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Do climate-smart agricultural practices drive food security of maize farming households in Ogun state, Nigeria?

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ABSTRACT

Using multiple Climate-Smart Agricultural Practices (CSAP) have proven to be effective in combating the challenges of climate variability which affect the food security of smallholders, especially cereal farmers. Limited information exists on CSAP users and food security in Nigeria. Therefore, the effect of CSAP on food security among maize farmers in Ogun State, Nigeria was examined. Primary data was collected from 252 maize farmers with the aid of a well-structured questionnaire through a three-stage sampling procedure and analyzed using descriptive statistics, household dietary diversity score, Simpson index and ordered logit regression model. On the average, the maize farmers were 47 years old, had household size of five persons and farm size of 1.8ha. Most maize farmers were high users of CSAP (60.00%) and also food insecure (54.15%) due to low dietary diversity score while, 45.85% were food secure due to medium and high dietary diversity. The level of CSAP used, positively influenced the probability of being food secure at 5% significance level, alongside age and access to extension agents at 1% level. Being a male maize farmer and household size reduced the probability of food security at 1% level. It was concluded that Climate-Smart Agricultural Practices improve food security among maize farmers and should thus be encouraged. Food security programs among farmers should target older farmers and females while increasing access to extension services and enlightenment on birth control measures.

***Keywords**: Climate Smart Agricultural Practices, Food Security, Household Dietary Diversity Score, Maize farmers.*

INTRODUCTION

Maize is the most important staple in the world which, in combination with rice and wheat, supply 51% of global caloric intake (Pariona, 2019). Global maize production stands at about 800 million tons. The United States is the leading producer with 392 million tons; almost half of global production; followed by China and Brazil (Food and Agricultural Organization Statistical Division - FAOSTAT, 2020). Nigeria is the 16th largest maize producer in the world and the second largest producer in Africa, after South Africa, with annual production of about 10.16 million metric tons. However, Nigeria's maize yield ranks 117th with 2.1 tons/ha compared to the United States with 28.5 tons/ha and Egypt, which has the highest yield in Africa, of 7.1 tons/ha (FAOSTAT, 2020). Maize is largely produced by smallholder farmers in the northern region of Nigeria, followed by the Southwestern states of Ogun, Ondo, Osun and Oyo.

Maize has become crucial for food security in Nigeria as it is a leading crop for human and animal consumption (Global Agricultural Information Network – GAIN Report, 2017). National consumption is about 11.5 million tons annually (USDA, 2020), indicating a demand gap of about 1.3 million tons. Howbeit, 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 preferences for an active and healthy life (Clay 2002 in FAO, 2002). Household food security is thus, applying this concept to the family level and focusing on the individuals within households. When sufficient, safe and nutritious food is not available as stated, it results in food insecurity which is also sub-nutrition or hunger. About 821 million people in the world suffer extreme hunger. When the number of people who suffer from moderate food insecurity is included, there are over two billion food insecure people in the world (FAO, 2019). Africa has the highest prevalence with 31.3% of the global number of hungry people while 237 million are in Sub Saharan Africa alone (FAO-UNECA, 2018). Food insecurity has been worsening since 2015, particularly in West Africa, where the rise in the number of undernourished people contributed nearly half of the increase in Africa's hungry population (FAO-UNECA, 2018). Since Nigeria, accounts for half of the population in West Africa and is the most populous country in Africa, its contribution to the increasing hungry population is expectedly significant.

Food shortages have sparked several crises around the world at different periods in distant and recent history, such as the 2008-2009 global food crises which was largely due to climate change. The on-going change in climate has been emphasized as a major cause of food shortage across the globe. The International Food Policy Research Institute (IFPRI) estimates that by 2050 the combined effect of increasing temperature, declining rainfall, floods and droughts could result in declining yields of maize, rice and wheat by up to 22% and food availability will decline by 500 calories per person, about 21% decline (IFPRI, 2009). This indicates a potential threat to Nigerian's food security. Given that the prevalence of undernourishment is increasing in Nigeria as evidenced in the entire West African sub region (see Table 1), achieving and safeguarding food security is crucial if the country will meet the Sustainable Development Goal of zero hunger by the year 2030.

TABLE 1. **Prevalence of undernourishment (PoU) in the world, 2005–2018**

Prevalence of undernourishment (%)	2005	2010	2015	2016	2017	2018
WORLD	14.5	11.8	10.6	10.7	10.8	10.8
AFRICA	21.2	19.1	18.3	19.2	19.8	19.9
Northern Africa	6.2	5.0	6.9	7.0	7.0	7.1
Sub-Saharan Africa	24.3	21.7	20.9	22.0	22.7	22.8
Eastern Africa	34.3	31.2	29.9	31.0	30.8	30.8
Middle Africa	32.4	27.8	24.7	25.9	26.4	26.5
Southern Africa	6.5	7.1	7.8	8.5	8.3	8.0
Western Africa	12.3	10.4	11.4	12.4	14.4	14.7

Source: FAO (2019)

The prevailing variations in climate and the effect on food production especially among rural farmers, makes it imperative for Nigeria's agriculture to adopt approaches and strategies to either mitigate the negative effects on food security, or to cope with them. Climate-Smart Agriculture (CSA) is one of such approaches. The CSA approach refers to land management practices that increase food security, boost the resilience and adaptive capacity of farmer households to climate variability, and mitigate climate change (FAO, 2013). The use of CSA by farmers is expected to increase agricultural production and income sustainably, with consequent increase in farmers' food security, build resilience to climate change and reduce greenhouse gases (GHG) emission (Fanen *et al.*, 2014). Climate Smart Agricultural Practices (CSAP) according to FAO (2010) thus include; conservation agriculture, agroforestry, mulching, intercropping, integrated pest and disease management, crop rotation, integrated crop-livestock management, aquaculture, improved water management, better weather forecasting for farmers - and innovative practices (specifically application of green energy in agriculture).

Several challenges still exist to the use of CSAP among cereal farmers, especially maize farmers, including; the competing demands for CSA materials such as crop residues and the use of new and innovative farm inputs and implements which are not suitable for traditional practices of rural farmers (Nwajiuba *et al.*, 2015). Further, empirical evidence on the relationship between use of CSAP and food security is quite limited in Nigeria. Literature abounds on factors that determine food security of smallholder farmers including; farmers' experience, household size, educational status, sex and age (Oli *et al.*, 2018; Aromolaran *et al*, 2017; Osuji *et al.*, 2017; Oti *et al.*, 2017; Onasanya and Obayelu, 2016; Leza and Kuma, 2015; Ojeleye, 2015) whereas fewer studies have assessed effect of CSAP on food security such as Wekesa *et al.*, (2018) in Kenya and Abegunde *et al.*, (2019) in South Africa. The use of CSAP and farmers' willingness to accept incentives in Nigeria have been assessed (Tiamiyu *et al.*, 2018) but not food security. Therefore, there is a need to examine the effect of level of CSAP used on the food security of maize farmers in Ogun State, Nigeria.

MATERIAL AND METHODS

Study area

The study was conducted in Ogun State, located in the South West Zone of Nigeria. The State has a total land area of 16,409.26 square kilometers (about 1.8 percent of Nigeria's total land mass); situated between Latitude 6.2°N and 7.8°N and Longitude 3.0^{o}E and 5.0°E. The climate of Ogun State follows a tropical pattern. The raining season starts in March and ends in November, followed by dry season. The mean annual rainfall varies from 128 cm in the southern parts of the State to 105 cm in the northern parts. The average monthly temperature ranges from 23°C in July to 32°C in February. Ogun State has had significant climatic variations in temperature and rainfall (see Figure 1 in the Appendix) which have been argued to contribute to the poor plan operations of maize farmers (NIMET, 2016). Ogun state has a total of twenty (20) local government areas including urban and rural. Agriculture is the mainstay of the state's economy which provides the major occupation for the people especially in the rural areas. Important arable crops cultivated include; maize, yam, cassava, rice, cocoyam, groundnut and melon while the production of banana, plantain, oranges, kola nuts, sugar-cane and pineapple are also common in the state (Solanke 2015).

Sampling procedure and data

Primary data was collected for the study from maize farmers who were household heads in Ogun state, through the use of well-structured questionnaires. A multi-stage random sampling technique was employed to select the respondents for the study. The first stage was a random selection of four (4) rural local government areas; Odogbolu, Ifo, Yewa South and Yewa North local government areas. The second stage involved the random selection of three (3) communities in each of the local government areas (Igan-Okoto, Oja-Odan, Ibese, Oke-Odan, Owo, Agosu, Imosan, Imodi, Ayepe, Coker, Ajibode and Akinsinde). In the third stage, twenty-one (21) households were randomly selected in each community, resulting in a total of 252 households. Data on socio economic characteristics, CSAP use of the maize farmers and food consumption of the households were collected. After data cleaning, 205 households gave complete information and were used for the analysis.

Data analysis

The data analysis was achieved using Descriptive statistics, Principal Component Analysis (PCA), *Household dietary diversity score, Simpson Index and Ordered logit Regression.*

The Descriptive statistics was used to profile the socio-economic characteristics of the maize farmers.

The PCA was used to obtain indices for the level of CSAP used by the maize farmers. Categorization of level of CSAP used was done using the mean of the indices as threshold. A farmer with an index greater than or equal to the mean value was categorized as high user and less than mean value was categorized as low user.

The Food security level of the household was estimated with the aid of Household Dietary Diversity Score (HDDS). The HDDS was developed in 2006 as part of the Food and

Nutrition Technical Assistance (FANTA) II project as an indicator of household food access. Household dietary diversity can be described as the number of food groups consumed by a household over a given reference period, and is an important indicator of food security. Following FAO (2007; 2008; 2009), the food items consumed by any member of the household in the preceding 24-hour period were clustered under nine (9) food groups namely: Cereals and grains, Roots and tubers, Legumes and nuts, Vegetables, Fruits, Meat, Fish, Seafood and eggs, Milk and other dairy products, Oils, butter and fats. Based on whether each maize farming household consumed any food item in the food groups, the HDDS has a score ranging from zero to nine (0-9), following IFPRI (2006) and Huluka and Wondimagegnhu (2019). Their HDDS was then calculated thus:

$$HDDS = \sum_{i=1}^{9} Foodi \quad (2)$$

Where:

$Food_i$= i^{th} food group consumed per individual

s= total number of food groups consumed.

The food score was determined using Simpson index, the score result represents the diet diversity of intake not quantity, though such scores have been shown to be significantly correlated with caloric adequacy measures (IFPRI 2006). It is specified as:

$$D = \frac{1}{\sum_{i=1}^{s} Pi^2} \quad (3)$$

Where:

D = dietary score

P = is the proportion ($Food_i$/N)

$Food_i$ = number of food group consumed per individual

N= total number of individuals found

s = is the number of food groups (9).

The cut-off values for categorizing the maize farmers as low/poor dietary diversity, medium dietary diversity and high dietary diversity followed IFPRI, WFP (2014) as shown on Table 2. Hence, farmers having dietary score of less than 4.5 were categorized as low/poor dietary diversity, indicating food insecure farmers. Maize farmers having dietary score of between 4.5 to 6 were categorized as medium dietary diversity while those with dietary score greater than 6 were categorized as high dietary diversity. Farmers of medium and high dietary scores were categorized as food secure.

TABLE 2. **Categorization of food security level**

S/N	Food security status	Categorization scale
1.	High or Good dietary diversity	> 6
2.	Medium or moderate dietary diversity	4.5 – 6
3.	Low or poor dietary diversity	Less than 4.5

Source: IFPRI, WFP (2014)

The effect of level of use of CSAP on food security was examined using ordered logit regression model. Using the three categories of diet diversity for household food security as the dependent variable *Y**. Following (Gujarati, 2008 and Greene, 2012) the model is specified as:

$$\gamma *= X^T\beta + \varepsilon \quad (4)$$

Since *Y** cannot be observed, we instead observe the categories of response for food security (low, medium and high diet diversity).

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \varepsilon_i \quad (5)$$

Y_i = Food security status (1=low dietary diversity; 2 = medium dietary; 3= high dietary diversity)
X_1 = Age (Years)
X_2 = Gender (1=male; 0=female)
X_3 = Marital status (1=married; 0= otherwise)
X_4 = Household size (number of persons)
X_5 = Years of farming experience (years)
X_6 = Access to extension service (1= Yes; 0= otherwise)
X_7 = Farm size (Hectare)
X_8 = Member of cooperative (1= yes; 0= otherwise)
X_9 = Access to credit (1= Yes; 0= otherwise)
X_{10} = CSAP level of use (1=high user, 0=low user)
Ei = error term.

The definition of variables and *a priori* expectation are presented on Table 3.

TABLE 3. **Definition of variables and *a priori* expectation.**

Variable	Definition	Expected sign
Y - Food security level	0=low dietary diversity; 1 = medium dietary; 2= high dietary diversity	+
Age	Years	+
Gender	1=male; 0=female	+
Marital status	1=married; 0= otherwise	+
Household size	number of persons	-
Maize farming experience	Years	+
Access to extension service	1= Yes; 0= otherwise	+
Farm size	Hectare	+/-
Member of cooperative	1= yes; 0= otherwise	+
Access to credit	1= Yes; 0= otherwise	+
CSAP level of use	1=high user, 0=low user	+

RESULTS AND DISCUSSION

Distribution of maize farmers' food security level

The distribution of food security level among the maize farmers is shown on Table 4. The results reveal that 54.15% of the maize farmers had low dietary diversity score, 22.93% had medium dietary diversity while 22.93% had high dietary diversity score. This indicates that the level of food insecurity among the households is high, as most of them have low dietary diversity score. This agrees with Akerele *et al.* (2013) who reported food insecurity for more than half of Nigerian households.

TABLE 4. **Distribution of food security status of maize farmers**

Dietary Diversity Group	Frequencies	Percentages
Low dietary diversity	111	54.15
Medium dietary diversity	47	22.93
High dietary diversity	47	22.93
Total	205	100

Source: field survey, 2018

Description of socio-economic characteristics of respondents

The socio-economic characteristics of the maize farmers by food security level as presented on Table 5 showed that on the average, the maize farmers were aged about 47 years. This shows that the farmers are still in their productive ages. Ability to work and contribute to the economy is expected to have positive implications for food security (Oti *et al.*, 2017), although; most farmers having low dietary diversity (63.06%) and medium dietary diversity (51.06%) fell within the age group of 41-50 years. Low dietary diversity also occurred for most farmers who were male (85.59%) and married (82.88%). Traditionally, males have the responsibility of catering for others especially when they are married. This may have implications for food security in the event of negative income effects. In the same vein, the household size was about 5 persons with most households of low dietary diversity (49.55%) having between 4-6 persons, while most households with medium dietary diversity (61.29%) had only between 1-3 persons. Food security level is expected to rise with a fall in household size (Leza and Kuma, 2015) due to a smaller number of dependents to spread the household income over. With respect to maize farming experience which averaged about 19 years, most (48.94%) farmers having high dietary diversity had been in maize production for about 11-20 years. Experience is expected to improve farmers' production activities and have positive effects on their welfare and food security level (Aromolaran *et al.*, 2017). Access to extension services was high among the farmers especially among all farmers with medium dietary diversity and 95.74% of farmers with high dietary diversity. Access to extension services is expected to improve farmers' knowledge of farm innovation which should have positive implications on their welfare and food security. The average farm size was 1.8 ha, indicating that most maize farmers were smallholders. Most farmers having low (63.06%), medium (82.99%) and high dietary diversity (78.72%) cultivated farm sizes of between 1.01-2 ha. Smallholders are expected to suffer food insecurity compared to medium and large holders of farm land (Osuji *et al.*, 2017). Further, most farmers with high dietary diversity (72.34%) had access to credit whereas, most farmers with medium dietary diversity (55.32%) had no access to credit. Access to credit is expected to improve upon the food security level due to availability of more funds to expand production, income, food consumption and consequently, food security. Finally, most maize farmers with high dietary diversity (89.36%) were members of cooperatives. Cooperative membership is expected to improve food security due to the information sharing that usually occurs in such social groups.

TABLE 5. **Socio-economic characteristics of farmers by food security level**

Variables	Low dietary diversity	Medium dietary diversity	High dietary diversity	Mean
Age				
30 - 40	16 (14.41)	19 (40.42)	9 (19.15)	
41 - 50	70 (63.06)	24 (51.06)	19 (40.42)	
51 - 66	25 (22.52)	4 (8.51)	19 (40.42)	46.5±7.1
Gender				
Female	16(14.41)	11(23.40)	9(19.15)	
Male	95(85.59)	36(76.60)	38(80.85)	
Marital status				
Single	5(4.50)	10(21.28)	4(8.51)	
Married	92(82.88)	32(68.09)	37(78.72)	
Separated	12(10.81)	3(6.38)	3(6.38)	
Widowed	2(1.80)	2(4.26)	3(6.38)	
Household size				
1 - 3	7(6.31)	19 (61.29)	5(10.64)	
4 - 6	55(49.55)	26(24.76)	24(51.06)	
7 - 11	49(44.14)	2(4.26)	18(38.30)	5.4±1.7
Farming experience (Years)				
1 – 10	10(9.01)	18(38.30)	7(14.89)	
11- 20	51(45.95)	19(40.42)	23(48.94)	
20 – 40	50(45.05)	10(21.28)	17(36.17)	19.4±7.6
Access to extension				
No	23(10.72)	0(0.00)	2(4.26)	
Yes	88(79.28)	47(100.00)	45(95.74)	
Farm size (Ha)				
0 - 1	20(18.02)	7 (14.89)	4(8.51)	
1.01 - 2	70(63.06)	39(82.99)	37 (78.72)	
2.01 - 3	21(18.92)	1(2.13)	6 (12.77)	1.8±0.5
Access to credit				
No	47(42.34)	26 (55.32)	13(27.66)	
Yes	64(57.66)	21 (44.68)	34(72.34)	
Membership of cooperative				
No	25 (22.52)	2 (4.26)	7 (14.89)	
Yes	86 (77.48)	45 (95.74)	42 (89.36)	

Source: Field survey, (2018). Figures in parenthesis represent percentages

Distribution of maize farmers' level of CSAP use

The level of CSAP use by maize farmers is presented on Table 6. The results reveal that most of the farmers (60%) are high users of CSAP. This is contrary to Tiamiyu *et al*. (2018) who found low CSAP use among farmers but follows relatively closely with Abegunde *et al*. (2019) who found medium use of CSAP with most farmers. High use of CSAP among the maize farmers may expectedly have positive implications for the food security level among the maize farmers.

TABLE 6. **Level of CSAP use among maize farmers**

Categorization of Level of use of CSAP	Frequencies	Percentages
Low user	82	40.00
High user	123	60.00
Total	205	100

Source: Field survey, 2018

Distribution of maize farmers' food security level by their level of CSAP use

The distribution of food security status of maize farmers by their level of use of CSAP is presented on Table 7. A higher proportion of low users of CSAP (54.88%) have low dietary diversity compared to the high users of CSAP (53.65%). Further, a higher proportion of farmers with high dietary diversity (31.71%) are high users of CSAP compared to the low users of CSAP who have high dietary diversity (9.76%). It is plausible that high level use of CSAP should improve the likelihood of food security among the farmers due to the mitigation effects of climate variability on the soil environment which should improve yield, output, income and food security (Elizabeth and Sophie, 2014).

TABLE 7. **Distribution of food security status of maize farmers by their level of use of CSAP**

Food security status	Low user	High user	Total
Low dietary diversity	45(54.88)	66(53.65)	111(54.15)
Medium dietary diversity	29(35.37)	18(14.63)	47(22.93)
High dietary diversity	8(9.76)	39(31.71)	47(22.93)
Total	82(100.00)	123(100.00)	205(100)
Pearson chi2(2) =19.5773			
Pr = 0.000***			

Source: Field survey, (2018). Figures in parenthesis represent percentage distribution.

Effect of level of CSAP use on food security level of maize farmers

The estimates of the ordered logit regression showing the effect of level of CSAP use on food security level of maize farmers are revealed on Table 8. The diagnostic statistics reveal a Pseudo R^2 of 0.1032 while the log likelihood of -185.2206 and the chi square statistic of 42.65 were significant at 1%, indicating the appropriateness of the model. The results revealed that aside from marital status, farm size, cooperative membership and access to credit, all other explanatory variables had statistically significant effects on food security level. These included: level of use of CSAP, age, gender, marital status, household size, and access to extension of the maize farmers.

The level of use of CSAP was positive and statistically significant at 5%. This indicates that being a high user of CSAP decreased the probability of having low dietary diversity by 4.6%. However, it increased the probability of having medium and high dietary diversity 1.1% and 3.5% respectively. This makes sense considering the fact that CSAP help to reduce the negative effects of climatic variations such as excessive temperature which could affect yield, income and consequently food security level of the farmer's household. Thus, encouraging high level of CSAP use among maize farmers will enhance their food security level. This is in agreement with Elizabeth and Sophie (2014) that CSAP improves food security. Similarly, age was positive and significant at 1%. An increase in age of the maize farmers by one year decreased the probability of having a low dietary diversity by 1.9%, but increased the probability of having medium and high dietary diversity by 0.4% and 1.4%, respectively. The result also showed that gender was negative and statistically significant at 1%. This indicates that being a male maize farmer increased the probability of having low dietary diversity by 19.4%. However, it decreased the probability of having medium and high dietary diversity by 2.2% and 17.1% respectively. Older farmers are likely to be more experienced and knowledgeable in maize production and this positively affects incomes and food security (Osuji *et al.*, 2017).

The result also showed that household size was negative and significant at 1%. This indicates that an addition of one member to the household increased the probability of having low dietary diversity by 6.8%. However, a 1% increase in the household size decreased the probability of having medium and high dietary diversity by 1.6% and 5.2% respectively. This is plausible considering the fact that additional household members can exert pressure on limited household income thereby reducing the proportion of food available to each household member. This result agrees with Beyene and Muche (2010) and Aidoo *et al*. (2013) that large household sizes affect household food consumption and results in food insecurity. Further, the result revealed that access to extension was positive and significant at 1%, indicating that if maize farmers have access to extension services, the probability of having low dietary diversity is decreased by 40.5%. Access to extension services also increased the probability of having medium and high dietary diversity by 18.3% and 22.1%, respectively. Extension services to maize farmers avail them of the knowledge of improved inputs, new techniques of farming as well as important information on maize production that can help to boost their food production and marketing with consequent increase in their food security level. This agrees with Ahmed *et al*. (2015) who found that extension agent contact ultimately influences the level of farm output and income earning capacity of farming households, and hence improves food security of the farmers.

TABLE 8. **Ordered logit regression estimates for the effect of level of CSAP use on food security level**

Variables	Coefficient	Standard Error	Z-value	P>Z Value	Marginal effect (low dietary diversity)	Marginal effect (medium dietary diversity)	Marginal effect (high dietary diversity)
Level of use of CSAP	0.2256**	0.1194	1.89	0.059	-0.0460	0.0110	0.0350
Age	0.0936***	0.0312	2.99	0.003	-0.0191	0.0045	0.0145
Gender (Male)	-0.9740***	0.4431	-2.2	0.028	0.1942	-0.0226	-0.1715
Marital status (Married)	-0.5776	0.5134	-1.12	0.261	0.1183	-0.0193	-0.0990
Household size	-0.3360***	0.1273	-2.64	0.008	0.0686	-0.0164	-0.0522
Farming experience	-0.0234	0.0285	-0.82	0.411	0.0047	-0.0011	-0.0036
Access to extension	2.4468***	0.8524	2.87	0.004	-0.4054	0.1837	0.2216
Farm size (Ha)	-0.0545	0.3632	-0.15	0.881	0.0111	-0.0026	-0.0084
Cooperative membership	0.3257	0.5203	0.63	0.531	-0.0667	0.0187	0.0480
Access to credit	-0.1255	0.3438	-0.37	0.715	0.0255	-0.0059	-0.0196
Log likelihood= -185.2206	**Pseudo R2= 0.1032**	**Prob> chi2= 0.0000**	**LR chi2(12)=42.65**				

Source: field survey, 2018. **** significance at 5% level, *** significance at 1%level**

CONCLUSION AND RECOMMENDATIONS

The study examined the effect of climate smart agricultural practices on food security level among maize farmers in Ogun State. Most maize farmers in the state were high users of climate smart agricultural practices. It was also established that most maize farmers had low dietary diversity, hence, were food insecure. The probability of being food secure was enhanced by being a high user of climate smart agricultural practices, age, being a male farmer and access to extension services while household size reduced the probability of food security of the farmers. Therefore, it is recommended that for increased food security among maize farmers, government and non-governmental agencies should encourage high use of climate smart agricultural practices. Further, female farmers should be targeted for food security programs. The government should pursue policy options that increase maize farmers' access to extension services while also providing enlightenment to the farmers on birth control measures in order to reduce their household sizes.

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COMPETING INTEREST

The authors have no conflict of interest around the study.

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APPENDIX

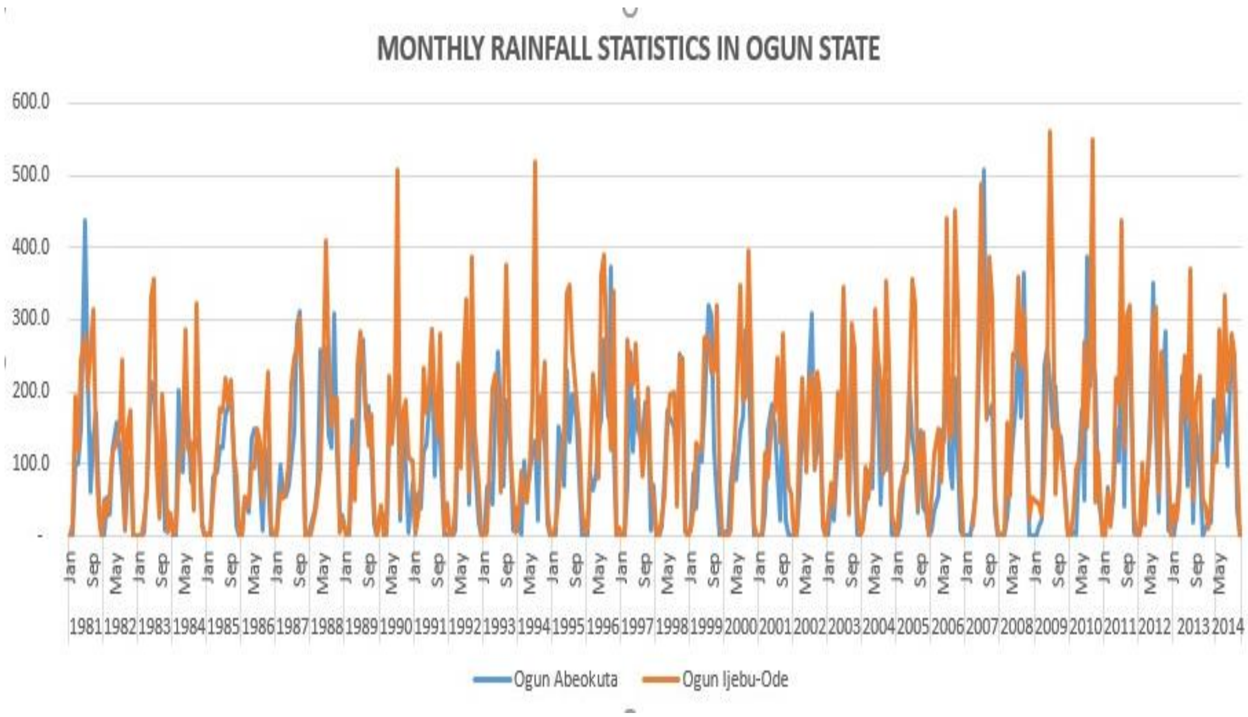

Figure 1: Annual Rainfall Statistics

Source: Author's computation, Data from NIMET (Nigerian meteorological agency)