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IMPLICATIONS OF CLIMATE CHANGE ON FOOD SECURITY IN TARABA SOUTH, NIGERIA

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ABSTRACT

The study examined the implications of climate change on food security of rural farming households in the Southern part of Taraba State. A multistage random sampling technique was employed to select 160 cassava farming households from four wards spread across two Local Government Areas in the southern part of Taraba State. Descriptive statistics, food security index, Logit regression model and correlation matrics were used to analyze the data. Results of the study showed that majority of the household heads (95.6%) were men, about 56% were within their economic active age of 31-50 years and 34% of the respondents had no education. About 54% of the households had 6–10 members and 63.75% respondents earned monthly income between ₦50,000 – ₦99,999. The level of food insecurity was high in the study area as only 20.63% of households were food secure. The Logit regression revealed that 12 out of 15 variables included in the model were significant at 1% and 5% in explaining the variation in food security status of households. Temperature and rainfall in the study area from 1983–2012 had an increasing trend at 0.25^{0}C and 0.129mm respectively. Temperature and rainfall were positively correlated to cassava yields at 0.56 and 0.65respectively and both were significant at 1%. Policies for reducing poverty and ensuring food security need to include ensuring improved educational level through adult education and training, exploring income diversification opportunities, increased awareness and access to better family planning facilities and evolving climate change strategies to provide farmers with early warning signals via organized extension service programmes.

Keywords: Food Security, Climate Change, Farm Productivity, Implications, Farming Households.

INTRODUCTION

Food security is an essential element of overall well being. Increasingly, in the last decade, attention has been focused on means of eliminating food insecurity and hunger worldwide. The idea of food security was presented for the first time in the World Food Conference in 1974 and viewed solely from the perspective of having adequate availability of food on a national scale. Today it is a condition in which all people have access at all times to enough food of an adequate nutritional quality for a healthy and active life (Adebayo, 2010). FOA's vision of a world without hunger is one which most people are able by themselves to obtain the food they need for an active and healthy life and where social safety nets ensures that those who lack resources will get enough to eat" (FOA, 2007).

The 1992, International Conference on Nutrition and the 1996 World Submit both emphasized the central need to decrease food insecurity and hunger globally. Certainly we have not succeeded in achieving this goal. Even the modest ambition of the hunger target of the Millennium Development Goals – having the number of people who suffer from hunger between 1990 and 2015 reduced – is also unlikely to be met on a global basis. Progress in reducing the global prevalence of under nourishment has slowed: the share of undernourished

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people in developing regions has remained essentially constant at about 16 per cent since 2000, after declining from 20 per cent in 1990 and has increased during the global financial crises that began in the late 2000's. The share of the population that is under nourished is highest in sub-Saharan Africa followed by South Asia (Emaziye, 2013).

Agriculture is the main source of food, industrial raw materials in Nigeria. It is predominantly a rain fed system and hence vulnerable to climate changes (Ibrahim *et al.,* 2010). Climate change and variability is a major threat to food security in many parts of the country which are largely dependent on rain fed and labour intensive agricultural production. Climate change refers to any variation in climate over time, weather due to natural variability or as a result of human activities (IPCC, 2001a; 2001b). Climate change and agriculture are inter-related processes, both of which takes place on a global scale. The main climate elements in agriculture are temperature, moisture, sunlight, wind and evaporation. Warming of the climate system is unequivocal as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising sea level consequently leads to increased rainfall and increased rainfall would lead to frequent flood and drought resulting in variability in crop yields in different ecological systems. Climate change in the form of higher temperatures, reduced rainfall and increased rainfall variability, reduces crop yields, reduces net farm revenues and threatens food security in low income based economies including African countries (FAO, 2007 and Achike, 2014). At the recently concluded 10^{th} session of IPCC WG II and the 38^{th} session of IPCC in Yokuhama, Japan, the world was warned that climate change impacts are leading to shifts in crop yields, decreasing yields overall and sometimes increasing them in temperate and higher latitudes. In light of these, some indigenous communities in Taraba State, Nigeria are adopting and changing hunting patterns to adapt to changes in rainfall and temperature.

Evidence has shown that climate change is already affecting crop yields in many countries. This is particularly true in low income countries where climate is primarily determinant of agricultural productivity and adaptive capacities are low. (Apata, 2010). Nigeria has not suffered the famine woes of its neighbors Niger or Chad, but its hunger profile is not good, and climate change is worsening it. Some 85 per cent of all Nigerian agriculture is rain fed, and many crops are sensitive to even tiny shits in rainfall and temperature. Available evidence shows that Nigeria is already being plagued with diverse ecological problems which have been directly linked to the on-going climate change. The Southern ecological zone of Nigeria largely known for high rainfall is currently confronted by irregularity in the rainfall pattern, while the Northern zone faces the threat of desert encroachment at a very fast rate per year occasioned by fast reduction in the amount of surface water, flora and fauna resources on land (FME, 2004; Obioha, 2008 as cited in Bello *et al,* 2013). All of these occur as production of staples like maize and yam is already stagnant. Productivity per hectare is low by commercial standards.

With nearly 70% of Nigeria's population dependent on agriculture and the sector contributing nearly 40% of the country's GDP, Nigeria remains vulnerable to climate variability and long term climate change. A decline in rain fed agriculture could be as high as 50% in some parts of Nigeria, unfortunately credible reports from Nigerian Meteorological Agency, NIMET (2012a) offered no much hope. The economic cost of degradation and poor management of renewable natural resources was at least 6.4% of GDP in Nigeria. Annual cost of yield decline as a result of environmental or land degradation from 1995-2004 was estimated at ₦210 billion. More than 60 per cent of this cost was attributed to root and tubers. The economic effects of climate change at the micro enterprise level can be gleaned from effects

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on farm net revenues. In similar vein, climate change adaptation could cost $100 billion globally (IPCC, 2014). This paper is therefore poised to examine the implications of climate change on food security of farming households in Taraba South, Nigeria. The specific objectives were to examine the socioeconomic characteristics of respondents; measure the food security status of the respondents; examine the determinants of food security among farming households; examine trends of climate variables in the study area; and estimate the influence of climate factors on farm productivity of the respondents.

METHODOLOGY

The Study Area

Taraba state is located at the North eastern part of Nigeria. It lies between $6^{o}25`$ and $9^{o}30`$ North and between longitude $9^{o}30`$ and $11^{o}45`$ East of the Greenwich Meridian. The State shares boundaries with Bauchi and Gombe States in the North, Adamawa State in the east and Cameroon Republic in the south. The State is bounded along its western side by Plateau, Nassarawa and Benue States. The State has a land area of 54, 428km^2, with a population of about 2,300,736 people according to the 2006 census. Taraba has 16 Local Government Areas with Jalingo as the State capital. The major occupation of the people of Taraba State is Agriculture. Cash crops produced in the State include coffee, tea, groundnuts and cotton. Crops such as maize, rice, sorghum, millet, cassava, and yam are also produced in commercial quantity.

Sampling Procedure

Multi-staged sampling technique was employed in this study. Purposive sampling was used in the first stage to select two Local Government Areas (LGAs) from Southern Taraba namely Ibi LGA and Takum LGA. The LGAs selected were those that have been affected by draught and or flood. In the second stage, purposive sampling was also used to select two wards from each of the LGAs. The selected wards were Dutse and Tikari in Takum LGA, and Wanu and Dampar in Ibi LGA. Random sampling was used in the third stage to select 40 farming households in each ward, making a total of 160 households. The target households selected in these wards were predominantly cassava farmers in both local government areas, as cassava is one of the major food crops grown in the region, which has mostly been affected by flood and or drought.

Sources of Data

Both primary and secondary data were used for this study. The primary data was gathered from households using well structured questionnaires. Data were collected on the socioeconomic characteristics of households, demographic characteristics, the determinants of their food security and their coping strategies to flood and drought. The secondary data used for this study were the annual mean time series data from Nigerian Meteorological Agency (NIMET) that included the following; temperature, and rainfall, and also annual yields of cassava farmers were collected from the National Bureau of Statistics.

Analytical Techniques

Four analytical techniques were employed in the study. These include;

- **i.** Descriptive statistics
- **ii.** Food security index

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iii. Correlation matrix
iv. Logit Model

Descriptive Statistics

This was used to examine the socioeconomic characteristics of the respondents examine trends of climate variables and examine the coping strategies employed by household farmers in the study area. These included the use of Tables and percentages and line graphs.

Food Security Index

Food security index was used to determine the level of food insecurity among the cassava farming households that have been affected by flood and or other climate hazard. Food security equation used by Emaziye *et al*. (2013) was adopted for this study. The equation was stated as:

$$C^* = C_j - Y_j \qquad (1)$$

Food security indicator for this study was defined by frequency and the number of different food consumed over a period of time (24 hours) where,

C^* = Food security index of cassava farming household
C_j = Quantity of food consumed (N = 1-5)
Y_j = Expected required food to be consumed (N = 5)
If $C^* = 0$ = The household will be said to be a food secured household
If $C^*<0$ = Then the household will be said to be food insecure
The required food = carbohydrate, protein, fat and oil, vitamin and minerals.

There are basically four ways of measuring household food security status; among them is dietary diversity which involves determining the frequency and the number of different foods consumed by an individual over a period of time. Dietary diversity method of measurement was preferred to other methods as it is very difficult to calculate exactly the quantity of rural household food consumption in kilogram's or calories as most daily food consumed by the rural farming households are not measured (Emaziye *et al*., 2013). Therefore, food security index of the rural farming household were obtained based on the frequency and the number of different foods consumed by household over a period of 24 hours (carbohydrate, protein, fat and oil, vitamins and mineral). Water was excluded as all the rural households consume water daily; hence a food secured household is expected to consume all the 5 categories (carbohydrates, proteins, fat and oil, vitamins and minerals).

Expected required food to be consumed (Y_j) = 5
Quantity of food actually consumed daily (C_j) ranges from 1 to 5
Food security index of rural household ($C^* = C_j - Y_j$) = 5-5 = 0 (food secured household)
While $C^*<0$ is food insecure household.
For the purpose of this study the food insecure household category was further categorized into mild food insecure, moderately food insecure and severely food insecure household.
Food security index of rural household ($C^* = C_j - Y_j$) = 4-5 = -1 (Mildly food insecure)
Food security index of rural household ($C^* = C_j - Y_j$) = 3-5 = -2 (Moderately food insecure)
Food security index of rural household ($C^* = C_j - Y_j$) = 2- 5 = -3 (Severely food insecure)

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Logit Model

Based on the results from the food security index, the Logit model was employed to identify the determinant of food security among farm households as employed by Ahmed *et al.* (2014a). The implicit form of the model is given as:

$$Z_1 = \beta X_1 + U_1 \quad (2)$$

Where:
Zi = the food security status of the i^{th} household (1 = food secured, 0 if otherwise)
Xi = Vector of explanatory variables
β = Vectors of the parameter estimates.
U_i = the error term
The explanatory variables included in the model are:
X_1 = Age of household head (years) (AGE)
X_2 = Gender of household head (X2) (GEND)
X_3 = Child Dependency Ratio (CDR)
X_4 = Household size (Number) (HASZ)
X_5 = Level of education (in years) (EDU)
X_6 = Income of household (₦) (HHINC)
X_7 = Farm size (Ha) (FASZ)
X_8 = Membership of Cooperatives Society (D = 1 if yes, D = 0 if otherwise) (COOPMEM)
X_9 = Access to Credit/Loan facilities (D = 1 if yes, D = 0 if otherwise) (CREDIT)
X_{10} = Years of farming experience (years) (FARMEXP)
X_{11} = Household asset (₦) (ASSETS)
X_{12} = Household access to extension agents (D = 1 if yes, D = 0 if otherwise) (EXTAG)
X_{13} = Household production enterprise (D = 1 if farming enterprise only, D = 0 if otherwise) (PRODENT)
X_{14} = Fertility of farmland (D = 1 if fertile, D = 0 if otherwise) FAFERT
X_{15} = Off farm activities (D = 1 if yes, D =0 if otherwise)

Correlation matrix

Correlation matrix was used to determine the relationship between temperature, rainfall and the yields of cassava in the State. It helped to show the relationship between temperature, rainfall and the yield of cassava in the state.

$$Y = A_0 + A_1X_1 + A_2X_2 + e \quad (3)$$

Where:
Y = yield of cassava (Kg/Ha)
X_1 = temperature (^{0}C)
X_2 = rainfall (mm)
e = error term
A_0, A_2 and A_2 = model parameters

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RESULTS AND DISCUSSION

Socioeconomic Characteristics of Rural Cassava Farming Households

Table 1: Gender of Household Heads

Gender	Frequency	Percentage
Male	153	95.6
Female	7	4.4
Total	**160**	**100**

Source: Field Survey, 2015.

The frequency distribution presented in Table 1 showed that 95.6% of household heads were males and only 4.4% of the household heads were females. The causes of female headed households in recent years include death of male counterparts, unpartnered adolescence fertility and family disruption. Based on the African cultural and religious beliefs that confer household headship and the responsibilities of sustaining the households to men, it is expected that households headed by men will be more food secure than their female counterparts.

Table 2: Age of Household Heads

Age (years)	Frequency	Percentage
21- 30	16	10
31 – 40	61	38.12
41 – 50	44	27.50
51 – 60	20.0	32
61 and above	7	4.4
Total	160	100

Source: Field Survey, 2015.

Table 2 revealed that about 66% of the respondents were from the age group of 31–50 years which implies that majority of the household heads were within their economic active age. This is a criterion that is meant to enhance their production and in turn their food security. However, older household heads are expected to have better access to land and better farming experience than younger household heads.

Table 3: Educational Level

Education (years)	Frequency	Percentage
No education	54	33.75
Pri. School (not completed)	5	3.13
Pry. School (completed)	6	3.75
Sec. School (completed)	22	13.75
Post. Secondary	51	31.88
Quranic	17	10.62
Total	**160**	**100**

Source: Field Survey, 2015.

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In Table 3, the results showed that about 34% of the respondents had no formal education and only about 32% had post secondary education. Education is an additional factor which is expected to influence the food security status of households. The awareness of food groups necessary for human growth and well being may be dependent upon the level of education of the household head. The knowledge of these food groups ultimately influences nutritional decisions that will enhance the quality of food intake.

Table 4: Household Size

Household Size	Frequency	Percentage
1 – 5	7	4.37
6 – 10	86	53.75
11 – 15	63	39.38
16 – 20	4	2.50
Total	**160**	**100**

Source: Field Survey, 2015.

Table 4 revealed that 53.75% of respondents had 6–10 members per household while 39.38% of respondents had 11–15 members per household. The extended nature of families living in rural areas could be the main reason for large household sizes. Household size can influence food security of farmers both positively and negatively. Positively in the sense that larger households tend to have adequate man power in farming activities which in turn is expected to increase their productivity and food security. Negatively, larger household tend to exert more pressure on the household head as food requirements increases with the number of persons in the households.

Table 5: Farm Size

Farm Size (ha)	Frequency	Percentage
Less than 1	38	23.7
1-2	73	45.6
2-3	38	23.8
3-4	9	5.6
4 and above	2	1.3
Total	**160**	**100**

Source: Field Survey, 2015.

In Table 5, results revealed that 23.7% of the respondents has less than one hectare of land while 45.6% had more than one hectares land. The farm size is an important criterion that is expected to enhance the food security of rural farming households. Table 5 showed that majority of the farming households were subsistent farmers and only a few were commercial farmers. Cultivating small farm sizes result in small output which implies low income levels and consequently high probability of being food insecure.

Table 6: Farming Experience

Farming Experience (years)	Frequency	Percentage
1 – 3	6	3.75
4 – 6	16	10.0
7 – 9	21	13.12
10 and above	117	73.12
Total	**160**	**100**

Source: Field Survey, 2015.

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Only about 13% of the respondents had farming experience of 7 – 9 years while majority of the respondents (about 73%) had farming experience of more than 10 years as represented in Table 6. It is expected that as farming experience increased, the farmers would develop new and better skills which will help to improve their productivity most especially in terms of flooding and drought. Farmers with more farming experience can easily predict when the rainy season starts and stops. They can use this to prevent dry spells at the onset of farming season and can also plant on time to avoid shortage of rainfall. Therefore as farming experience increases, the food security status of households is expected to be better.

Table 7: Child Dependency Ratio

Dependency Ratio	Frequency	Percentage
0 (none)	8	5.0
0.01 – 0.49	35	21.9
0.5 – 0.99	22	13.8
1.0 and above	95	59.4
Total	**160**	**100**

Source: Field Survey, 2015.

Table 7 showed that only 5% of the respondents had no dependant and majority of the households (59.4%) had a CDR of 1.0 and above. This implies that majority of the household heads in the study area have a lot of dependents. A high child dependency ratio exerts stress or burden on the household income, as the dependent populations do not contribute financially to the up keep of the house. Therefore households with high dependency ratio were prone to food insecurity.

Table 8: Household Monthly Income

Household Monthly Income (₦)	Frequency	Percentage
Less than 50, 000	2	1.25
50,000 – 99,999	102	63.75
100, 000 – 149,999	30	18.75
150,000 – 199,999	5	3.12
200,000 and above	4	2.5
Total	**160**	**100**

Source: Field Survey, 2015.

About 63.75% of respondents earned between ₦100,000 – ₦199,999 monthly as shown in Table 8. Since rural cassava farmers had no fixed income, their monthly income levels were calculated based on the amount of yields (in bags) they were able to produce and sell in the previous farming seasons. According to Engel’s law, as income rises, the proportion of income spent on food falls, even if actual expenditure on food rises. In other words, as the income of a household increases, the household consumption increases and so does it savings. It is therefore expected that an increase in the income of farming households will lead to an increase in their food security.

Table 9: Frequency Distribution of Household Assets

Assets	Frequency*	Percentage
Livestock	120	23.5
Extra land	76	14.9
Motor cycle	142	27.8
Motor vehicle	20	3.9
Radio/TV set	152	29.8

*** Multiple responses existed:** **Source: Field Survey, 2015.**

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The commonest assets owned by respondents in the study area as shown in Table 9 were mostly livestock (Cows, goats, chickens, sheep and pigs). Other household assets included extra land, motor cycles and radio/television set for those households with higher income levels. The significance of household ownership of assets hinges on the fact that households could liquidate these assets during emergencies (poor harvest, sickness, natural disaster, etc). Household assets therefore become a critical factor in combating such emergencies. Food security is therefore expected to increase as household assets increases.

Food Security Status Rural Farming Households
Classes of Food Consumed by Households

The food security indicator used for this study was defined by the frequency and the number of different foods consumed over a period of 24 hours as presented in Table 10. A comprehensive list of five (5) classes of food was used as stated in the food security index. The frequency of food consumed by each household was compared to the expected level to obtain their food security status.

Table 10: Food Groups Consumed by Households

Food Groups	Frequency*	Percentage
Carbohydrates	160	28.2
Proteins	154	27.2
Fats and oil	78	13.8
Vitamins	124	21.9
Minerals	50	8.8

***Multiple choices existed: Source: Field Survey, 2015.**

Carbohydrate is a very important class of food. It is the largest single source of energy in a diet. Therefore adequate consumption of carbohydrates can give the required energy level for adults. According to Table 10, all respondents consumed a food item under this class at least once in the last 24 hours. Taraba State ranks high among the leading producers of tubers (yam and cassava) and cereals (millet, sorghum) in the nation. These crops have high tolerance to changes in temperature and rainfall. They are often harvested in sufficient quantities by farming households in the study area under normal farming conditions. This explains high consumption of the food group in the study area.

Almost all the respondents had consumed a food item among the protein class at least once in the last 24 hours. Proteins giving foods are of both animal and plant origins. Taraba State also produce cowpea in large quantities and is also rich in sea food (fishes precisely). This might be the reason for such high consumptions in proteins. Consumption of protein in adequate quantities can also give the required energy level for day to day activities. The 1985 FAO – WHO consultation in Human Nutrition estimated the daily protein requirement for healthy adults to be 0.6g/kg per day (Ministry of Health, 2003).

Taraba State is known for its richness in palm trees and its people engage in the production of palm oil for consumption and commercial purposes. It was therefore expected that the consumption of fats and oil would be high among respondents. However, Table 10 indicates low consumption of fat and oil even when it is available in adequate quantity. Respondents might be more interested in the financial gain from oil production especially than consumption. This might also suggest that food insecurity can occur even when food is available in adequate quantity. Adequate amount of dietary fat is essential for health and intakes of dietary fats must be sufficient to meet requirements for essential fatty acids and fat

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soluble vitamins. For most adults, dietary fat should supply at least 15% of their energy in take; women of reproductive age should consume at least 20% of their energy from fat (Oxford University press, 2015).

Vitamins are consumed for metabolic processes and protection. Table 10 indicated a high consumption level of this food group. Household gardening and river bank cultivation of vegetables and food crops is a common feature in the study area hence the availability of vegetables all though the seasons. Taraba State is also a "fruit haven" in Nigeria which makes it readily available for consumption.

Minerals help in developing body tissue and metabolic processes. They are the main providers of ions. According to Table 10, respondents consumed food items under this class in low quantity. The reason for such low consumption in minerals might be the nature of its availability, as most of the food items have to be bought for consumption. Also, rural farmers might not know the importance of the consumption of this class of food.

Food Security Status of Farming Households

Table 11: Food Security Index of Farming Households

Food Security Index	**Frequency**	**Percentage**
Food secure (0)	33	20.63
Mildly food insecure (-1)	41	25.63
Moderately food insecure (-2)	66	41.25
Severely food insecure (-3)	20	12.5
Total	**160**	**100**

Source: Computed by Researcher, 2015.

The frequency distribution of the food security index of rural cassava farmers in Southern Taraba is presented in Table 11. Out of 160 respondents, only 20.63% met the criteria of being food secure. The remaining 79.38% were therefore considered to be food insecure households. In accordance to the 2006 United States Department of Agriculture (USDA) classification by ranges of severity of food insecurity, this study, therefore, classified food insecure households into three groups namely; mildly food insecure, moderately food insecure and severely food insecure which represents 25.63%, 41.25% and 12.5% respectively. This result implies a high level of food insecurity which suggests the detrimental effect of flooding or drought on the livelihood of respondents in the study area.

Determinants of Food Security

Table 12: Determinants of Food Security in Taraba South

Variables	**Coefficient**	**Std. Err.**	**t-value**
GEND	4.794646	5.396334	0.89
AGE	3.241192	1.549231	2.09**
CDR	-5.978713	2.379394	-2.51**
HASZ	-3.730531	1.670899	-2.23**
ASSET	1.886648	0.9051632	2.08**
COOPMEM	0 .4118137	0.1917904	2.15**
FARMEXP	7.143052	5.457179	1.31
PRODENT	-1.48449	2.010267	-0.74
OFFARM	3.50789	0.9088587	3.86***
FASZ	3.012204	1.262397	2.39**

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EXTAG	4.140923	1.845113	2.24**
EDU	1.9466	0 .6626263	2.94***
FAYLDS	2.553572	0.6491869	3.93***
HHINC	1.75927	0.8226347	2.14**
CREDIT	0.560514	0.0094972	5.90***

Note ** = Significant at 5% * = Significant at 1%.**
Source: Regression Result from Field Survey, 2015.

The results of the Logit regression analysis is presented in Table 12. The Logit regression revealed that 12 out of 15 variables included in the model were significant in explaining the variation in food security status of households in the area. At 5% level, age, child dependency ratio, household size, household assets, corporative membership, farm size, extension agent contact and household income significantly affected the household food security status. While at 1% level of significance, off-farm activities, level of education, access to credit and farm yields affected the food security status of households. The value R^2 was 77.42% indicating a good fit and correctness of the variable specified in the model.

Age of Household Head (AGE)

The coefficient of age was significant at 5% and showed a positive relationship with household food security stats. This implies as household head increases in age, the possibility of such household being food secure also increases. Older household heads have access to more farming lands and have more farming experience compared to younger household heads. Many studies have shown that age has a positive effect on productivity. Age in correlation with farming experience has a significant influence on the decision-making process of famers with respect to risk aversion, adoption of improved agricultural technologies and other production related decisions (PROSAB, 2009 and Ahmed *et al.* 2014b).

Child Dependency Ratio (CDR)

The coefficient of CDR was significant at 5% but as expected *a priori*, was negatively related to the food security status of the respondents. This implies that as CDR increases, the food security status of households decreases. Households with high dependency ratio may lack sufficient resources to carter for their upkeep. Dependents usually do not contribute to the financial requirements in the household, this in turn exerts a lot of dependence on the limited family resources. A high CDR results in increased household food requirements and probable reduction in quality and quantity of food.

Household Size (HASZ)

The coefficient of household size was significant in determining food security at 5% but had a negative relationship with food security status of households as expected *a priori*. This implies that as household size increases, the food security status of the respondents decreases. Large household size, however, increases the probability of availability of family labour and a high level of income to meet the requirements of food in terms of quantity and quality.

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Household Assets (HHAST)

The coefficient of household assets was significant at 5% and had a positive relationship to the food security status of the respondents as expected *a priori*. Assets are seen as readily available convertible resources to meet household needs in lean periods, and cushion the effects of adverse circumstances such as crop failure, drought, flood etc. Assets common to rural households included, livestock, extra land and motor vehicles. The positive relationship between household assets and food security implies that as household assets increases, the food security status of households also increases.

Membership of Corporative Society (COOPMEM)

The coefficient of membership of corporative society was significant at 5% and was positively related to the food security status of the respondents. This implies that food security status of household increases with cooperative membership. Active participation in corporative societies tends to attract benefit in terms of helping members in mobilizing resources for agricultural operations and marketing. It also assists in the training and education of members in modern agricultural practices. Consequently, as the level of participation increases the probability of being food secure also increases.

Off–Farm Activities (OFFARM)

The coefficient of off-farm activities was significant at 1% and was positively related to the food security status of households as expected *a priori*. Off-farm activities improve the purchasing power of households and access to food in quality and quantity. This implies that as off-farm activities of the respondents increase, their food security status also increases.

Farm Size (FASZ)

The regression coefficient of farm size variable was significant at 5% and was positively related to the food security status of households as expected *a priori*. Farm size in this study refers to the land area under cultivation during the survey year. Households with larger farm sizes are likely to produce more food which in turn increases the income level of households and improve their food security status. Land holding among rural households is small compared to their family size. Their farm output might likely be insufficient to support their food requirements, hence food insecurity.

Extension Agent Contact (EXTAG)

The coefficient of number of extension agent contact was significant at 5% and was positively related to the food security status of the respondents. Frequent extension contacts exposes the farmers to new and improved farming practices, improved seedling, more access to fertilizers etc. This implies that as extension agent contact becomes more frequent, the probabilities of being food secure also increases among farming households. However, the rate of extension agent visit is very low in rural areas. Only 26.87% of the respondents had access to extension agent visit.

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Level of Education (EDU)

The regression coefficient of the level of education was significant at 1% and as expected *a priori* was positively related to the food security status of the respondents. Studies (PROSAB, 2009 and Ahmed et al. 2014) revealed that the level of education (years of schooling) helps farmers to access and employ production information efficiently. Consequently, this implies that as the level of education of household head increases, the probability of being food secure also increases.

Farm Yields (FAMYLS)

The coefficient of farm yields was significant at determining the level of food security at 1% and as expected *a priori* was positively related to the food security status of the respondents. An increase in the farm yields of the respondents increases their income level which in turn increases their food security. This implies that as farm yields increases, the probability of being food secure also increases.

Household Income (HHINC)

The coefficient of household income was significant at 5% and was positively related to the food security status of the respondents as expected *a priori*. An increase in household income leads to an increase in the purchasing power of that household. As purchasing power of households increases, the quantity and quality of food consumed also increases. Climate change, however, poses a threat to this positive trend, as regional and aggregate shifts in food production and availability will affect markets volume and commodity prices. When food items become scarce, due to the impacts of weather related extreme events such as a drought or flood, resulting in falling per capita food production, prices will rise which in turn will require an increase in income to meet food requirements.

Access to Credit (CREDIT)

The coefficient of access to credit was significant at 5% and was positively related to food security status of the respondents. This implies that access to credit tend to positively influence food security. Access to credit is very important to farming households as it serves as an additional source of income. With access to credit, households can increase productivity and be food secure. Farming households can also access credit by being members of cooperative societies.

Trends of Temperature and Rainfall in Taraba South

Table 13: Trends of Temperature and Rainfall

	Temperature (^{0}C)	**Rainfall (mm)**
Mean	33.67	104.7
Maximum Value	34.48	129.02
Minimum Value	32.94	47
Standard Deviation	0.42	18.75
Coefficient	0.025	0.129

Source: NIMET, 2015.

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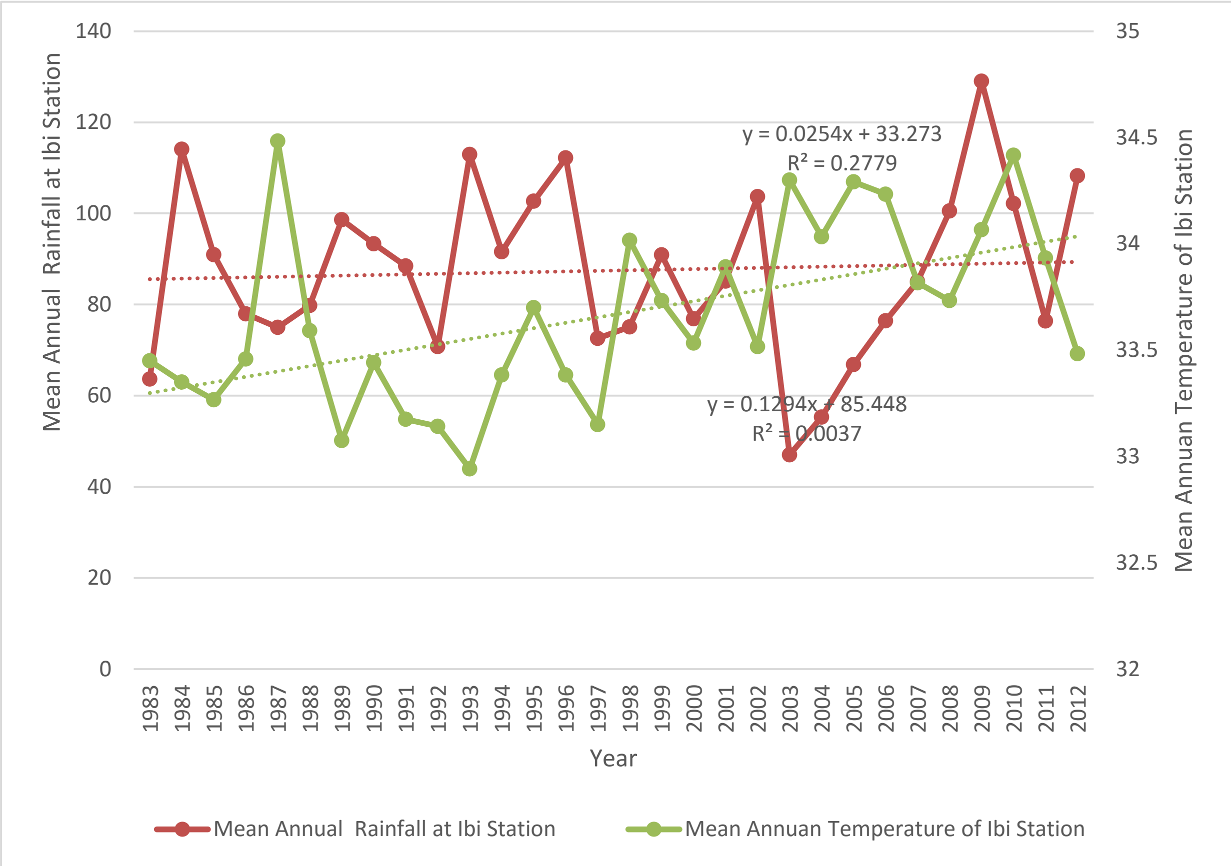

Fig 1: Trends of Temperature and Rainfall in the Southern Part of Taraba

Temperature data from Ibi Meteorological Station between 1983 and 2012 showed an increasing trend with a trend coefficient of 0.025^{0}C per year (Table 13). Annual mean temperature in Southern Taraba state rose by 0.025^{0}C per unit change in time (Figure 1). The trend analysis results revealed an increasing trend in mean annual temperature in the region. The increasing trend in temperature is a reflection of the global warming resulting into general increase in earth's temperature. Consequently, crops were smothered by excessive heat thereby reducing food production in the study area.

Rainfall record from Ibi Meteorological Station, between 1983–2012 is presented in Table 13. Annual mean rainfall in the Southern part of Taraba State rose by 0.129mm per unit change in time (Figure 1). This revealed an increasing trend with the positive value of the trend coefficient of rainfall in the region. The positive trend in mean annual rainfall might be due to the topography of the region. Taraba State's topography is largely made up of undulating plains and rising hills. Mountains have a strong influence on the atmosphere: they alter the flow of air and respond to solar radiation differently than the surrounding atmosphere. Consequently, in mountainous environments, precipitation is enhanced in some regions and decreased in others. The persistent increase in rainfall in this region exposes it to risk of frequent flooding.

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Implications of Climate Change on Farm Yields

Table 14: Correlation Matrix between Cassava yields, Temperature and Rainfall

	Yields	Temperature	Rainfall
Yields	1.00		
Temperature	0.5637***	1.0	
Rainfall	0.6521 ***	0.1217	1.00

Note: * = significant at 1%**

Source: Computer Generated Analysis, 2015.

Pearson correlation coefficient was used to determine the relationship between yield, temperature and rainfall. The results are presented in Table 14. The correlation analysis showed that there was a significant positive relationship between yield and temperature with (r= 0.56) which implied that as temperature increased the yields of cassava produced also increased in the study area. The result of the correlation matrix between rainfall and cassava yields also exhibited a positive and significant relationship with (r=0.65) implying that as rainfall increases cassava yields increased as well in the study area. The study, however, noted that the right temperature and rainfall will boost production of food crops which ultimately improves food security status. The effect of flooding or drought is a setback to agricultural production which is a reflection of the food insecurity level in the study area.

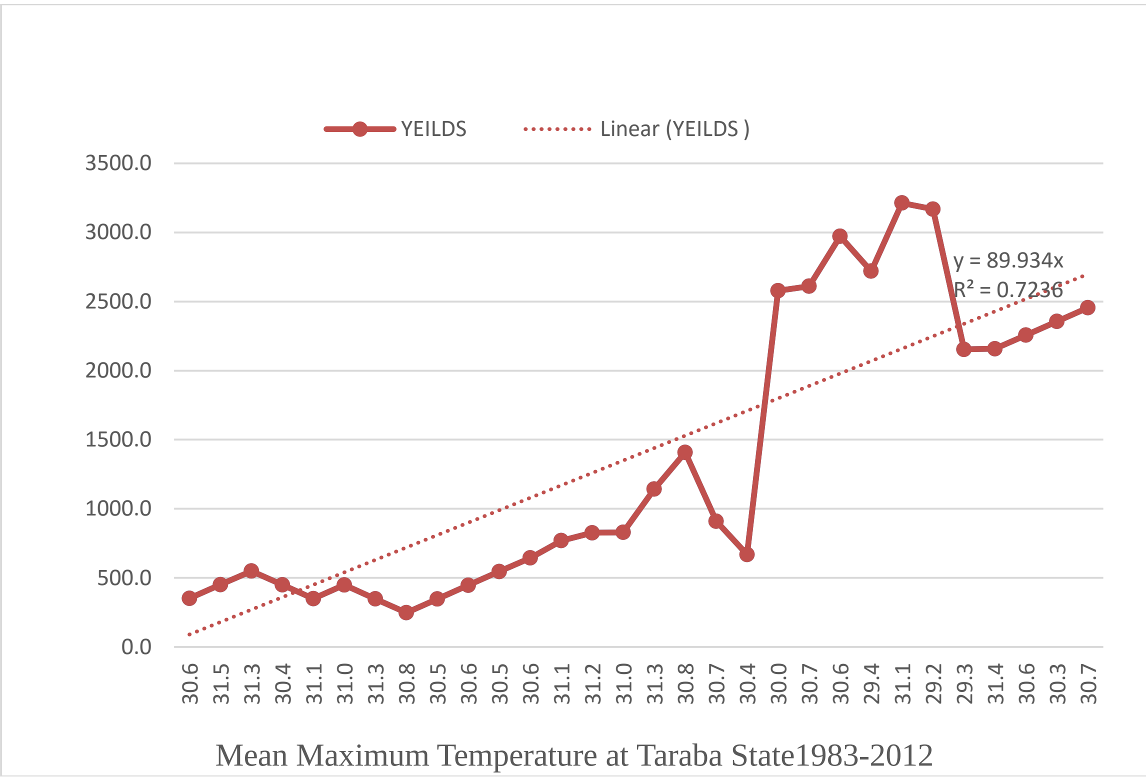

Fig 2: Line Graph Showing Relationship between Cassava Yields and Temperature in Taraba State from 1983 - 2012

Contrary to the *a priori* expectation, cassava yields were expected to decrease as temperature increased. Study has shown that cassava grows best in areas with a mean temperature of 25^0C–29^0C and a soil temperature of about 30^0C, below 10^0C the plant stops growing. Judging from the trend of temperature above, the Southern part of the State, exhibited a

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maximum annual mean temperature of 31^0C and a minimum annual mean temperature of 30.8^0C. This shows that the temperature in the area is greater than the mean temperature required to grow cassava. Studies have shown that cassava can withstand periods of drought (FAO, 2013). Although the crop can withstand periods of drought, the increasing trend of temperature may cause the crops to be smothered by heat. Fig 2 revealed that cassava yields were increasing with the prevailing level of temperature in the study area. Temperature might not be the only reason for the changes in the growth of cassava yields, but it is definitely one of the factors affecting the growth of cassava in the study area. Increase in temperature can cause dry spells. If a long dry spell occurs, the seedlings die (false start) and the farmers are compelled to replant. This can lead to a shorter growing season due to replanting or late onset and/or early cessation of the rains. This will consequently lead to increased spending on cassava stalks in other to meet production levels. Once production levels are not met, food availability decreases and this in turn affects the food security status of rural households.

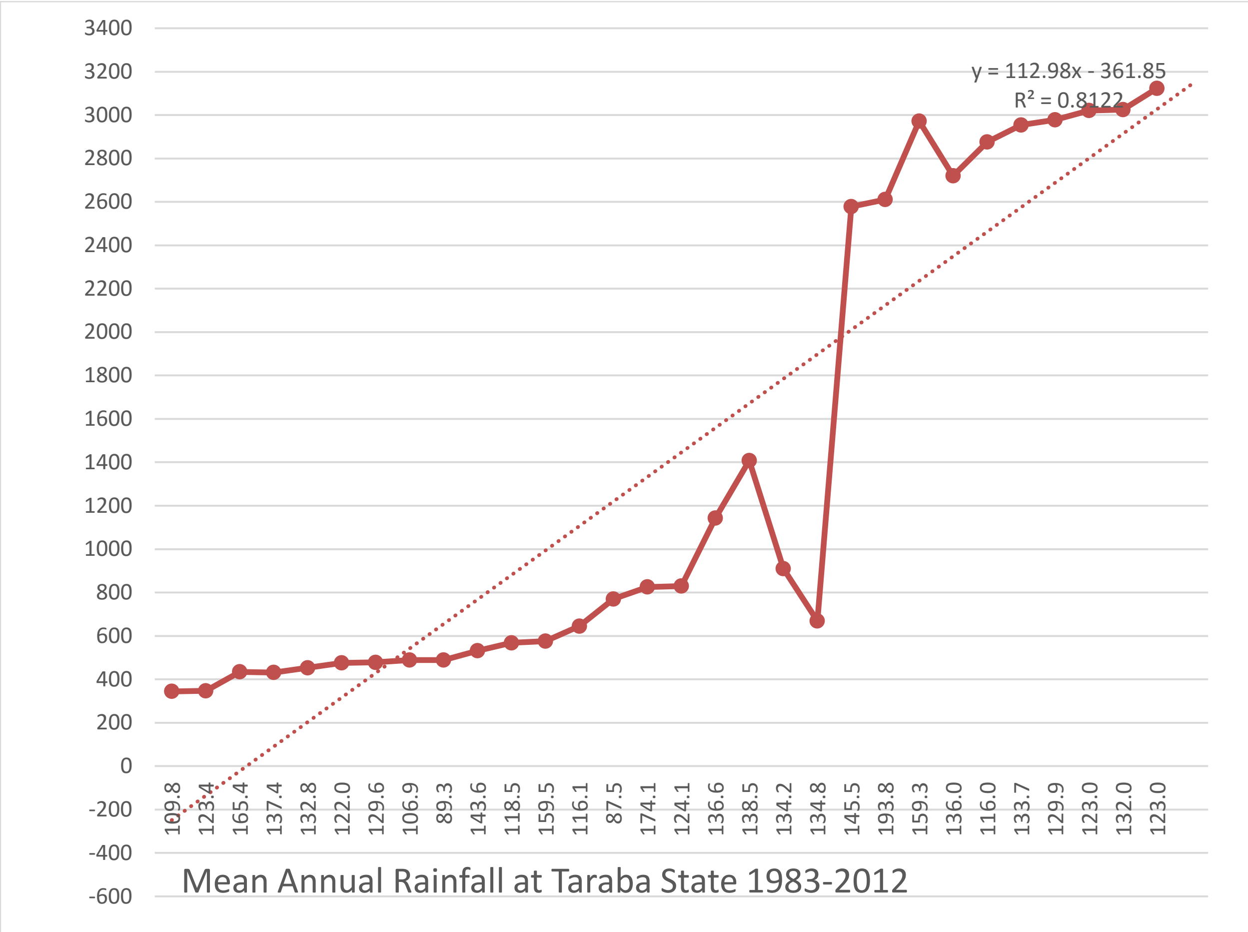

Fig. 3: Line Graph showing Relationship between Cassava Yields and Rainfall in Taraba State from 1983 – 2012

As *a priori* expected, cassava yields were expected to increase as rainfall increases. Cassava can grow in areas that receive just 400mm of average annual rainfall but much higher yields can be obtained with higher levels of water supply (FAO, 2013). Table 13 showed that Taraba South had a mean annual rainfall of about 104.0mm. This is more than enough rainfall needed for cassava growth in the area. Crops generally require certain amount of rainfall during growth periods for maximum yield and when this becomes excessive it leads to flooding which in turn leads to poor harvest if at all. Fig 3 showed that production of

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cassava is increasing even with the prevailing amount of rainfall. But the increasing trend of rainfall inevitably leads to flooding of the area, which is caused by the release of excess water from Lagdo dam in the Republic of Cameroon and aided by the presence of the River Benue passing through some of the communities in the study area. Although cassava can withstand periods of drought, it is very sensitive to soil water deficit during the first three months after planting. Water stress at any time in that early period reduces significantly the growth of roots, and impairs subsequent development of the storage roots. (FAO, 2013).

Taraba State has suffered from periodical extreme climate events, manifested in the form of frequent flooding (Oruonye, 2012; Oruonye 2014). Thus any change in climate mostly manifested as an increase in frequency and severity of extreme weather events such as flood, has a potential to significantly reduce agricultural production and household food security. It should be noted that climate is not the single determinant of yield, nor is the physical environment the only decisive factor in shaping food security Parry *et al.*, (2004), but climate change would severely compromise agricultural production and access to food (IPCC, 2001a).

CONCLUSION AND RECOMMENDATIONS

The study examined the socioeconomic implications of climate change on the food security status of rural farming households in Southern Taraba, Nigeria. Based on the different food groups consumed by households and the influence of extreme weather conditions such as excessive heat and flooding, only 20.63% of the respondents were food secure. The study also established that an increase in those variables that significantly determine and are positively related to food security would increase the food security status of the respondents.

A number of specific policy recommendations can be proffered from the results of this study. These include:

• The need to promote sustainable livelihood among rural households through job creating programmes and enactment of policies for reducing poverty and ensuring food security such as National Poverty Eradication Programmes (NAPEP) and Graduate Internship Scheme (GIS) in rural areas. These empower the rural households by exploring income diversification opportunities thereby improving wage earning capacity.

• Policies of reducing poverty and ensuring food security need to include climate change strategies. A detailed analysis of the risk and possible solutions could assist in finding appropriate adaptation strategies and play an important role in achieving food security and fighting poverty. Climate change management authorities such as NIMET should be encouraged to provide farmers with early warning signals via an organized extension service programme.

• Visit of extension agent has the ability of helping the farming households with better decision making process which will enhance better production.

• Nutrition oriented programmes should also be implemented to improve on the food substitution capabilities of the households. This becomes effective by ensuring improved educational level through adult education and training and increased awareness and access to better family planning facilities.

• Climate change is accompanied by the incidence of pest and diseases, particularly during dry spells. This is further compounded by the fact that farmers are often poor and rarely have access to safe and effective pesticides, robust varieties of plan/seeds and adequate irrigation facilities. Government should assist the farmers with necessary inputs at subsidized rates to combat the menace of climate change in the study area.

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