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Effect of Climate Smart Agricultural Practices Adoption on the Food Security Status of Smallholder Farmers in Imo State, Nigeria.

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Abstract

The study investigated the effect of Climate Smart Agricultural Practices adoption on food security among the smallholder farmers in Imo State. Specifically, the study described the socioeconomic characteristics of the respondents; ascertained the various climate smart agricultural practices (CSAP) adopted in the study area; and analyzed the effect of CSA adoption on the food security status of the farmers. A multi-stage sampling procedure was employed to select 120 respondents needed for the study. Data were analyzed using descriptive analytical tools such as mean, frequencies and logit regression; household food consumption score HFCS and Household Dietary Diversity Scores HDDS. The results of the findings revealed that the first-fifth practiced CSA among the farmers having highest frequency of used and percentage were; the use of compost materials (89.20%), use of mulching and planting improves crop variety (86.70% each), use of organic fertilizer (84.20%) and planting cover crops (83.30%) and ranked first to fifth respectively. The result finally showed that the mean HFCS of the respondents was 34.4421 with minimum and maximum of 14.00 and 64.50. The result also showed that more than half (54.20%) of the respondents had an acceptable HFCS (≥35) as compared to 31.70% of the farmers at the borderline and 14.10% with poor HFCS. Furthermore, the study found the HFCS mean of 34.4421 which fall on the category –borderline. Sex, education, distance from house to farm, livestock production, experienced no of CSAPs adopted are significant and positively affect the level of food security while age negatively affected the food security status of the farmers. The result concluded that CSAPs adoption had positive and significant effect on the food security status of the smallholder farmers and therefore recommends that efforts should be intensified by various stakeholders to ensure that adequate measures are put in place so that farmers would be aware of the CSA practices and their food security would be met.

Keywords: Climate, Smart; smallholder farmers, Food security

Introduction: According to Food and Agriculture Organization (FAO, 2016), one of the greatest challenges facing the world in the 21st century is climate change. Climate change has become a critical socio-economic as well as environmental problem. Climate change has become a major constraint to agricultural production more especially in Africa Nigeria inclusive down to Imo State. According to Intergovernmental Panel on Climate Change (IPCC), climate change affects crop production in several regions of the world, with negative effects such as hampering agricultural growth and threat to food and nutrition security more common. Climate Change negatively affects the production and productivity of livestock, crops and fisheries (FAO, 2016) as well as threatening various sectors of economic development including natural resources, forestry, tourism, manufacturing and health (IPCC, 2017). Climate Change will continue to exert its influence not only on crop production, but also on the increasing hunger and food insecurity (FAO, 2016). Despite producing most of the world's food, smallholder farmers tend to be food insecure themselves: globally, they form the majority of people living in poverty. Specifically, the percentage of food insecure people has been on the increase in Nigeria, increasing steadily from about 18% in 1986 to about 33.6% in 2004 and 41.0% in 2010 according to (NBS, 2012). Helping raise the incomes and improve the livelihoods of the smallholder farmers holds the key to building sustainable food systems, advancing food security and achieving Zero Hunger. The application of climate smart agricultural practices (CSA) to cope with climate change was viewed as a key strategy for restructuring the agriculture sector and also help prepare farmers to cope with the adoption of appropriate methods and skills for the production, processing and marketing of agricultural supplies.

Climate Smart Agriculture (CSA) is an approach that is based on principles of sustainable development, which promotes agricultural practices. According to (Neufeldt, Jahn, Campbell, Beddington, Declerk, 2013) it aims at "sustainably increase agricultural productivity and incomes, build resilience and capacity of agricultural and food systems to adapt to climate change, and to remove or reduce greenhouse gases while enhancing national food security". Some CSA practices (e.g. intercropping/multiple cropping, agroforestry, conservation agriculture etc.); are quite widespread and their proliferation has been facilitated by ease of adoption, and multiple benefits such as food, income diversification and improved resilience. Climate Smart

Agriculture aims at supporting livelihoods at farm level by ensuring food security of smallholder farmers and helping to improve the management and utilization of natural resources. It also fosters the adoption of appropriate methods and skills for the production, processing and marketing of agricultural supplies. Whereas at the national level, CSA pursues legitimate and relevant technically and financial policies that would support nations to establish/entrench climate change adaptation into their agricultural sector. Smallholder farmers in Nigeria especially in Imo State are faced with a lot of challenges which has a negative effect on their productivity, reduces their food security at the same time contributing great loss to agriculture (FAO, 2014). Climate-Smart agricultural practices are believed to be the best approach to tackling the concurrent challenges from climate change, meeting the productivity, resilience, emission standards and increased food production tthat will curb food insecurity ravaging the country today. Food security exists when "all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preference for an active and healthy life" (Perez-Escamilla and Segall-Correa, 2008). To achieve effective food security smallholder farmers need to be aware of the prevailing climatic conditions and adopt CSA practices. Climate Change affects food Production and availability, access, quality, utilization and stability of food systems. However, according to (Neate 2013) despite the attractiveness and conceptual promise of CSA, it's success in Nigeria and Africa at large have shown to be scanty and mixed in terms of result. Hence, there is dearth of information on the influence of CSA on the food security of smallholder farmers in Imo State, this study tends to investigate the effect of the adaptation of CSA practices on food security of smallholder farmers in Imo State Nigeria.

Materials and Methods: Description of the Study area: This study was conducted in Imo State. The area was selected due to its high potential for food production which is attributed to its good soil but under threat of soil degradation. Imo State is bordered by Abia State on the East, River Niger and Delta State to the West, Anambra State on the North, and Rivers State to the South (Imo ADP, 2022). The state lies within latitudes 4°45'N and 7°15'N, and longitude 6°50'E and 7°25'E with an area of around 5,100 sq km (Imo ADP, 2022). Imo State is made up of three distinctive agricultural zones namely, Orlu, okigwe and Owerri. There are two main seasons in the state- dry and rainy seasons. The annual rainfall is between 1900mm and 2200mm while the mean annual temperature is between 200C with a relative humidity of about 75% annually (Imo ADP, 2022). The state has experienced environmental degradation including soil erosion, flooding and loses of quality and quantity of natural biodiversity which poses a threat to its food production potential. The people in the state are mainly farmers (Imo ADP, 2022). All these necessitated the choice of the state for the study.

Data collection and Analysis: A multistage sampling procedure was used to select 120 smallholder farmers for the study. The study used primary data collected from respondents gotten from the list obtained from the state Agricultural Development Program. Well-structured questionnaire was used to elicit relevant data from the farmers. Data were analyzed using descriptive analytical tools such as mean, frequencies, multinomial logit regression; household food consumption score HFCS and Household Dietary Diversity Scores HDDS**.** Food security indicators (household food consumption score, HFCS and Household Dietary Diversity Scores were used as proxies for food security of farmers. These tools were developed by World Food Program (WFP) in 1996 and are commonly used as proxies for access to food (WFP, 2021).
HCFS is a weighted score based on dietary diversity, food frequency and nutritional importance of food groups consumed. The HFCS of a household is calculated by multiplying the frequency of foods consumed within 7 days with the weighting of each food group. HDDS is similar to HFCS with slight difference in the components of the various food clusters. While HFCS takes into account food items consumed within 7 days, the HDDS takes into account food items consumed within the last 24 hours. But the foods taken during ceremonies and major occasions were not included to reduce the bias that would have risen in capturing such meals.

The following steps were followed:

i. Grouping the food items in the specified food groups (condiments are exempted)
ii. Summing all the consumption frequencies of food items within the same group
iii. Multiplying the value of each food group by its assigned weight
iv. Summing the weighted food group scores to obtain HFCS
v. Determining the household food consumption status based on the following thresholds 0-35 are food insecure while >35 are food secure.

For HDDS, each food group was assigned a score of 1 (if consumed) or 0 (if not consumed). The household score ranged from 0 to 12 and is equal to the total number of food groups consumed by the household.

HDDS= sum (A+B....+L)

The average household dietary diversity score for the farmers can be calculated this;

Sum {HDDS/ (Total number of households surveyed)} …………………………………………… (1)

Target was established using the average dietary diversity of 33% of households with the highest diversity. Since the dependent variable food security is qualitative in nature (i.e dichotomous) it can only take two values (1 and 0) either the presence of something or absence. The value of 1 means that household is food secure and zero means otherwise because this measure of food security in binary manner yields results which have more policy implication. Hence the factors affecting the food security status of the farmer was analyzed using logit regression model. The logistic regression technique can be used to model the relationship between the dichotomous dependent variable and set of independent variables that are hypothesized to affect the outcome.

Therefore, the logistic regression model following Wooldrize (2010) is given by;

$$\text{Ln } (P_i/ (1\text{-Pi}) =)) = \beta_0+\beta_1X_{1i}+\beta_2X_{2i}+\ldots.+\beta_{14i}X_{14i}\ldots\ldots \quad (2)$$

Where;

(Pi/ (1-Pi) = the odd ratio in favor of food security i.e the ratio of the probability that the household is food secure to the probability that it is not food secure.

The subscript i shows the ith observation in the data.

β0 is the intercept of the model

While X_1, X_2, X_3.......X_{14} are the explanatory variables. The estimated coefficients do not directly affect the change in corresponding explanatory variables on the probability of the outcome. Rather the coefficients reflect the effect of individual explanatory variables on its log of odds. The positive coefficient shows that the odd ratio will increase and vice versa. The logistic regression coefficients will be estimated using the maximum likelihood estimation method. Hence the dependent variable

Y= ln(Pi/(1-Pi)=))= food security status

X_1 = Age (years)
X_2= Sex (1=male, 0= female)
X_3 = Educational level (years)
X_4 = Household size (No)
X_5 = Occupation (1 = farming, 0= other occupation)
X_6 = Availability of labour (1 = available, 0 = unviable)
X_7 = Distance from house to market (km)
X_8 = Livestock production (1 = owned livestock, 0 = otherwise)
X_9 = Access to credit (N)
X_{10} = Access to market (1 = access, 0 = otherwise)
X_{11} = Received palliative (1 = received, 0 = otherwise)
X_{12} = Experience flooding (1 = Yes, 0 = No)
X_{13} = Experienced crop/animal disease (1 = Yes, 0 = No)
X_{14} = No CSAPs adopted (No of CSAPs adopted)

Results: Socio-Economic Characteristics of Respondents

The result in Table 1 showed some of the socio-economic characteristics of the small holder farmers in the study area. Some of the socio/demographic variables presented and discussed in the study were; age of the farmers, sex, household size, level of education, marital status, farming experience, membership of cooperative, farm sizes, occupation, ownership of land, access to credits and monthly income etc.

Various Climate Smart Agriculture practices (CSAP) adopted by the farmers in the Study Area : The results in Table 2 presented the results of participation in climate smart agriculture among small holder farmers in Imo State, Nigeria**.** The results in Table 2 shows that the first-fifth practiced CSA among the farmers having highest frequency of used and percentage were; the use of compost materials (89.20%), use of mulching and planting improves crop variety (86.70% each), use of organic fertilizer (84.20%) and planting cover crops (83.30%) and ranked first to fifth respectively.

Food Security Status of the smallholder farmers: In order to determine the food security status of the small holder famers in Imo State, the Household Food Consumption Score HFCS and Household Dietary Diversity Scores (HDDS) is estimated using a typical seven-day food dataset through categorizing food items into food groups and subsequently adding the consumption frequency of food items belonging to that particular group. A consumption frequency beyond 7 is captured as 7, and multiplied by the attained score for every food group by its weighting. Weighted food group scores are added together, and finally the HFCS, a continuous measure, is categorized into appropriate thresholds of food consumption groups as follows: 0 to 21 (poor), 21.5 to 35 (borderline), and above 35 (acceptable) following FAO (2011).

Food Groups and Weight in HFCS and HDDS: Results in Table 3 presented the food groups and weights in HFCS and HDDS among the smallholder farmers in the study area. The results showed that the consumption mean for vegetable and fruits (4 times in a week) to be higher than that of the cereals and oil (3 times weekly each), pulses, milk and sugar (2 times in a week) and finally meat and fish (1time in a week). The therefore, showed the weighted household food consumption score for the milk (8) to higher than other food group such as cereal and pulses (6 each), vegetables, fruits and meat and fish (4 each) and oil (1.5) and sugar (1). The result finally showed the mean HFCS of the respondents to be 34.9972 with minimum and maximum of 14.00 and 64.50.

Household Food Consumption Scores: The dietary diversity score, however, does not show the amount (quantity) of food a household consumed. Diet differs between seasons and other foods are presumed to be obtainable in large amounts and at lower costs for short periods. A Household Food Consumption Score (HFCS), a frequency-weighted HDDS, was further estimated as an indicator of dietary diversity and frequency of consumption by use of the frequency consumption of seven various food groups.

Determinants of Food Security among Small holder Farmers in Imo State, Nigeria: The results in Table 5 showed the logit regression estimates of the determinants of food security among small holder farmers in Imo State, Nigeria. The results showed the likelihood ratio statistics as indicated by chi^2 statistics were highly significant (P <0.0000), suggesting the best fit of the model. The Pseudo R^2 of 0.5046 indicated that about 50.46% of the variation in the degree of food security status of the farmers was explained by the in dependable variables. The results showed that most of the variables tested for the probability to contribute to ensure food security had the expected signs. The study found that the coefficients for age were negative and significant at 10% level of probability. The negative sign for age indicates that the probability of the farmers being food secured decreases with increasing age. This could arise from the fact that younger farmers are still strong and active, and are ready to work, access information that will geared towards food security. Gender was highlighted as an important predictor of household food security status by Elias et al. (2013). The coefficient for sex was also positive and significant at 10% level of probability. This implied that the male farmers are probably and likely to be food secured than the female. This is not expected because women are traditionally known for agricultural production, and were expected to be more food secured than men. However, the possibility of the result may be due to the fact that male farmers involved in the study area are more involved in food security crop production other than a cash crop following Okoye et al., (2018). The findings are similar with Mathenge *et al.,* (2010).

The study also found that the coefficient for educational level of the farmers to be positive and significant at 5% level of probability. This indicated that increase in years of education of farmers will increase the level of food security and vice versa. Again, education may expose households to diversified livelihood portfolios that are likely to increase food procurement means. The finding agrees with those of Agbola (2014) and Mango et al. (2014), that education status has a positive correlation with household food security status. The coefficient for distance from home to farm was also positive and significantly related the food security status of the respondents in the study area. This implied that farmers that have close distance to farm were food secured than those with longer distant to farm from home. This is expected and the farmers will have a close watch of their farm, thus geared towards proper management, and increased output.

Discussion: The result of the socio-demographic characteristics of the farmers in the study area is presented in Table 1. The study found that the average age, educational level and farming experience of the farmers were 47.42, 11.4833 and 25.1167 years respectively with household size of about 6 persons. This implies that most of the farmers are still very agile, energetic and within their productive age; and more so had formal education and large farming experience which may positively influence their climatic smart agriculture. The finding on the age was in line with Olayiwola et al. (2017). Aboaba et al., (2020) study similarly corroborates with the findings of the study that one-quarter (25%) of rural household heads were between 31 and 40 years old, with a mean of 49 years which was slightly above the finding of this study. This finding is comparable with Demissie (2019), Kom et al. (2020), and Tekeste (2021); study in Climate-smart agriculture practice (CSAP) and its impact on food security in Siyadebrina Wayu Woreda North Shewa Ethiopia, and Ojoko et al. (2017) study in factors influencing the level of use of CSAPs in Sokoto state, Nigeria. The large household size of about 6 person found in the study also explained the large number of persons eating from the same pot. Production tends to increase if there are more members in the household. Family size is an important source of family labour since it implies a reduction in the cost and availability of labour following Ezeibe et al. (2015).

However, having basic education is expected to enhance the overall quality of the farmer by providing him/her with basic numeric and literacy skills following Okoye et al., (2020), thus increased participation in climate smart agriculture. Farming experience is very important in farming activities; more experienced farmers are more likely to choose climate smart technologies as it helps the farmer in the area of proper farm management to maximize profit. The large number of farming experience (25 years) found in the study implied that the farmers had a wide range of experience in farming, which may positively influence their participation in climate smart agriculture for increased productivity, increase their income and improve their food security status (Ambali *et al*., 2012). The result of the study is consistent with Khatri-Chhetri et al. (2017), Ojoko et al. (2017) and Ayenew and Tilahun (2022). However, the farmers had an average farm size of 1.5392 with extension contact of 4 times on an average annually. This implies that the respondents had small land holdings. Land is a vital resource in agricultural output, and farmer households who have access to land and other resources will be able to host the novelties or techniques required for a fruitful agricultural endeavor. They grow crops on a small scale, and the likely implication of this is small output. The finding was in consistent with the findings of Okoye *et al*., (2020) who found small holder's farmers in South East with the total area of land cultivated for agricultural activities of 1.54 and 0.73 hectares for male and female farmers respectively. The distance from the home to the farm was about 6.4km and annual income of about N 280,726.6667. This explained longer distance to travel especially during wet and on-seasons with moderate income although poor for to an extent and dependent on the type of crop and duration.

The study also showed that more than half (55.80%) of the respondents were female farmers, majority married (67.50%) and ownership of their farm land (62.50%). This indicated the dominance of female farmers and married in agricultural activities in the study area with moderate number having right ownership of their farmlands. In line with the findings, Mfundo (2013) and Pujiwidodo (2016) observed that small-scale farming in South Africa is experienced mainly at a local level by elder female. In contradiction, Aboaba *et al*., (2020) study in Southwestern, Nigeria found dominance of males over their female counterparts and explained the results possibly due to the fact that most farming activities require more strength which most females may not be able to provide. A larger proportion (67.50%) of the respondents that were married, implied how matured and responsible they are to cater for their households, and had a clear knowledge of their wellbeing. There is also an implanted sense of responsibility as marital status prompts commitment to business because of the family needs that must be met. Subsequently, this would enhance participation in CSA and improvement in their food security status; following (Ayoade and Adeola, 2012); Aboaba et al., (2020). Generally, land acquisition is believed to constitute much constraint for efficient utilization of land especially when it is purchased or hired (Yusuf, 2015). Interestingly, the study found many (62.50%) of the having ownership of the farmland and this is expected to have positive impact of adoption of CSA practices and on ensuring food security.

Furthermore, less than half of the farmers belonged to cooperative society (40.80%), access to market (19.20%), have access to irrigation facilities (37.50%) and participate in other off farm activities (21.70%). This was an indication of poor access to improve livelihood facilities such as access to market and irrigation facilities. The low number of respondents belonging to cooperative society also indicated a poor interaction and dissemination of agricultural information among the farmers. Okoye *et al*., (2020) noted that belonging to cooperative organization and such networks ensure cooperation among farmers in the use of scarce and communal resources; being members of the cooperatives will generally help the farmers in accessing agricultural information. The prevalence of social organization and communication facilities may substantially increase participation in CSA adoption in the study area. However, the number of respondents not involved in other off farm activities was also an indication of full time farmers in the study area interviewed.

Also, more the half (54.20% and 53.80%) of the respondents were found to have access to credit facilities and experienced drought in the last 5 years respectively. This implied that at least an average number of the farmers had access to credit and have experience of drought in the past years. The average number of the respondent with credit may be as a result of availability of credit facilities to farmers in the study area, and this is expected to encourage them to gear towards adoption of CSA practices. Hence, average experience of drought in the past years will expose the farmers to practices to mitigate and adapt in the changing weather condition. More so, most (90.20%) of the farmers have access to labour supply and majority (71.70% and 86.30%) experienced insufficient rains and experienced flooding in the past 5 years respectively. Access to labour may also explained the large household size found in the study and/or the cheapest of paid labour. However, availability of labour also is an expected factor to influencing adaptation of CSA and production of surplus food to ensure food security. Many of the respondents that also indicated having past experience in insufficient rain and flood in the study area is a good to explain and undertake this study since they are experience and possibly must have adopted one or more CSA along the time to solve the problem. Ojoko et al. (2017) noted that experience is very important in farming activities, as it helps the farmer in the area of proper farm management to maximize profit.

These results in Table 2 showed that CSAP was being practiced in the study area, but at different levels of usage, which might be a result of some factors influencing their usage. However, the highest CSAP on the use of Compost materials simply indicated the level of awareness of farmers on the importance of compost in soil amendment and its impact in long-term crop management plan. Composting also helps dairies manage manure; it has agronomic benefits, controls plant diseases, and adds nutrients to the soil (Mir, 2014). In organic cropping systems, compost provides a primary source of nutrients for the crop provides a supplementary nitrogen source that compliments fertilizer nitrogen to provide more sustainable farming systems in conventional cropping systems. Mulch is a layer of any material, usually vegetative matter, spread on the soil surface. A layer of organic litter characterizes all productive natural environments – deserts are not productive (TOF, 2010). This implied that as the second practiced CSA was indicated by the farmers in the study area, might showed availability of mulching materials and intentional used to retains soil moisture, balances soil temperatures, and provides organic matter and nutrients as it decomposes. El-Beltagi et al., (2022) noted that the use of mulching and mulching materials have a substantial impact on water conservation in agriculture by altering the microclimate and lowering the soil evaporation. However, each form of mulch has its own set of advantages and disadvantages, making it appropriate for some conditions but not for others. The practice of mulching at time also depends on the availability, durability, or pricing of materials which are factors that might affect usage and practice. The result of the study found that the use of planting improved variety as also the second practice CSA in the study area. This is not surprising as noted by Wondimagegn *et al.,* (2011) that farmers use improved varietal seeds and breed to increase output, thus, increase farm income. In line with the discussion, Okoye *et al.*, (2020) recommended that policies made towards coming up with a resistant variety will go a long way to increase volume and as well adapt to the changing climatic condition.

The use of organic and cover crop as the fourth and fifth CSA practiced in the study area was in line and among the preferred CSA adopted by the farmers in Ayenew and Tilahun (2022) study. The aforementioned study noted that the widely adopted climate-smart practices found in the study were tree planting, effective use of nitrogen fertilizer, irrigation, crop diversity, crop rotation, intercropping, use of organic manure, minimal tillage, and use of terraces, livestock breed improvement, and diversification and mulching. However, TOF, (2010) noted that cover crops are grown to provide soil cover and organic matter and to suppress weeds. They may be incorporated into the soil while young or can be used as a mulch layer at a later stage of maturity. Cover crops are often used to provide soil cover during the dry or cold season and are just rolled down or slashed and left in the field one or two weeks before planting the main crop.

The study also showed other CSA practices practiced by the respondents with percentage values above 50.00% as; use of fertilizer (82.50%), planting local varieties; efficient use of inorganic fertilizer; use of diversified crops and animal breeds and pesticide and use of improved livestock breeds (76.70% each), intercropping (64.20%), planting disease resistant varieties (62.50%), use if legumes in crop rotation and moving to a different site (61.70% each), using information from weather forecast (59.20%), use of irrigation water and use of terrace (57.50% each), planting shade trees on the crop land (55.80%), use of bio-cha (54.20%), planting food crops and animals breeds (50.80%) and ranked 6th to 20th position respectively. These findings affirmed that above moderate number of farmers in the study area perceived the negative effect of climate change on their cropping activities and therefore the need to use CSAPs as a remedy to these problems. This also is an indication as their high level of awareness and knowledge of the CSAPs in the study area, which may be attributed to their level of education and years in farming experience.

Other CSA with percentage below 50.00% were; use of life/plant barrier (48.50%), changing planting dates and use of zero tillage (46.70% each), changing the timing of farm operations (45.80%). The average adoption level of improved cassava varieties was 65.2% which indicates moderate adoption level. The result in Table 3 indicated that the farmers were consuming more of vegetables and fruits than other food groups. This may be probably due to availability and accessibility of these food forms in the locality. However, the higher HFCS of food group -milk (8) found in the study may be attributed to the livestock production as part of the main occupation of the respondents The result in Table 4 showed the Household Food Consumption Scores HFCS Threshold of the farmers in the study area. The result revealed that more than half (54.20%) of the respondents had an acceptable HFCS (≥35) as compared to 31.70% of the farmers at the borderline and 14.10% with poor HFCS. Furthermore, the study found the HFCS mean of 34.4421 which fall on the category – borderline.

Considering that less than or equal to HFCS of 35 are food insecure, the result therefore concludes that the farmers in the study area are food insecure although they are at the borderline of food security. A little effort should be made to increase the HDDS to push them out from the borderline to acceptable line. This supports the notion that the higher the HDDS, the more acceptable the HFCS (IFPRI, 2008). The results showed that a large proportion of the farmers were in acceptable level of food security category but generally, they are food insure. Aboaba et al., (2020) noted that the bulk of food produced comes from rural areas; rural Nigerian households are at a high food insecurity level, which is a very alarming conclusion. The study also is consistent with findings by Ayoade and Adetunbi (2013) who reported that about 65% of farming households in south western Nigeria were food insecure.

The findings presented in Table 5 showed that the coefficient for livestock production participation was positive and significantly related with the status of food security among farmers in the study area. This implied that farmers who are into livestock production will probably be more food secured than their counterparts who were not into the production. The related may be related with the HDSS results where farmers were seen to consume average protein (meat and like products).

The coefficient of number of CSAPs adopted was found to be positively signed and significant t at 10% level of probability, indicating that with increased level of CSAPs adoption, the probability of food security among the smallholder farmers increased and vice versa. This positive relationship between no of CSAPs adopted and food security status of the smallholder farmers indicate that there is significant positive effect on the practice of climate smart agriculture on their food security status. This is in line with *a priori* expectations. This also agrees with the findings of Ekwe (2014), that income which is a proxy for food security is positively related to farmers' adoption of new technologies. This implies that income/food security encourages the adoption of improved technologies/CSAPs. On the other hand, increase in adoption of improved technologies could result in increase in yield as well as accruable income and by extension food security.

Conclusion: Climate Smart Agriculture (CSA) is an approach that is based on principles of sustainable development, with specific purpose of promoting agricultural practices, build resilience and reduce greenhouse gases while enhancing food security. The findings conclude that the adoption of climate Smart agricultural practices has significant positive effect on the food security of Smallholder Farmers in Imo State Nigeria. Therefore, the study conclude that farmers who adopt CSA practices are more food secured. It is therefore recommended that government at all level should ensure that adequate measures are put in place so that farmers would be aware of the CSA practices and their food security would be met

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Table 1 Socio-Demographic Characteristics of the small holder Farmers in Imo State

Variables	Mean	Std. dev	Minimum	Maximum
Age (years)	47.4250	18.1616	18.00	88.00
Household size(number)	5.7333	2.50	1.00	11.00
Education (years)	11.4833	4.9160	0.00	16.00
Farming experience (years)	25.1167	16.0954	3.00	55.00
Farm size (hectare)	1.5392	1.5467	0.01	8.00
Number of extension contact	3.7142	0.1625	0.00	10.00
Distance from home to main road (km)	6.4454	9.6587	0.000	60.00
Income (yearly)	280716.6667	210872.9030	50000	1,000,000
Dummy				
Sex (female)	67(55.80)			

Marital status (married)	81(67.50)
Membership of cooperation	49(40.80)
Ownership of land	75(62.50)
Access to credit facilities	65(54.20)
Access to labour supply	108(90.00)
Access to market	23(19.20)
Access to irrigation facilities	45(37.50)
Experienced insufficient rains	86(71.70)
Experienced flooding	106(86.30)
Experienced drought	64(53.80)
Participate in other off-farm activities	26(21.70)

Source: Field Survey, 2022
Figures in parentheses are the percentage values

Table 2: Participation in Climate Smart Agriculture among Small holder farmers in the Study Area

Climate Smart Agriculture practices	Frequency*	Percentage	Rank of Practice
Planting improved crop variety	**104**	**86.70**	**2***
Planting local varieties	92	76.70	7
Changing planting dates	56	46.70	22
Use if legumes in crop rotation	74	61.70	13
Moving to a different site	74	61.70	13
Intercropping	77	64.20	11
Water harvesting	47	39.20	25
Use of irrigation water	69	57.50	16
Use of organic manure	99	82.50	6
Planting shade trees on the crop land	67	55.80	18
Use of mulching	**104**	**86.70**	**2***
Changing the timing of farm operations	55	45.80	24
Planting disease resistant varieties	75	62.50	12
Using information from weather forecast	71	59.20	15
Efficient use of inorganic fertilizer and pesticide	92	76.70	7
Using organic fertilizer	**101**	**84.20**	**4***
Planting cover crops	**100**	**83.30**	**5***
Use of compost materials	**107**	**89.20**	**1***
Use of bio-cha	65	54.20	19
Use of terrace	69	57.50	16
Use of life/plant barrier	58	48.30	21
Use of zero tillage	56	46.70	22
Planting food crops and animals breeds	59	50.80	20
Use of diversified crops and animal breeds	92	76.70	7
Use of improved livestock breeds	92	76.70	7
Mean	**78**	**65.25**	

Source: Field survey, 2022
***Multiple Responses**
Note: 0 -33% = Low level of adoption
31 – 66% = moderate level of adoption
67 – 100%= high level of adoption

Table 3: Food Groups and Weight in HFCS and HDDS

Food group	**Consumption mean**	**Weight**	**HFCS**
Cereals and tuber	3	2	6
Pulses	2	3	6
Vegetables	4	1	4
Fruits	4	1	4
Meat and fish	1	4	4
Milk	2	4	8
Oil	3	0.5	1.5
Sugar	2	0.5	1
HFCS	**34.4421**		
Minimum	**14.00**		
Maximum	**64.50**		
Std. deviation	**11.7005**		

Source: Field survey, 2022

Table 4: Household Food Consumption Scores Threshold (n = 120).

Household Food Consumption Score (HFCS)	**Frequency**	**Percentage**

0<21 (poor)	17	14.10
21.5<35 (Borderline)	38	31.70
>/ 35 (acceptable)	65	54.20
Mean	34.4421	

Source: Field survey, 2022

Table 5: Logit Regression Estimates of the Determinants of Food Security among Small holder Farmers in Imo State, Nigeria

Variables	Parameters	Coefficient	Std. error	Z value
Constant	b_0	-1.3987	1.1193	-1.25
Age	X_1	-0.0277	0.0126	-2.16*
Sex	X_2	0.8720	0.3339	2.61**
Educational level	X_3	05371	01770	3.03**
Household size	X_4	0.0192	0.0637	0.30
Occupation	X_5	-0.1351	0.3422	-0.39
Availability of labour	X_6	0.2402	0.3532	0.68
Distance from house to market	X_7	-0.0258	0.0106	2.43*
Livestock production	X_8	0.4369	0.1923	2.27*
Access to credit	X_9	-0.1732	0.4057	-0.43
Access to market	X_{10}	-0.1326	0.4252	-0.31
Received palliative	X_{11}	-0.2129	0.2797	-0.76
Experience flooding	X_{12}	-0.0283	0.3784	-0.07
Experienced crop/animal disease	X_{13}	0.0878	0.5351	0.16
No CSAPs adopted	X_{14}	0.2247	0.0941	2.39*
Chi^2		45.20***		
Log likelihood		-59.681		
Pseudo R^2		0.5046		
Number of observation		120		

Source: STATA 13 Results. * and ** = Significant at 10% and 5% respectively.
Figures in parenthesis are t-values.