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Effects of Climate-Smart Agricultural Practices on Food Security Situation of Farmers in Nasarawa State, Nigeria

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ABSTRACT

This research sought to find the 'Effects of Climate-Smart Agricultural Practices on Food Security Situation of Farmers in Nasarawa State'. A multistage sampling approach was used to select 222 farmers. Primary data were collected using a questionnaire. Data were analyzed using principal component analysis, household dietary diversity score, Poisson regression analysis and descriptive statistics. Principal component analysis grouped climate-smart agricultural practices into 5 components namely; comprehensive field management (42.0%), on-farm risk reduction (16.0%), crop/livestock management (13.0%), agroforestry (9.0%) and soil conservation practices (20.0%). A household dietary diversity score of 2.7 was obtained. Results of regression analysis showed that participation in non-agricultural activities, household size, valuable farm assets, comprehensive field management, on-farm risk reduction and crop/livestock management were significant. The absence of information (36.0%) and capital (28.8%) were the main challenges to the use of the technology. The research concludes that climate-smart agricultural practices have the potential to improve the food security situation of the farmers.

INTRODUCTION

Food insecurity is the greatest danger posed by climate change for vulnerable human populations. Efforts to improve global food security are most needed as the demand for food is increasing due to a rapid population growth. Sub-Saharan Africa is a region where yields of food crops are declining, with farmers receiving only a quarter of the yields of Asian farmers (Abdulazeez *et al.*, 2022). Understanding the exact impact of climate change on food security is complex because vulnerabilities are unevenly distributed around the world, it ultimately hinges on the ability of communities and countries to address risks. African crop yields estimated to decline by 10-20% by 2050 could even be up to 50% due to climate change (Eliot, 2022). Given the severe food insecurity around world, especially in Nigeria, it is important to take measures to mitigate the negative outcomes of climate change on farm production.

Climate-smart agriculture is not a new set of practices, given the need to collectively discourse food security and climate change. It is a means to introduce the necessary changes in agricultural systems (FAO, 2013). Climate-smart agriculture shares sustainability and guiding principles for food security. It emphasizes on production, farming households, increasing productivity, incomes and ensuring their stability. This package also focuses on four measurements of food security in times of availability, accessibility, use and durability. Climate-smart agricultural measures include substantiated approaches such as use of mulch, intercropping, and incorporated pest innovations such as disease management, reduced/minimum soil tillage practices, use of legumes in crop rotation, planting of trees on arable land, planting of crops on forest land, mixed farming, aquaculture, irrigation, detailed weather forecasting for farming households and timely notification strategies (Meriam *et al*., 2023). Furthermore, it includes adopting recent technologies such as modifying crop genetics to assist farming households cope with climate uncertainties and prepare the environment. Additionally, climate-smart agriculture has an interest in post-harvest management of agricultural outputs along the value chain to reduce losses and enable sustainable consumption patterns. Without climate-smart agriculture, surrounding areas could become uncultivable due to land degeneration through desertification, soil corrosion, continuous-cultivation and over grazing (Saowanee, 2020).

The negative impact of climate change will lead to a decrease in the supply of agricultural outputs. According to Kichamu-Wachira *et al.* (2021), climate smart agriculture has been advanced as an alternative to conventional farming due to their importance in enhancing quality food production. However, few studies have quantitatively investigated the effects of CSA practices on yield. This has led to a state of persistent malnutrition, hunger, and poverty. Often, overcoming the threats of climate change, subsistence farmers have consciously or unconsciously incorporated climate-smart agricultural practices. However, it is unclear which of these practices or combination of practices give the best payoffs in terms of improving food security and the challenges associated with their use as well as the food security status of the farmers. This study was concerned with filling this knowledge gap. Therefore, the study analyzed the effects of climate-smart agricultural practices on the food security situation of farmers in Nasarawa State. To meet the main objective, the study specifically focused on (i) identifying the climate-smart agricultural practices adopted by the farmers in the study area (ii) measuring the food security situation of the farming households in the study area (iii) examining the effects of climate-smart agricultural practices on food security situation of the farmers in the study area (iv) determining the challenges affecting the use of climate-smart agricultural practices in the study area.

METHODOLOGY

Nasarawa State has 13 Local Government Areas (LGAs) divided into three agricultural zones namely: central, western and southern zone respectively. The survey was executed in the Southern Agricultural Zone, this comprises of five (5) local government areas, namely; Awe, Keana, Obi, Lafia, and Doma. The zone is known for its long rainy season (May to October). The zone is placed between latitudes 9.00°N and 9.33°N and longitude 8.15°E and 9.33°N of the Greenwich prime meridian. The average annual rainfall is about 107.3mm and the average annual temperature is 22.7-36.0°C. Products cultivated in the study area encompass; roots and tuber crops (e.g., cassava and yam), grains, legumes, cocoyam. Furthermore, farmers in the research area put up domestic animals comprising: cattle, poultry, goats and sheep. Tree crops grown by farmers include: citrus, mangoes and cashews. Vast of the population are farmers who immerse in exchange and handicrafts as odd-jobs. The major ethnic groups are Eggon, Alago, Koro (migili), Kambari and Gwandara (Agidi, Hassan and Tajam, 2017).

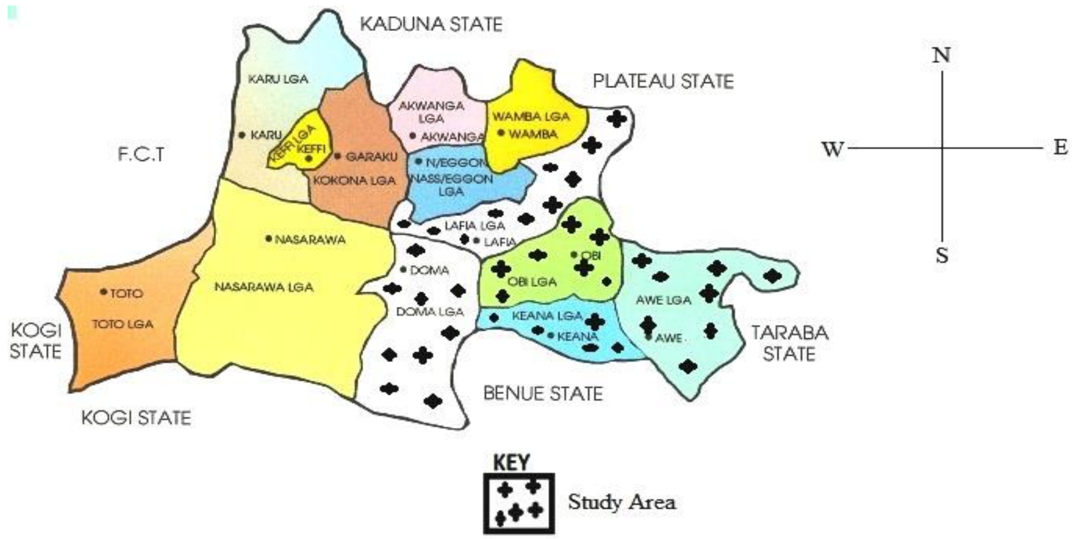

Figure 2.1: Map of Nasarawa State, Showing the Study Area

A multi-stage sampling approach was utilized to select the farmers. During this stage, 3 Local Government Areas (Lafia, Doma and Keana) were randomly chosen from the 5 LGAs in the study area which includes Awe, Doma, Lafia, Keana and Obi. Second, the three communities involved in agricultural production were purposively selected from each of the three LGAs, resulting in a total of nine (9) communities. Finally, due to the large number of the population, 14% of the farmers were randomly selected from each of the nine communities giving an aggregate of 222 farmers sampled for the study.

Primary data were obtained using questionnaire. Statistical package for social sciences (SPSS), principal component analysis (PCA), household dietary diversity score (HDDS), poisson regression and descriptive statistics, were employed to analyze the data acquired for the study.

The principal component analysis grouped related practices into components. This was then used for further analysis. The principal component analysis criterion is exemplified as following:

$$Y_1 = a_{11}x_{12} + a_{12}x_2 + \dots a_{1n}X_n$$

. .

. .

$$Y_j = a_{j1}x_{j2} + a_{j2}x_2 + \dots a_{jn}X_n$$

Where;

$Y_1 \dots Y_j$ = are unrelated principal components

$a_1 \dots a_n$ = correlation coefficients

$X_1 \dots X_j$, = specific strategic choices influenced by specific factors.

Household dietary diversity scores (HDDS) were calculated at 24-hour recall using different food groups consumed by different farmers and their households. According to Hussien *et al*. (2021), there is no particular threshold value for classifying food groups. In this study, HDDS ≤3 was used as benchmark for classifying the low dietary diversity group. The range of 4-6 was classified as the moderate category, while HDDS ≥7 classified as high dietary diversity group. The HDDS calculation is illustrated below:

$$\text{Average}=\frac{\sum_{i=1}^{n} \text{HDDS}}{N}$$

where n= 1, 2, . . , 12 per day

N= total number of farmers

A poisson regression model was utilized to examine the effects of climate-smart agricultural practices on food security situation of the farmers (HDDS). The model is stipulated as follows:

$U_{11} = \gamma_1(W_1, K_1) + \ldots\ldots + \varepsilon_{mn}$

. .

. .

$U_{ij} = \gamma_j(W_i, K_i) + \ldots\ldots + \varepsilon_{ji}$

Where:

$j = 0, 1, 2, .., m;$
$i = 1, 2, .., n$
$U_{11 \ldots}$ U_{ij}= farmers' HDDS,
$\gamma_{1 \ldots} \gamma_j$= are vectors of fitted parameters to be estimated,
$W_{1, \ldots,}$= are vectors of adopted climate-smart agriculture practices.
$K_{1} \ldots K_i$ = vectors of farmer characteristics,
$\varepsilon_{mn} \ldots \varepsilon_{ji}$ = the stochastic terms.

RESULTS AND DISCUSSION

Climate-smart agricultural practices used by the farming households

Table 1 illustrates the descriptive statistics of the makeup of the individual components (climate-smart agricultural practices) generated from the principal component analysis. The vast generally employed element was that of comprehensive field management practices. 42% of farmers use at least one or more element of this component. The second factor was on-farm risk reduction practices used by 16% of the farmers. The third component relates to crop/livestock management practices used by 13% of the farmers which includes effective utilization of nitrogenous fertilizers, and utilization of better livestock breeds and crop varieties. The fourth component, which involves agro-forestry practices used by 9% of the farmers, includes planting crops on forest lands and planting trees on arable field. The fifth and second most frequent component was of soil conservation practices used by 20% of farmers.

Table 1: List of climate-smart agricultural practices

Group	Rate of Users (%)	Elements
Comprehensive field management practices (component 1)	42	Utilization of organic fertilizers, modification in time of planting, utilization of mulching, diversifying livestock breeds and crop varieties, Irrigation, utilization of enhanced crop varieties, bound/Tied ridge system.
On-farm risk reduction (component 2)	16	Reduced/minimum or no tillage, adoption of living obstacles, adoption of terraces.
Crop/livestock management practice (component 3)	13	Effective utilization of nitrogenous fertilizers, utilization of better livestock breeds and crop varieties.
Agro-forestry practice (component 4)	9	Planting crops on forest land, planting trees on arable field.
Soil conservation practice (component 5)	20	Reduced/minimum or no tillage, utilization of mulching.

Field survey, 2021

Measurement of food security situation of farmers using household dietary diversity score (HDDS).

The findings in Table 2 show that the average HDDS was 2.7 (100%) for all the farmers, this explains that the farmers in the study area are food insecure. Majority (75.7%) of the farmers belonged to the class with low dietary diversity group (consumed 3 or less food groups). Additionally, the finding also shows that some farmers (21.2%) consumed 4-6 food groups and are classified as moderate dietary diversity group while few of the farmers (3.1%) consumed about 7 or more food groups (high dietary diversity group). The reason is that majority of the farmers do not participate in non-agricultural activity as an alternative means of generating additional income to meet their food needs and further, lack financial support and information as key challenges to the use of climate-smart agricultural practices to improve their food security situation.

Table 2: Food security situation of farmers using HDDS

Food Groups	Frequency	Percentage (%)
Grains	176	29.3
Tubers/Roots	111	18.5
Vegetables	78	13.0
Fruits	32	5.3
Meats	12	2.0
Eggs	24	4.0
Fish and other sea foods	21	3.5
Legumes and seeds	36	6.0
Milk and dairy products	52	8.7
Fats and oil	15	2.5
Sugar/honey	25	4.2

Spices, condiments and Beverages	18	3.0
Average HDDS	2.7	100
Groups/Classes	Frequency	Percentage
Low dietary diversity group (consume 3 or less food groups)	168	75.7
Moderate dietary diversity group (consume 4 to 6 food groups)	47	21.2
high dietary diversity group (consume 7 to 12 food groups)	7	3.1
Total	222	100

Field survey, 2021

Effects of climate-smart agricultural practices on food security situation of farmers:

The aftermaths of the poisson regression model are shown in Table 3. The estimated goodness-of-fit chi-square = 70.663 with a statistic of 0.355, indicates that the data conforms to the model. The result shows that farmers' food security situation has been affected by several factors which includes; participation in non-agricultural activities, valuable farm assets, household size, comprehensive field management, on-farm risk reduction and crop/livestock management methods.

Participation in non-agricultural activities had a precise and significant effect on food security situation of the farmers at 10% level of significant. As a result, farmers who engage in non-agricultural employment are more likely to generate additional income to fund capital-intensive practices, thereby, improving their food security status. This is in agreement to a survey by Danso-Abbeam *et al*. (2021), which hypothesizes that non-agricultural earnings promote the utilization of resilient and improved adaption methods. The study acknowledges that non-agricultural income can fund production to meet labor delays emanating from the competing labor demands. According French *et al*. (2019), households in which individuals are employed have more ability to acquire food continuously.

Valuable farm assets were positive and had a significant effect on food security situation of the farmers at 5% level of significant. This indicates that farmers will be very productive because the value of productive agricultural assets creates an opportunity of achieving food security. Established on the findings, asset availability provides a means to diversify farming to become less risk-averse in attaining food security using climate-smart agricultural practices. This finding is comparable to Newton (2020), who highlighted that fairly meager price of farming purchases, restricts technology acceptance. Agriculturist with poor-price farm purchases need technology that compel few of such assets.

The farmers' household size was found to be significant at the 10% level and negatively correlates with farmers' food security situation. Based on the standard prediction, for an increase in unit of household size, the farmers are less likely to be food insecure. This is similar to a study by Victor *et al*. (2020), which assumed that the effect of household size as it aligns with climate-smart agricultural practices on farmers' food security situation may not be predicted, since larger household size are more likely to fall into poverty. Thereby, imposing more burdens on farmers, the number of people needed for a meal. Household size, on the other hand, may imply the availability of labor by assigning significant agricultural activities to other family members. This could improve the food security situation of the farmer.

Comprehensive field management practices (component 1) were positive and significant at 1%. This means that the food security situation of the farmers in the study region is affected by the comprehensive field management practices they adopt. This indicates that those who use these methods will achieve improved food situation. Based on this result, a prudent combination of these methods will have the greatest broad effect on the food security situation of the farmers. According to Opeyemi *et al*. (2021), farmers' households have the potential to achieve greater food security by using climate-smart agricultural technologies.

The on-farm risk reduction methods were found to be significant at the 10% level and correlates with farmers' food security situation. The result is that farmers are more likely to be food secure when they use on-farm risk reduction methods. These practices include reduced/minimum or no tillage, use of living obstacles and use of terraces to help remediate and restore degraded lands and drained areas.

Crop/livestock management practices were positively associated with farmers' food security situation at the 10% significant level. This includes the effective use of nitrogenous fertilizers, and the use of better varieties of livestock and crop. As the utilization of these methods increases, the potential to achieve food security is guaranteed. A study by Wekesa *et al*., (2018), observed that the majority of farming households using climate-smart agricultural practices used at least one of the strategies in the package that encompassed at slight a crop management method. This attention indicates that most farmers have to procure their main crop/livestock production management methods for food production.

Given the chi-square significance of 0.000 ($P<0.05$) for climate-smart agricultural practices coefficient, the H0 was rejected. The Ha, which states that 'climate-smart agricultural practices have important implications on the food security situation of farmers in Nasarawa state,' was accepted.

Table 3: Effects of climate-smart agricultural practices on food security situation of farmers

Variable	Coefficients	Robust standard errors	P>Z
Socio-demographic traits			
Gender	0.395	0.1022	0.674
Age	0.405	0.0069	0.405
Educational situation	-0.075	0.1034	0.468
Household/Family Size	-0.022	0.0115	.061*
Participation in non-agricultural activity	0.218	0.1263	.085*
Valuable farm assets	0.266	0.1203	.027**
Size of Farm land	0.718	0.0379	0.781
Perception on farm characteristics			
Terrain	-0.019	0.0916	0.838
Fertility	-0.074	0.1117	0.507
Erosion	0.014	0.0925	0.887
Bad incidences			
Floods	-0.019	0.1217	0.875
Shortage of rain	0.074	0.1011	0.464
Storms	0.169	0.1562	0.208
Institutional factors			
Distance to the market	0	0.0011	0.77
Annual contact with extension agents	0.018	0.0925	0.844
Group Membership	0.001	0.1253	0.993
Access to credit	0.099	0.1602	0.536
No. of climate-smart agricultural practices			
comprehensive field management practices	0.11	0.0259	.000***

On-farm risk reduction practices	0.129	0.0731	.077*
Crop/livestock management	0.157	0.0909	.085*
Agro-forestry	-0.044	0.1077	0.681
Soil conservation practices	0.065	0.1426	0.647
Constant	0.359	0.3832	0.14
Pearson Chi-square = 70.663	0.355		.000***

Field survey, 2021

Challenges to the use of climate-smart agricultural practices by the Farmers:

An attempt was made to recognize the challenges faced by farmers using climate-smart agricultural practices to attain food security. The result in table 3.4 shows that there are significant factors limiting the use of climate-smart agricultural practices by farmers in the study area. Absence of information is the most limiting factor (36.0%). A contemporary study by Lelethu *et al*. (2022), discovers that farmers who received information about their farms using modern information and communication technology had higher yields. The next limiting factor was scarcity of capital (28.8%). The availability of capital will boost farmers' financial resources, increase their cash base and enable households to buy significant contribution. Arguably, where capital is available, farmers are further inclined to utilize capital-intensive climate-smart agricultural practices, particularly irrigation, utilization of better livestock breeds and crop varieties or planting of trees on agricultural land, etc. also, competently paying for labor-intensive technologies. Jonathan *et al*. (2021) presumed that capital raises farmers' ability to purchase better seeds, fertilizers and other climate-smart agriculture inputs. Nonetheless, this technology goes beyond other investment options accessible to farmers. Other challenging factors include labor shortages (23.2%) and inadequate access to water (12.0%).

Table 4: Challenges to the use of climate-smart agricultural practices by farmers.

Constraints	Frequency	Percentage
Scarcity of capital	67	28.8
Absence of information	84	36.0
Labor shortages	54	23.2
Inadequate access to water	28	12.0
Total	**233**	**100**

Field survey, 2021

CONCLUSION

Climate-smart agriculture has a significant association with farmers' food security situation. The rate at which climate-smart agriculture were encompassed into farming activity was still low, with comprehensive field management practice being the most commonly used practice to improve agricultural productivity. The result of the household dietary diversity score shows that farmers are food insecure. Absence of information on the need for climate-smart agriculture practice and scarcity of capital were the main challenges to adopting this technology in the study area.

Based on the findings, the study recommends farmers to employ climate-smart agriculture wherever possible, in order to have a greater impact on their food security status and an elixir to mitigate the negative consequences of climate alteration on agricultural activities. Considering the constraints, capacity building of support dissemination agents is necessary to assist in creating agricultural policies that can hasten the design and development of improved messages and the spread of climate-smart agriculture practice.

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