a social change. Embracing these new practices, farmers are altering their traditional methods, which in turn leads to a broader shift in their lives. The theory of social change provides a framework to examine how this technological shift directly impacts the smallholder rice farmers' food security status and social well-being. Essentially, the study investigates how the adoption of CSA, a new technology designed to strengthen livelihoods and increase food availability, initiates a process of social change that improves the lives of the farmers who use it. The various explanations on social change theory provide some classification into the causation, process or functional analysis. Adoption of CSA practices as an agent of change has causal tendencies to social and economic effect. The CSA practices as agent of social change, is assumed that it increases agricultural production which revolved around welfare and increased food security. The theory therefore provides the framework for understanding the social change that has taken place in the living condition of the rice farmers including food security.

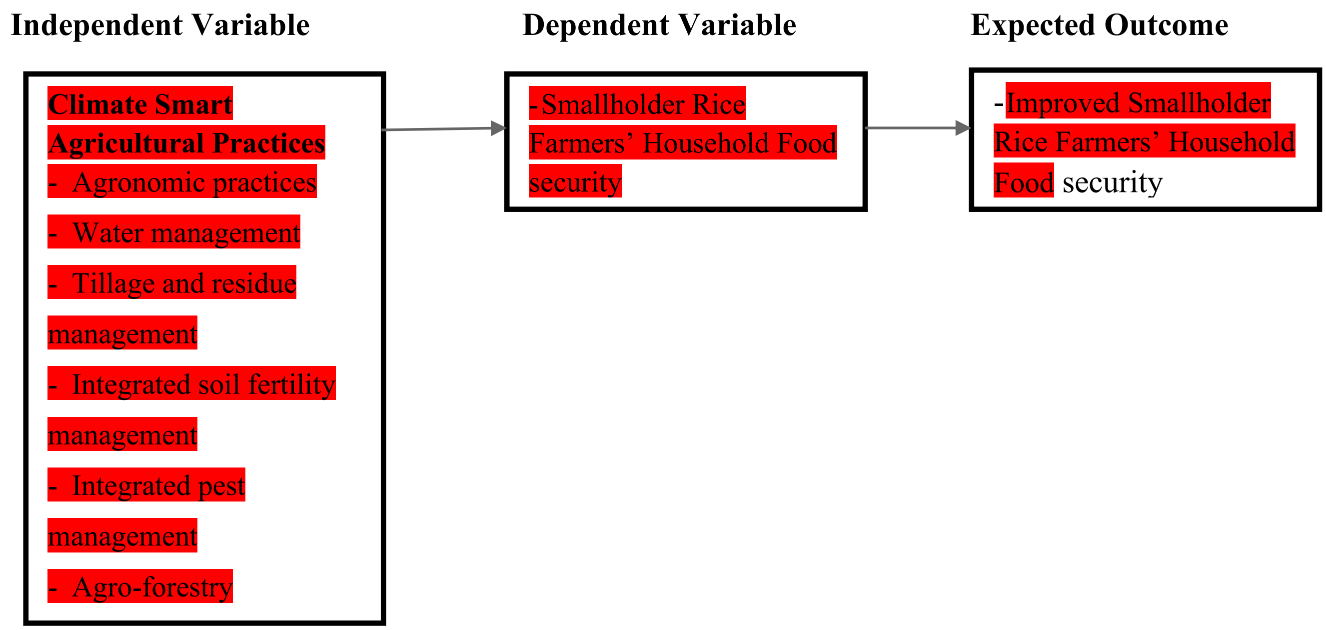

Fig 1. Schematic representation of the effects of climate-smart agriculture on household food security of smallholder rice farmers.

3. Research Methodology

3.1 Perspective of Paradigm

The study adopts a positivist paradigm, emphasizing objective measurements and the statistical, mathematical, or numerical analysis of data collected through polls, questionnaires, and surveys.

3.2 Study Area

Kwara State, located in North-Central Nigeria, is endowed with substantial natural resources, particularly in agriculture, tourism, and solid minerals. The state benefits from invigorating weather, making it a popular destination for tourists. It also boasts rich tourist attractions that stand out among other states in the federation. In terms of solid minerals, Kwara State is rich in resources such as gold, limestone, marble, feldspar, clay, kaolin, quartz, and granite rocks. Agriculture is a major economic activity in Kwara State, with the state producing a wide variety of agricultural products. Among these, rice production is particularly significant. The state's rice farming is concentrated in two primary geographical zones (North and South), reflecting its ecological diversity. Despite these agricultural resources, Kwara State faces high levels of poverty, especially among smallholder rural farmers. These farmers, who make up the majority of the population, are economically disadvantaged, socially marginalized, and politically excluded, limiting their contribution to the state's development.

Kwara State comprises 16 Local Government Areas (LGAs), each playing a role in the state's agricultural sector. These LGAs are Asa, Baruten, Edu, Ekiti, Ifelodun, Ilorin East, Ilorin South, Ilorin West, Irepodun, Isin, Kaiama, Moro, Offa, Oke Ero, Oyun, and Patigi. Rice production is prominent in several of these LGAs, spread across the state's three primary geographical zones. This study focuses on the impact of Climate-Smart Agriculture (CSA) practices on the household food security of smallholder rice farmers in these areas.

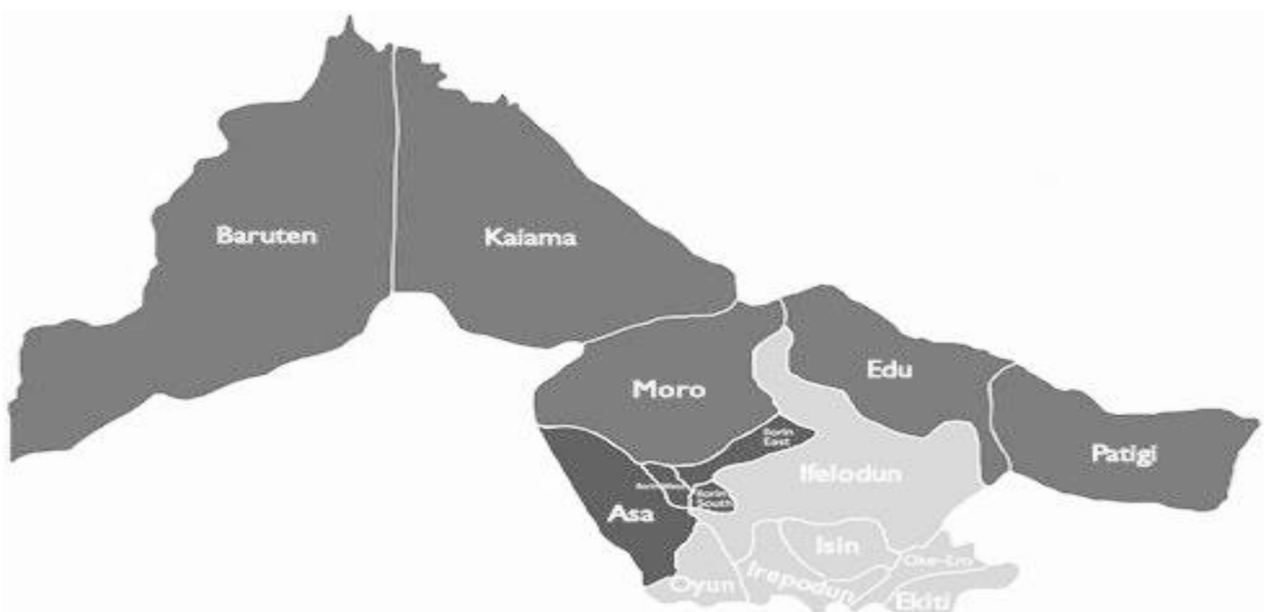

Fig. 2. Map of Kwara State, showing the local government areas.

3.3 Research Plan

This research design is of the non-experimental type.

1. Population: The study population comprises all registered rice farmers in Kwara State, divided into three rice production zones (A, B, and C).

2. Sampling Method: Multistage sampling technique:

- First Stage: Random selection of two Local Government Areas (LGAs) from each zone, totaling six LGAs.
- Reason: To ensure a representative and unbiased selection of LGAs across different ecological, political, cultural, and administrative contexts within each zone.
- Second Stage: Random selection of one community from each selected LGA.
- Third Stage: Inclusion of all registered farmers in the selected communities, resulting in a sample size of 424 respondents.
- Reason: To achieve a comprehensive and complete assessment of CSA practices and food security among all eligible farmers in the selected communities.

3.4 Research Time

The study was conducted over a specific period of 8 weeks to capture the necessary data, typical of cross-sectional studies.

3.5 Type of Data Collection

Data were collected using a structured questionnaire: The instrument was validated by two senior research experts from National Agricultural Extension Research and Liaison Services (NAERLS) Ahmadu Bello University, Zaria, ensuring face and content validity through experts review and revisions. Reliability was confirmed through a pilot study and split-half method, yielding Cronbach's Alpha values of 80 and Guttman Split-Half Coefficient of 0.79, indicating acceptable internal consistency. The level of CSA practices adoption was scored on a scale from 1 (not adopted) to 5 (always adopted). The Household Food Insecurity Access Scale (HFIAS), designed by USAID, was used to measure household food security.

3.6 Type of Data Analysis

1. Descriptive Statistics: Mean and standard deviation were used to summarize the data.
2. Multiple Regression Analysis: To analyze the effect of CSA practices on household food security. Put the regression model specification here as guide.

3.7 Methodology

- Cross-sectional Survey Design: To assess the impact of CSA practices on household food security among small-holder rice farmers.
- Sampling Technique: Multistage sampling to ensure representativeness.
- Data Collection Instruments: Structured questionnaire for CSA practices. HFIAS for measuring food security, converted into an Open Data Kit for electronic data collection.

3.7.1 Household Food Insecurity Access Scale (HFIAS)

The Household Food Insecurity Access Scale (HFIAS) was used to measure the effect of CSA practices on the household food security of small-holder rice farmers. The Household Food Insecurity Access Scale (HFIAS) is a method based on the premise that food insecurity (access) produces predictable behaviors and responses that can be gathered and quantified via a survey and summarized in a scale (Ballard, *et al.,* 2011).

The HFIAS is built from a short questionnaire that captures households' behavioural and psychological manifestations of insecure food access, such as having to reduce the number of meals consumed or cut back on the quality of the food due to a lack of resources, similar to other experience-based indicators. The home can be placed on a spectrum that represents the degree of food security based on their responses to the questionnaire. There are nine structured questions on the HFIAS. When using the HFIAS as a continuous indicator, each of the nine questions is given a score from 0 to 3, with three being the highest frequency of occurrence, and the total is summed up. The overall HFIAS score can vary from 0 to 27, indicating the level of food insecurity. Households are classified as food secure, mildly food insecure, moderately food insecure, or severely food insecure as a categorical variable. The instrument was converted electronically into smart phone embedded Open Data Kit for easy coding of the data collected.

3.7.2 Research Variables and Regression Model

The general form of the equation for multiple regression is:

$y = \beta_0 X_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 \ldots + \beta n Xn + E$

The explicit form of effect of CSA on household food security is

- Dependent Variable: Y= Household food security
- Independent Variables:

X_1= Agronomic practices (improved seed varieties, crop rotation, intercropping, cover crop)

X_2= Water management (irrigation, bunds, terracing, contouring, water harvesting)

X_3= Tillage and residue management (conservation tillage, incorporation of crop residues)

X_4= Integrated soil fertility management (organic fertilizer, efficient use of inorganic fertilizer)

X_5= Integrated pest management (blend of cultural, biological and chemical control)

X_6= Agro-forestry (intercropping crops and trees, live fencing)

E= Error term

Thus, the model specified that the full sample data generated from farmers on CSA practices was used for the identification of significant CSA practices on the response variables. At the end of the analysis when the variables for the CSA practices were entered into the regression model, their resultant effects were observed and reported under results and discussion (item 4).

4. Results and Discussion

Result on Table 1 revealed that adoption level of construction of drainage system by smallholder rice farmers was high with a mean of 4.78±0.43. This is followed by the efficient application of fertilizers in split -small but repeated dosages with a mean 4.48±0.69 and a mean of 4.46±0.70 for ploughing and harrowing. But, integrating cultivation of appropriate tree species along with rice on farm land had the least mean value of 2.39±0.72 which falls below the *a priori* expectation for a mean value of 3. This implies that CSA adopted level was high among smallholder rice farmers. These findings contradict that of Tiamiyu, et al. (2017), Wamalwa (2017) and Diallo, et al. (2019). Tiamiyu, *et al.* (2017) conducted research on analysis of farmers' adoption of climate-smart agricultural practices in Northern Nigeria. The results of the study showed that adoption of selected CSA practices was generally low. Wamalwa (2017) conducted similar research in Kenya, the study reported that CSA adoption was generally low in Kenya. Diallo, *et al.* (2019) carried out a study on factors influencing the adoption of CSA by farmers in Ségou region in Mali, the result showed that the level of adoption of Climate-Smart technologies was low among the farmers.

Table 1: Distribution of smallholder rice farmers by adoption level of CSA practices in Kwara State, Nigeria.

Climate-Smart Agricultural Practices	Sometime adopted (%)	Moderately adopted (%)	Mostly adopted (%)	Always adopted (%)	Mean ±SD	Remark	Rank
Construction of drainage system	0	0.7	20.5	78.8	4.78±0.43	High	1st
Efficient application of fertilizers in split -small but repeated dosages	0	6.1	34.7	59.2	4.48±0.69	High	2nd
Ploughing and harrowing	0	15	26.5	58.5	4.46±0.70	High	3rd
Cultivating improved rice varieties	0	19.4	26.3	54.2	4.42±0.66	High	4th
Incorporating refuse into the soil	0	13.4	29.2	57.3	4.41±0.72	High	5th
Cultivating and ploughing in leguminous plants into the soil.	5.7	11.3	28.1	55	4.38±0.76	High	6th
Blending chemical and other pest control measures	1.8	15.8	27.1	55.2	4.34±0.85	High	7th
Blending biological and other pest control measures	1.4	18.4	26.4	53.8	4.31±0.82	High	8th
Intercropping crops with rice	18.5	42	19.5	20	2.48±0.70	Low	9th
Mulching	49.7	31.1	10	9.2	2.41±0.69	Low	10th
Integrating cultivation of appropriate tree species along with rice on farm land	57.3	29.2	13.4	6.1	2.39±0.72	Low	11th

SD= Standard Deviation
Source: Field survey (2022)
Note: Any mean score of 3.0 and above will be regarded as high adoption, while mean value below 3.0 would be considered as low adoption.

Result in Table 2 shows that smallholder rice farmers who adopted climate-smart agricultural practices were food secure throughout the past four weeks. This implies that smallholder rice farmers who adopted CSA practice were able to overcome the adverse effect of climatic factors that had the tendency to cause considerable crop yield losses, thereby adversely affecting small-holder rice farmers' household food security. This finding is in line with Adesina and Loboguerrero, (2021) who concluded that adopted CSA practices increase food security of farmers. The finding is also in line with Mujeyi, *et al.* (2021) who asserted that CSA practices improve food security of both crop and livestock farmers in Zimbabwe. The finding is also in agreement with Ngema, (2018) who concluded that some selected CSA practices improve household food security.

Table 2: Smallholder rice farmer by description of CSA adopted practices on smallholder rice farmers' household food security.

QUESTIONS	Yes (%)	No (%)	If yes, how often did this happen?			Mean (±SD)	Remark
			Rarely (%)	Sometimes (%)	Often (%)		
Smallholder rice farmer or any household member not having enough food in the past four weeks.	29.2	70.8	6.4	16.0	8.8	0.59±0.99	food secured
Smallholder rice farmer or any household member not able to eat the kinds of foods preferred because of a lack of resources in the past four weeks.	31.4	68.6	13.0	11.6	6.8	0.57±0.94	food secured
Smallholder rice farmer or any household member have to eat a limited variety of foods due to a lack of resources in the past four weeks.	32.1	67.9	10.1	13.0	9.0	0.63±1.02	food secured
Smallholder rice farmer or any household member have to eat some foods that he/she really did not want to eat because of a lack of resources to obtain other types of food in the past four weeks.	33.0	67.0	13.0	8.5	11.6	0.65±1.05	food secured
Smallholder rice farmer or any household member have to eat a smaller meal than he/she needed because there was not enough food in the past four weeks.	29.7	70.3	14.2	10.1	5.4	0.51±0.88	food secured
Smallholder rice farmer or any household member have to eat fewer meals in a day because there was not enough food in the past four weeks.	26.7	73.3	10.8	9.0	6.8	0.49±0.92	food secured
Having no food to eat of any kind in farm household because of lack of resources to get food in the past four weeks.	30.7	69.3	13.9	11.1	5.7	0.53±0.90	food secured
Smallholder rice farmer or any household member go to sleep at night hungry because there was not enough food in the past four weeks.	27.8	72.2	13.4	8.5	5.9	0.48±0.88	food secured
Smallholder rice farmer or any household member go a whole day and night without eating anything because there was not enough food in the past four weeks.	35.6	64.4	15.8	12.0	7.8	0.63±0.97	food secured

SD= Standard Deviation
Source: Field survey (2022)
Note: Any mean score of 2.0 and above would be regarded as food insecure, while mean value below 2.0 would be considered as food secure.

The finding of research question three in Figure 3 shows that (10.8%) and (13.9%) of smallholder rice farmers who adopted CSA practices were severely food insecure and moderately food insecure respectively. A moderately food insecure household usually sacrifices quality by eating a monotonous diet or undesirable foods occasionally or frequently, and/or has begun to cut back on quantity by reducing the size of meals or the number of meals, seldom or occasionally. It does not, however, suffer from any of the three most serious conditions. A household that is highly food insecure has progressed to often reducing meal size or number of meals, and/or has experienced any of the three most severe circumstances (running out of food, going to bed hungry, or going a whole day and night without eating), even if only seldom. In other words, any household that experiences one of these three conditions even once in the last four weeks (30 days) is considered severely food insecure. This means that farm households who were severely food insecure and moderately food insecure adopted CSA without efficiently carrying out the recommended practices likewise it maybe unconnected with the fact that poor management of resources ensued among the households. The findings in Figure 3 also show that (46.1%) of the respondents were mildly food insecure and (29.2%) of respondents were food secured. This reveals that majority of the respondents who adopted CSA as recommended with proper household management were food secured hence. A food secure household does not encounter any of the food insecurity (access) situations, or only worries on rare occasions. A household that is mildly food insecure (access) is concerned about not having enough food occasionally or frequently, and/or is unable to consume favored meals, and/or eats a more monotonous diet than wanted, and/or eats some foods that are regarded undesirable, but only on rare occasions. However, it does not reduce quantity or suffer from any of the three most serious conditions (running out of food, going to bed hungry, or going a whole day and night without eating). The objective of CSA practices that seek to reduce negative effect of climate change on crop yield which adversely affect smallholder farmers' livelihood is achieved in the study area.

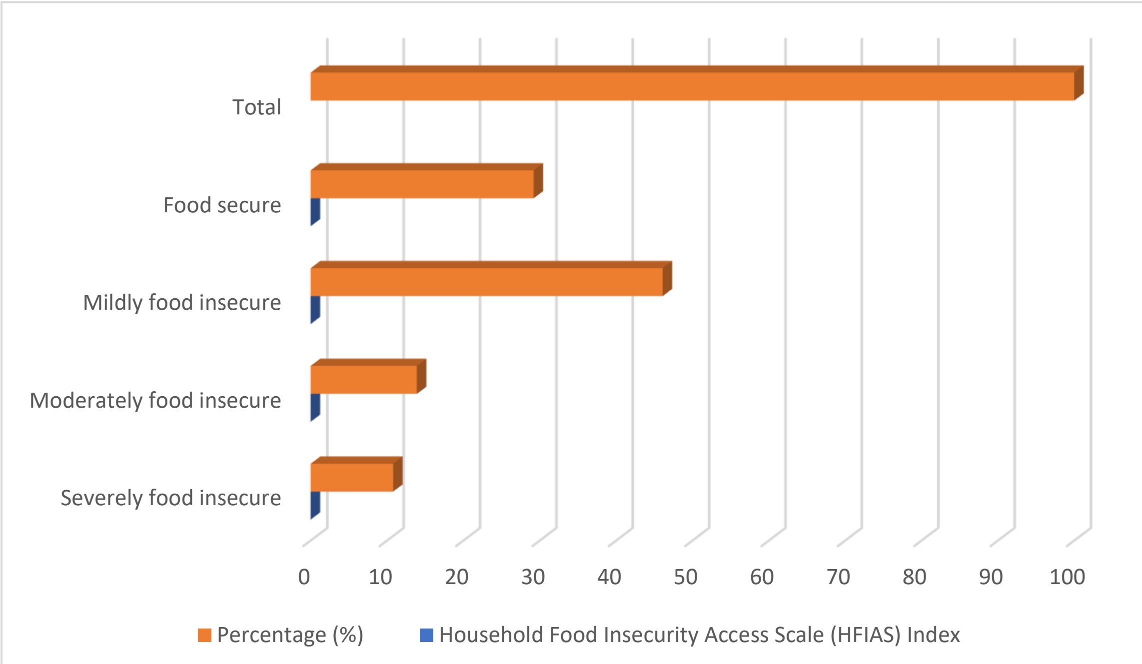

Figure 3. Distribution of smallholder rice farmers by categories of household food security. **Source: Field survey (2022).**

This is in line with finding of study by Bright (2017) who investigated the impact of climate-smart agricultural practices on small-scale farmers' food security in Kenya's Teso North Sub-County. The study sought how adoption of CSA affects food security among small-scale farmers in Teso North Sub-County. The result showed that a complete package with crop management, field management, farm risk reduction and specific soil management practices had the highest implication to food security. Further, this finding is in consonant with Hasan, *et al.* (2018) who researched on the impact of climate-smart agriculture adoption on the food security of coastal farmers in Bangladesh. The study showed that among the sampled households, (32%) were assessed as food secure, (51%) were mildly to moderately food insecure and (17%) were severely food insecure. The study posited that adoption of CSA practices was positively associated with household food security in terms of per capita annual food expenditure (β = 1.48 Euro, p = 0.015). This finding also agrees with that of Oyawole et al. (2020) who conducted research on the adoption of agricultural practices with climate-smart agriculture potentials and food security among farm households in Northern Nigeria. The study shows that (37.0%) of the farm households were food insecure, and adoption of the AP-CSAPs was generally low.

Result in Table 3 shows that integrated soil fertility management (0.264) was significant at 1% level (*P*=0.006) which is less than the 0.05 alpha level of significance. This means that adoption of integrated soil fertility management significantly increased household food security of smallholder rice farmers by 26%. Therefore, integrated soil fertility management and integrated pest management had significant effect on smallholder rice farmer's household food security. Yet, the findings on multiple regression shows that only integrated soil fertility management, water management and integrated pest management significantly affect household food security. The coefficient of determination (R^2) value (0.39), showing that the model accounted for variability of independent variables by 39%. Given that 0.006 and 0.002 were less than the alpha value of 0.05 level of significance, the null hypothesis which state that climate-smart agriculture adopted practices have no significant effect on smallholder rice farmers' household food security in Kwara State is hereby rejected. This is in line with the studies of Ali et al. (2022) and Ebenehi et al. (2024) which found that using improved crop varieties and better water management are crucial for building sustainable food systems. The insignificant variables such as agronomic practice is due to it limited adoption in rice production in Kwara State.

Table 3: Multiple regression estimates showing the effect of adoption of CSA practices on smallholder rice farmers' household food security.

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig. (P)
	B	Std. Error	Beta		
(Constant)	-0.197	0.253		-0.779	0.436
Tillage and residue management	-0.005	0.061	-0.007	-0.078	0.938
Agronomic practices	-0.013	0.061	-0.022	-0.214	0.831
Integrated soil fertility management	0.264***	0.097	0.441	2.736	0.006
Water management	0.105**	0.060	0.100	1.751	0.081
Integrated pest management	0.224***	0.072	0.404	3.096	0.002
Agro-forestry	0.052	0.083	0.082	0.627	0.531
R^2	0.39				
Adjusted R square	0.31				

**, ***Significant at 5%, and 1% respectively.

Source: Field survey (2022).

5. Conclusions and Recommendations

5.1 Conclusions

The findings of this study indicate that the adoption of Climate-Smart Agriculture (CSA) practices among smallholder rice farmers in Kwara State is generally high. Specifically, practices such as integrated soil fertility management and water management significantly enhance the livelihoods of these smallholder rice farmers by improving their household food security. This indicates that smallholder rice farmers utilized the CSA practices and benefited from sunsidzed inputs and other services. Smallholder rice farmers adopted climate-smart agricultural (CSA) practices, positively influenced household food security and overall livelihood, helping to mitigate the adverse effects of climate change. These CSA practices are instrumental in mitigating the adverse effects of climate change on food security. This is so because the study established that CSA practices significantly related to improved food security and livelihood of smallholder rice farmers in the area.

5.2 Recommendations

1. For Smallholder Rice Farmers: It is recommended that smallholder rice farmers continue to adopt and maintain high levels of climate-smart agricultural practices. These practices are crucial for mitigating the adverse effects of climate change on household food security.
2. For Agricultural Development Agencies: Kwara State and Federal agricultural development agencies should actively promote and disseminate CSA practices to other crop farmers through extension services. This will help reduce the negative impacts of traditional, less sustainable agricultural practices on both human health and the environment. By expanding the reach of CSA practices, these agencies can contribute to greater overall food security and environmental sustainability. For future research, it is suggested to examine the effects of CSA adoption on smallholder maize and cassava farmers' productivity and livelihoods in Kwara State.

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