Почвознание агрохимия и екология, 55, 1/2021
Bulgarian Journal of Soil Science Agrochemisty and Ecology, 55, 1/2021

Effect of climate change on rural farming households' food security in Ogun state, Nigeria

Olalekan Fatoki*, Titilayo Oguntoye, Olayinka Arowolo, Ajibola Ogunsola

Department of Forest Economics and Extension Services, Forestry Research Institute of Nigeria Ibadan, Oyo State, Nigeria
Corresponding author*: gobite2002@yahoo.com

Citation: Fatoki, O., Oguntoye T., Arowolo O., & Ogunsola, A. (2021). Effect of climate change on rural farming households' food security in Ogun state, Nigeria, *Bulgarian Journal of Soil Science Agrochemisty and Ecology, 55*(1), 3-14.

Abstract

The study examined the effect of climate change on rural households' food security in Ogun State, Nigeria. Primary and secondary data were used for the study, whereby the primary data were collected through questionnaire administered to arable food crop farmers while time series data (1990 - 2019) on annual temperature, rainfall and humidity were collected from Nigeria Meteorological Agency (NIMET). Descriptive statistics and quantitative techniques were used in analysing the data. On average, the farmers' age was 42 years, were males and married. Most of the farmers experienced increased temperature and change in rainfall patterns. The Food Security module showed that most of the farmers were food insecure. The logit regression model revealed that socioeconomic factors that significantly affected food security were education, income, access to extension services, irrigation, credit and cooperative membership. Temperature and rainfall had significant effect on food security. Temperature was negative and significant at 5% while rainfall was positive and significant at 1%. The study recommends that rural farmers should be provided with training on water harvesting techniques during periods of excess rainfall to ensure availability of water for farming all year round.

Key words: Arable food crop farmers, Climate change, climate variables, food security, Ogun state.

Introduction

Climate change is a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and / or the activity of its properties, and that persists for an extended period typically decades or longer (Inter-governmental Panel on Climate Change, 2007). Through flooding, extreme temperature, drought and increased salinity of water supply used for irrigation, climate change has become a subject of global debate. Climate change is different from climatic variability, this term denote inherent dynamic nature of climate on various temporal scales. Such variations could be monthly, seasonal annual decadal, periodic, quasi-periodic or non-periodic. The changing climate is a challenge for both current and future generations as its impact will increase the vulnerability of societies around the world, especially in developing countries where the impacts will be severe, but those living in highly risk-prone area of developed countries could also be greatly impacted. Available evidence shows that climate change is global, likewise its impacts, but biting effects will be felt more by the developing nations especially those in Africa, due to their low level of coping capabilities (Nwafor 2007; Jagtap, 2007; Onyenechere, 2010).

The agricultural sector is important in any nation's socio-economic and industrial fabric because of the multifunctional nature of the sector (Ogen, 2007). This sector remains the main source of livelihood for most rural communities in developing countries in general. In Africa, agriculture provides a source of employment for more than 60 percent of the population and contributes about 30 percent of Gross Domestic Product (Kandlinkar & Risbey, 2000; Ijeoma, 2012). Rainfed farming dominates agricultural production in Sub-Saharan Africa, covering around 97 percent of total cropland and exposes agricultural production to high seasonal rainfall variability (Alvaro et al., 2009). In Nigeria, agriculture is the main source of food and employer of labour employing about 60-70 percent of the population (Adebisi-Adelani & Oyesola, 2014). Since agriculture in Nigeria is mostly rain-fed, any change in climate is bound to impact on its productivity and socioeconomic activities in the country. The impact could be measured in terms of effects on crop growth, availability of soil water, livestock production, incidents of pests and diseases, sea level rises and decrease in soil fertility (Adejuwon, 2004; Anyadike, 2009).

Food security exists when all people have physical, social and economic access to sufficient, safe and nutritious food at all times which meets their dietary needs and food preferences for an active healthy life (Gibson, 2012). A country will be food secured when its population doesn't live in hunger or fear of starvation. However, climate change is the most serious threat to achieving food security and the alleviation of poverty and diseases in Nigeria. Climate change, agriculture and food security is now a subject of global concern as a result of the number of empirical literature that is currently available on the subject matter. However, most available literature seem to focus on the industrial countries where the economic impacts are likely to be less harmful because of better adaptation techniques and technology than the developing nations. Adams et al. (1999); Easterling et al. (1993); Tobey et al. (1992); Darwin et al (1995); Kaiser, (1993), Maddison (2006) etc., were in the streams of authors to initially assess the economic impact of climate change on food production in industrial countries.

The literature on climate change and agriculture appears scanty in Africa when compared with that available in industrialised countries; though the subject matter is gradually attracting much attention (Hassan, 2008). Downing (1992); Onyeji and Fischer (1994); El-Shaer et al. (1997); Hassan, 2008; Deressa et al. (2008) and Gbetibuo (2009) among others were the first stream of African researchers to measure the economic impact of climate change on food production. This is followed by a series of multi-country analyses carried out in 11 African countries, coordinated by the centre of environmental economics and policy in Africa, University of Pretoria, in close collaboration with many agencies in the involved countries.

Population of Nigeria is projected to increase by more than 50 percent in the coming two decades (FAO, 2008; Adebisi-Adelani, 2014). During this 20 years period, the rural population is projected to increase by more than 25 percent and the agricultural component is expected to grow by a slightly lower proportion, moderated by climate change and undercapitalization of the small holder farmers. For instance, Okoli and Ifeakor (2014) noted that the food security threat posed by climate change is severe in Nigeria, where agricultural yields and per capita food production have been steadily declining, and where population growth will double the demand for food, water and forage in the next 20 years.

Studies that relate climate change to food production and security in Nigeria are more of general analyses of potential impacts of climate change on crop production and animal husbandry (NEST, 2004; Adejuwon, 2004; Abiodun & Olabimpe, 2007; Adefolalu, 2007; Jagtap, 2007; Nwafor, 2007; Odjugo, 2009). The crucial issue in this study is whether food supply can keep pace with population increase which in turn determines the food security status of households under this climate variability. A good number of researchers have carried out extensive survey on climate change and agricultural production in Nigeria with respect to the impacts of climate change (Agbola & Ojeleye, 2007; Apata et. al., 2009; Ajetomobi et. al., 2010; Ayinde et. al., 2011; Obioha, 2009; Odjugo, 2010; Onyeneke & Madukwe, 2010; Ozor & Cynthia, 2011; Sofoluwe et. al., 2011; Umar & Ibrahim, 2011), but these studies did not provide critical insights in terms of the relationship between food security and climatic variables. In view of this, it is necessary to embark on a study that will assess the effect of climate change on food security of rural farming households who are the direct victim of the effects. Climate change will affect all four dimensions of food security in Nigeria namely; availability, accessibility, stability and utilization (FAO, 2008). This study will provide necessary information that will help in designing appropriate coping strategies to achieve sustainable food security among farming households in Nigeria. Meanwhile, the focus of this study will be on arable food crop farmers as they are more vulnerable to climate change. The objectives of the study are to analyse the perceived effect of climate change among arable food crop farmers, determine the food security status and examine the effect of climatic change on food security status of the farmers.

Materials and Methods

Study Area

The study area was Ogun State in South-western Nigeria. The state lies between longitude 202'E and 3055'E and latitude 700'N and 7018'N. It is approximately 1.9% (16,762 km2) of Nigeria's 923,219 km2 land area of which over 70% is suitable for arable crop production. It is located in the moderately hot, humid tropical climatic zone of south western Nigeria. It has a tropical climate with two distinct seasons - the rainy and the dry season. The three main vegetation types in the study area are the tropical rainforest, guinea savannah and derived savannah. It is made up of 20 Local Government Areas spread across the four main agricultural zones of the state - Abeokuta, Ijebu, Ikenne, and Ilaro. The overall population of the state is 3,728,098 according to the National Population Commission census report in 2006.

Sources of Data Collection

The research data was obtained through primary and secondary source. The primary data was collected with the aid of structured questionnaire from arable food crop farmers in the study area. Data collected include socio-economic characteristics (such as age, gender, marital status, educational status, farming experience etc.), their perception of climate change effects among others. Secondary data on climatic variables such as annual rainfall, annual temperature and annual relative humidity from 1990-2019 was sourced from Nigeria Meteorological Agency (NIMET). This was used to calculate the mean annual temperature, rainfall and relative humidity used as independent variable for the logit regression.

Sampling Technique

Multistage sampling technique was employed for the study. The first stage involved the random selection of 3 agricultural zones which are Abeokuta, Ijebu ode and Ilaro zones from the 4 agricultural zones in the state. The second stage involved the random selection of 5 blocks from each of the zones resulting to 15 blocks in total. In the final stage, systematic sampling technique was employed to select 12 households from each of the blocks selected to arrive at 180 rural households that were used for the study.

Analytical techniques

Descriptive Statistics

Descriptive statistics in form of frequencies and percentages were used in the description of the socio-economic characteristics and perception of farming households to climatic variations.

United State Department of Agriculture (USDA) Food Security Module

Food security status of households will be assessed using the United States Department of Agriculture

(USDA) household food security module. USDA approach to household food security assessment centres on how the households responds to series of questions (Table 2) about behaviour and experiences that are known to characterize households that have difficulty in meeting their food needs. As shown in table 3, a household is food secure if there is no affirmative response to any question, or affirmative responses to one or two questions out of the 15 food security questions.

The relationship between food security status and climatic elements along with other socio economic characteristics of household were examined in a logit model. It models a latent variable: unobservable variable (food insecurity) which can take all values in (-∞, to +∞). According to Gujarati (2004), underlying latent model is

$$y_i = \begin{Bmatrix} 1 \ if \ y_i^* > 0 \\ 0 \ if \ y_i^* \leq 0 \end{Bmatrix}$$

$$y_i = \alpha + x_i\beta_i$$

If P is probability of being food insecure then probability of being food secure is , therefore, we can write the odd ratio ($P_i/1\text{-}P_i$) as

$$P_i/(1\text{-}P_i)=(1+e^{yi})/(1+e^{-yi})=e^{yi}$$

Taking the natural log of the odd ratio gives the logit. Therefore the logit model is written as

$$L_i = \ln(P_i/1\text{-}P_i)= y_i = \alpha + x_i\beta_i$$

Explicitly,

$$y_i = \alpha + x_i\beta_i + e_i$$

y_i = Food security status of household (Food secure - 1, food insecure - 0)
β_i = Parameters of interest associated with the x_i
e_i = Error term
α = Constant
X_1 =Age of household head (Years)
X_2 = Educational level of household head (years)
X_3 = Household size
X_4 = Farm size (hectare)
X_5 = Income (naira)
X_6 = Gender (male = 1; female = 0)
X_7 = Access to extension services (yes = 1; otherwise = 0)
X_8 = Access to credit (yes = 1; otherwise = 0)
X_9 = Access to heavy machineries (yes = 1; otherwise = 0)
X_{10} = Access to irrigation (yes = 1; otherwise = 0),
X_{11} = Association membership (if belongs to association = 1, otherwise = 0)
X_{12} = Experience of drought (Yes = 1, otherwise = 0)
X_{13} = Experience of flood (Yes = 1, otherwise = 0)
X_{14} = Mean annual temperature (0C)
X_{15} = Mean annual rainfall (mm)
X_{16} = Mean annual relative humidity (%)

Results

Socioeconomic Characteristics of the Respondents

Socioeconomic characteristics of the rural farmers are presented on table 4. The age distribution shows that the average age of the farmers is 42 years. Most of the farmers (76.7%) were males and majority (64.5%) were married. A substantial proportion of the respondents (43.9%) had at least primary education followed by 16.7% that had secondary education. Furthermore, Majority of the respondents (76.1%) had household size that is between 4 and 9 while 23.1% had between 1 and 3. As shown in table 4, a large proportion of the farmers (45.6%) had over 20 years of farming experience followed by 36.1% that had between 10 and 20 years of experience.

Perceived Effect of Climate Change by the Respondents in the Last Five Years

Results in table 5 shows that majority of the farmers (90.0%) experienced increased temperature in the last five years which would have affected their farming activities. Most of the farmers (88.3%) claimed to have experienced excessive rainfall in the study area during the time period considered. Furthermore, a large percentage of

Table 1. Data of Annual Temperature, Rainfall and Relative Humidity from 1990-2019

Year	Temperature	Rainfall	Relative humidity
1990	26.09	980.9	64.87
1991	27.3	980.9	65.83
1992	26.574	990.9	50.75
1993	25.9	990	50.75
1994	28.9	1350	55.89
1995	30.3	1350.8	63
1996	31.18333	1455.5	67.08333
1997	31.18333	1455.5	70.25
1998	30.53333	1909.3	71.79167
1999	30.975	1470.7	66.54167
2000	28.95833	1273.3	67.16667
2001	26.575	947.4	67
2002	26.15833	1909.9	66.875
2003	31.10833	1366.2	70.33
2004	30.83333	1516.2	69.79167
2005	31.63333	1453.6	68.58333
2006	31.24167	1408.9	70.5
2007	31.95833	1490.2	65.125
2008	28.63333	1026.4	68.45833
2009	31.18333	1547	69.33333
2010	31.46667	1070.9	71.375
2011	32	1482.5	67.25
2012	30.83333	1285.7	69.75
2013	29.8	1026.4	71.70833
2014	31.18333	1500.5	69.70833
2015	33	1718.9	69.5
2016	31.50833	1285.2	66.375
2017	31.95833	1909.2	74.33333
2018	32.01667	1912.8	69.875
2019	32.40833	1702.9	72.375

Source: NIMET, 2020

the arable crop farmers (95%) noticed changes in rainfall pattern.

Household Food Security Classification

The result of the households' food security classification using the USDA Food Security Module is presented on table 6. Generally, about 63.3% of the rural farmers were food insecure while 36.7% were food secure. A substantial proportion (38.3%) of the respondents had low food security while 25% had very low food security status. Furthermore, about 23% had marginal food security status while 13.9% were highly food secure.

Relationship between Socioeconomic Characteristics, Climatic Variables and Food Security in the Study Area

The relationship between socioeconomic char-

Table 2. Households Food Security Situations According to USDA Module

Food Security Module	**Response** No	Yes
Household without children		
We were worried our food would run out before we got money to buy more		
The food we bought just didn't last and we didn't have money to get more		
We couldn't afford to eat balanced meals		
Some adults in the household had to cut the size of their meals or skip meals because there wasn't enough money to buy food		
Some adults couldn't eat what we felt we should eat because there wasn't enough money for food		
How often did this happen in the last 12 months		
Some adults were hungry but didn't eat because of not been able to afford enough food		
Some adults lost weight because there wasn't enough money for food		
Some adults in the household could not eat for a whole day because there wasn't enough money to buy food		
How often did this happen in the last 12 months		
Household with children		
We relied on only a few kinds of low-cost food to feed the children because we were running out of money to buy food		
We couldn't feed the children a balanced meal because we couldn't afford that		
The children were not eating enough because we just couldn't afford enough food		
Had to cut the size of some of the children's meal because there wasn't enough money to buy food		
How often did this happen in the last 12 months		
The children were hungry but we just couldn't afford more food		
At least one of the children had to skip a meal because there wasn't enough money to buy food		
At least one of the children could not eat for a whole day because there wasn't enough money to buy food		

Source: USDA Guide, 2016

Table 3. USDA Food Security Classification Based on the Food security Questions Above

Number of Affirmative Responses		**Status**
Households with Children	Households without Children	
0-2	0-2	High Food Security
3-7	3-5	Marginal Food Insecurity
8-12	6-8	Low Food Security
13-18	9-10	Very Low Food Security

Source: USDA, 2016

acteristics, climatic elements and food security using binary logit regression model is presented on table 7. Socioeconomic factors along with climatic elements were analysed to determine the factors that affect rural households' food security in the study area. The estimated model has a pseudo R^2 of about 0.092 which is good enough. The Chi-squared value for the logistic regression model and their statistical significance show that the model is well fitted. Six of the socioeconomic factors have significant coefficients at different levels of significance. Educational level is positive and has a significant ($p<0.05$) effect on food security. This implies that an additional year gained in acquiring formal education will increase the probability of been food secure by 0.08 unit. Income is also positive and significant at 1%, which shows that an increase in income of the rural farmers will lead to an increase in the probability of been food secure. Furthermore, Access to extension services and credit facilities are significant at 1% and these will increase the probability of been food secured by 0.04 and 0.06 units respectively.

Other socioeconomic variables that are significant are access to irrigation ($p<0.05$) and cooperative membership ($p<0.10$).

Table 7 further reveals that two climatic variables have significant effects on food security. Temperature has a negative relationship and it is significant at 5%. This implies that a degree rise in temperature will decrease the probability of been food secured. Rainfall positively affects food security as expected and it is significant at 1%, which means an increase in the amount of rainfall will increase probability of been food secured by 0.03 units. Relative humidity is positive but not significant.

Table 4. Socioeconomic Characteristics of the Respondents

Variables	Frequency	Percentage %
Gender		
Male	138	76.7
Female	42	23.3
Age		
<30	30	16.7
30 – 39	59	32.8
40 – 49	68	37.8
50 – 59	13	7.2
Above 60	10	5.5
Marital status		
Single	42	23.3
Married	116	64.5
Widowed	15	8.3
Divorced	7	3.9
Educational level		
No formal education	63	35.0
Primary	79	43.9
Secondary	30	16.7
Tertiary	8	4.4
Annual income		
<50,000	54	30.0
50,000 – 100,000	77	42.8
100,000 – 150,000	36	20.0
>150,000	13	7.2
Household size		
1 – 3	43	23.9
4 – 6	71	39.4
7 – 9	66	36.7
Years of farming experience		
<10	33	18.3
10 – 20	65	36.1
Above 20	82	45.6

Source: Field Survey, 2020

Table 5. Perceived Effect of Climate Change by the Respondents in the Last Five Years

Variables	Frequency	Percentage %
Increased temperature	162	90.0
Excessive rainfall	159	88.3
High intensity sunlight	135	75.0
Change in rainfall patterns	171	95.0
Occurrence of drought	92	51.1
Too stormy rainfall	97	53.8

Source: Field Survey, 2020

Table 6. Food Security Classification of the Rural Farming Households

Food security status	Frequency	Percentage %
Very low food secure	45	25.0
Low food secure	69	38.3
Total food insecure	114	63.3
Marginal food secure	41	22.8
High food secure	25	13.9
Total food secure	66	36.7

Source: Computed from 2020 Field Survey

Discussion

The majority of the arable food crop farmers were within their economically productive age and are males which imply that they will be active enough to cope with the stress of farming and the threats posed by climate change. The literacy level of the farmers can help increase their awareness level of the changing climate. The farmers had large household size which may have negatively affect their purchasing power and consumption of adequate food. However, this can have some advantages as there will possibly be availability of more hands to assist with farming activities and combat the challenges imposed by climate change which can eventually lead to increased productivity. The high level of experience of the farmers is an indication that they will probably be more knowledgeable to cope with uncertainties imposed by climate change. Furthermore, the excessive rainfall experienced by the farmers is an indication probably that flooding was common in the last five years as well as soil erosion as excess rainfall can result in flooding and soil erosion if there is no proper drainage system available. The change in rainfall patterns experienced may have affected farming activities such as planting season and watering of crops during period of droughts as rural farmers in Nigeria depend mostly on rain-fed farming.

The high food insecurity situation among the farmers might be as a result of factors such as unfavourable climate, lack of access to credit and extension services among others. This result is in line with the findings of Obayelu (2012) who reported 23.7% of the respondents were food secure among rural households in Kwara and Kogi state using the same food security module as this

Table 7. Logit Regression Showing the Relationship between Food Security, Climate Change and Socio-economic Variables

Variables	Coefficient	t-ratio	Marginal effect
Age of household head	-1.768	0.97	-0.040
Educational level	2.266***	3.46	0.089
Household size	-0.564	1.24	-0.012
Farm size	0.043	0.46	0.829
Income	0.003***	3.21	8.13e-07
Gender	1.212	1.08	0.031
Access to extension services	0.269***	4.01	0.045
Access to credit	0.350***	3.98	0.064
Access to heavy machines	0.004	0.54	0.008
Access to irrigation	1.084**	2.68	0.093
Cooperative membership	0.609*	1.75	0.015
Occurrence of drought	-0.362	0.45	-0.067
Occurrence of flood	-0.161	0.82	-0.023
Mean annual temperature	-2.939**	2.51	-0.382
Mean annual rainfall	0.043***	4.34	0.036
Mean annual humidity	2.644	1.24	0.930
Constant	2.346	0.98	
Log likelihood	-210.675		
LR $chi^2(16)$	54.32		
Prob > chi^2	0.00		
Pseudo R^2	0.092		

***, **, * denotes statistical significance at 1%, 5% and 10% respectively
Source: Computed from 2020 Field Survey

study. Also, Olarewaju (2018) reported that 22% of the households were food secure among wetlands residents in Ogun-Osun river basin in South western, Nigeria using the same methodology. The result of the relationship between socioeconomic factors and food security with respect to education is an indication that the farmers with higher years of education are more likely to be food secured than those with lower years of education. This is in consonance with the findings of Oyebanjo et al., (2013). A probable reason is that farmers that are educated are likely to be aware of improved technologies and research breakthroughs because of their exposure.

Income also enhanced the likelihood of been food secured which implies that farmers that earned high income were better off than those with low income because they can afford the resources needed to purchase adequate food items. This finding is in line with the study carried out by Alonge, (2014) in study carried out on food security determinants among forest households in Ogun State. Farmers with extension access were more likely to be food secure because of the awareness and improved knowledge gained in addressing agricultural production problems. The positive effect of irrigation access implies that farmers that have access to water for irrigation purpose were more food secure compared to those that lack this opportunity. This may be as a result of the fact that farmers that have access to irrigation were able to farm all year round which can help ensure stability of food supply in their households.

The result of the logit regression further revealed that temperature significantly affect food security which means that increasing temperature will affect the likelihood of been food secured. This is consistent with the findings of Ayinde et al., 2011 in the research carried out on the effect of climate change on agricultural productivity in Nigeria in which temperature exerted negative influence on agricultural productivity. This may be as a result of the fact high temperature is harmful to soil fertility which will affect agricultural production and by extension food security. The positive effect of rainfall on food security supports the findings of Idumah et al., 2016 that rainfall is a key determinant of agricultural production and food security in Nigeria. Also, the result supports the fact that rain-fed farming dominates agricultural production in Nigeria and change in rainfall pattern will affect productivity of farmers (Adejuwon, 2004). However, excessive rainfall may cause flooding which will consequently result in soil erosion and affect plant growth. As shown in the logit regression result, experience of drought is negative but not significant. This negative effect is an implication that farmers who do not face the challenge of drought were likely to be more food secure than those affected.

Conclusion

The study reveals that majority of the farmers in the study area are males and are still in their economic productive year which means they can cope with the stress of farming and threats posed by climate change. The farmers had large household size that can help to achieve increased productivity. The result of the perceived effect of climate change reveals that the arable food crop farmers are conversant with the changing weather pattern of their area. This result shows that majority of the farmers' experienced increased temperature and too much rainfall in the last five years.

The result of the USDA food security module shows that a large proportion of the farmers are food insecure which may be as a result of unfavourable climate and other socioeconomic factors. The logit regression shows that socioeconomic factors such as educational level, monthly income, access to extension services, irrigation and cooperative membership are positive and significant determinants of food security. Two of the climatic elements considered have significant effect on food security. Temperature is negative and significant at 5% while rainfall is positive and significant 1%. Therefore, it can be concluded that climate change have significant effect on food security status of rural farming households.

Recommendations

From the findings of the study, the farmers experienced excessive rainfall and change in rainfall patterns and the result of the logit regression revealed that rainfall and access to irrigation have significant effect on food security among arable food crop farmers. As a result of this, there is need to empower rural farmers in designing small scale water harvesting techniques during the period of excess rainfall to ensure availability of water for farming during period of scarcity.

References

Abiodun, A., & Olabimpe, A. (2007). Agriculture in Africa: mitigation and adaptation to global warm up. In: Proceedings of the International Conference on Climate Change and Economic Sustainability Held at Nnamdi Azikiwe University, Enugu, Nigeria. 12 – 14 June, 2007.

Adams, R. M., Glyer, J. D., McCarl, B. A., & Dudek, D. J. (1999). The implications of global change for western agriculture. *Western Journal of Agricultural Economics, 13*, 348-356.

Adebisi-Adelani, O., & Oyesola, O. (2014). Farmers' perception of the effect of climate change on tomato production in Nigeria. *International Journal of Vegetable science, 20*, 366-373.

Adefolalu, D. O. A. (2007). Climate change and econo-mic sustainability in Nigeria. Paper presented at the international conference on climate change, Nnamdi Azikiwe University, Awka 12-14 June 2007.

Adejuwon, S. A. (2004). Impacts of climate variability and climate change on crop yield in Nigeria. Paper presented at the Stakeholders' Workshop on Assessment of Impacts and Adaptation to Climate Change (AIACC), Conference centre, Obafemi Awolowo University, Ile-Ife, 271-279.

Agbola, T. & Ojeleye, D. (2007). Climate change and food production in Ibadan, Nigeria. *African Crop Science Conference Proceedings, 8*, 1423-1433.

Ajetomobi, J. O., Abiodun, A. & Hassan, R. (2010). Economic impact of climate change on irrigated rice agriculture in Nigeria. Paper presented at the Joint 3rd African Association of Agricultural Economists (AAAE) and 48th Agricultural Economists Association of South Africa (AEASA) Conference, Cape Town, South Africa, September 19-23.

Alonge, T. (2014). Evaluation of forest resources on food security in Ogun State, Nigeria. Unpublished Master of Agriculture thesis, Department of Agricultural Economics and Farm Management, Federal University of Agriculture Abeokuta, Nigeria.

Alvaro, C., Tingju, Z., Katrin, R., Richard, S. J., & Claudia, R. (2009). Economy-wide Impact of Climate Change on Agriculture in Sub-Saharan Africa. Discussion paper at International Food Policy Research Institute (IFPRI), 00873:1.

Anyadike, R. N. C. (2009). Climate change and sustainable development in Nigeria: conceptual and empirical issues. In: Implications of climate change for economic growth and sustainable development in Nigeria. Enugu Forum Policy Paper 10. African Institute for Applied Economics, Nigeria.

Apata, T. G., Samuel, K. D. & Adeola, A. O. (2009). Analysis of climate change perception and adaptation among arable food crop farmers in South-western Nigeria. Paper presented at the conference of International Association of Agricultural Economics, Beijing, China, August 16-22.

Ayinde, O. E., Muchie, M., & Olatunji G. B. (2011). Effect of climate change on agricultural productivity in Nigeria: A Co-integration Model Approach. *Journal of Human Ecology, 35*(3), 189-194.

Darwin R., Marinos, T., Lewandrowski, J., & Raneses, A. (1995). World agriculture and climate change: economics and adaptations. AER-703. U.S. Department of Agriculture, Economic Research Service, Washington, D.C.

Deressa, T., Hassan, R. M., Alemu, T., Yesuf, M., & Ringler, C. (2008). Analyzing the determinants of farmers' choice of adaptation methods and perceptions of climate change in the Nile Basin of Ethiopia. IFPRI Discussion Paper, 00798.

Downing, T. E. (1992). Climate change and vulnerable places: global food security and country studies in Zimbabwe, Kenya, Senegal and Chile. Research Paper No 1, environmental change unit, University of Oxford, Oxford, United Kingdom, pp 54.

Easterling, W. E., Crosson, P. R., Rosenberg, N. J., McKenney, M. S., Katz, L. A, & Lemon, K. (1993). Agricultural impacts of and response to climate change in the Missouri-Iowa-Nebraska-Kansas (MINK) Region. *Climatic Change, 24*, 23-61.

El-shaer, M. H., Rosenzweig, C., Iglesias, A., Eid, H. M. & Hellil, D. (1997). Impact of climate change on possible scenarios for Egyptian agriculture in the future. *Mitigation and Adaptation Strategies for Global Change, 1*, 233-236.

Food and Agriculture Organization (2008). Climate change, bioenergy and food security: options for decision makers identified by expert meeting. Prepared for the high-level conference World Food Security: The Challenges of Climate Change and Bioenergy, June 3 – 5, Rome.

Gibson, M. (2012). The feeding of nations: re-defining food security for the 21st century. CRC Press (Taylor & Francis/Routledge), Boca Raton, Florids, USA. pp 684.

Gbetibuo, G. A. (2009). Understanding farmers' perceptions and adaptations to climate change and variability: the case of the Limpopo Basin, South Africa. IFPRI Discussion Paper 00849.

Gujarati, D. N. (2004). Basic Econometrics. (4th ed.) Tata McGraw-Hill.

Hassan, R. & Nhemachena, C. (2008). Determinants of African farmers'strategies for adapting to climate change: multinomial choice analysis. *African Journal of Resource Economics, 2*(1), 83-90.

Idumah, F. O., Mangodo, C., Ighodaro, U. B. & Owombo, P. T. (2016). Climate change and food production in Nigeria: implication for food security in Nigeria. *Journal of Agricultural Science, 8*(2), 74-83.

Ijeoma, S. (2012). Nigeria and climate change adaptation. International Society of Sustainability Professionals Insight, 1-6.

IPCC (2007) Summary for policy makers. In: Climate Change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, ML, Parry OF, Canziani JP, Palutikof PJ, van der Linden E and Hanson CE., (Eds.), Cambridge University Press, Cambridge, UK, pp 7-22.

Jagtap, S. (2007). Managing vulnerability to extreme weather and climate events: Implications for agriculture and food security in Africa. Proceedings of the International Conference on Climate Change and Economic Sustainability held at Nnamdi Azikiwe University, Enugu, Nigeria, pp 45-52.

Kaiser, H. M. (1993). Adaptation to global climate change at the farm level. In H. Kaiser and T. Drennen, (eds.), *Agricultural dimensions of global climate change*. St Lucie Press, Delray Beach, Fla.

Kandlinkar, M., & Risbey, J. (2000). Agricultural Impacts of Climate Change: if adaptation is the answer, what is the question? *Climate Change. 45*, 529-539.

Maddison, D. (2006). The perception of and adaptation to climate change in Africa. Discussion paper, No. 10, Centre for Environmental Economics and Policy in Africa, Pretoria, South Africa: University of Pretoria.

Nigerian Environmental Study Team (2004). Regional Climate Modeling and Climate Scenarios Development in

Support of Vulnerability and Adaptation Studies: Outcome of Regional Climate modeling Efforts over Nigeria, NEST, Ibadan Nigeria. pp 12-20.

Nwafor, J. C. (2007). Global climate change: The driver of multiple causes of flood intensity in Sub-Saharan Africa. Paper presented at the International Conference on Climate Change and Economic Sustainability held at Nnamdi Azikiwe University, Enugu, Nigeria, pp 67-70.

Obayelu, A. E. (2012). Comparative analysis of households' socioeconomic and demographic characteristics and food security status in urban and rural areas of Kwara and Kogi States of North-Central Nigeria. *African Journal of Food, Agriculture, Nutrition and Development, 12*(3), 24-34.

Obioha, E. (2009). Climate Variability, Environmental Change and Food Security Nexus in Nigeria. *Journal of Human Ecology, 26*(2), 107-121.

Odjugo, P. A. O. (2009). Quantifying the Cost of Climate Change Impact in Nigeria: Emphasis on Wind and Rainstorms, *Journal of Human Ecology, 28*(2), 93-101.

Odjugo, P. A. O. (2010). General Overview of Climate Change Impacts in Nigeria, *Journal of Human Ecology, 29*(1), 47-55.

Ogen, O. (2007). The agricultural sector and Nigeria's development: comparative perspectives from the Brazilian agro-industrial economy 1960-1995. *Nabula, 4*, 184-194

Okoli, J. N., & Ifeakor, A. C. (2014). Overview of climate change and food security: adaptation strategies and mitigation measures in Nigeria. *Journal of Education and practice, 5*(32), 14.

Olarewaju, T. O. (2018). Wetlands Attributes, Associated Livelihood Outcomes and Willingness to Pay for Wetland Development among Households in Communities around Ogun River Basin, Nigeria. Unpublished PhD thesis, Department of Agricultural Economics, Federal University of Agriculture, Abeokuta, Nigeria.

Onyeji, C., & Fischer, G. (1994) An Economic Analysis of Potential Impacts of Climate Change in Egypt, *Global Environmental Change, 14*, 4.

Onyenechere, E. C. (2010). Climate change and spatial planning concerns in Nigeria: Remedial measures for more effective response. *Journal of Human Ecology, 32*(3), 137-148.

Onyeneke R. U., & Madukwe, D. K. (2010). Adaptation measures by crop farmers in the Southeast rainforest zone of Nigeria to climate change. *Science World Journal, 5*(1), 32-34.

Oyebanjo, O., Ambali, O.I., & Akerele, E.O. (2013). Determinants of food security and incidence of food insecurity among rural farming households in Ijebu division of Ogun State, Nigeria. *Journal of Agricultural Science and Environment, 13*(1), 92-103.

Ozor, N., & Cynthia, N. (2011). The role of extension in agricultural adaptation to climate change in Enugu State, Nigeria. *Journal of Agricultural Extension and Rural Development, 3*(3), 42-50.

Sofoluwe, N. A., Tijani, A. A., & Baruwa, O. I. (2011). Farmers' perception and adaptation to climate change in Osun State, Nigeria. *African Journal of Agricultural Research, 6*(20), 4789-4794.

Tobey, J., Reily, J., & Kane, S. (1992). Economic implication of global climate change for World agriculture. *Journal of Agriculture and Resource Economics, 17*, 195-204.

Umar, H. S., & Ibrahim, H. Y. (2011). Mitigating Climate Change through Organic Agriculture: A Case Study of Farmers. Participation in Organic Farming Practices in Nasarawa State, Nigeria'.*Journal of Life and Physical Science, 4*(1), 44-52.

United States Department of Agriculture (USDA) (2016). Survey Tools. United States Department of Agriculture-Economic Research Service. http://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-theus/survey-tools.aspx Accessed on 28th November, 2019