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IMPACT OF CLIMATE CHANGE ON FOOD PRODUCTION AND FOOD SECURITY IN NIGERIA: A CASE STUDY OF ONDO WEST LOCAL GOVERNMENT AREA

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Abstract

The issue of climate change and its impact on agriculture has become an unending discussion, and is of major international concern. This could be attributed to the increase in greenhouse gases. That's why the United Nations Framework Convention on Climate Change has called for stabilization of greenhouse gas concentration in the atmosphere at a level that would prevent serious anthropogenic interference with the climate system, and to ensure that food production is not threatened but secured. This paper investigates the impact of climate change on food crop production and food security in Tropical Africa; Nigeria. The study examines the incidence of climate change and their probability of occurrence on food production, and the trend in the food crop yield level of the farmers among other objectives. A total of fifty (50) seasoned food crop farmers were sampled and interviewed in the study area. Sampling was done using snowballing technique to identify a sample frame and simple random sampling was carried out to select the fifty respondents. Both descriptive and inferential statistics were used in data analysis; frequencies, means and loggit regression techniques were used. The food crop farmers in the study area produce mainly cassava, yam, maize, vegetables (tomatoes, pepper, and okra) and tree crops. The study revealed that climate change results in adverse conditions of flooding, drought, diseases, pests' outbreak, erratic rainfall and high temperature with high probabilities of occurrence. Also that farmers use various management strategies to address the possibilities of loss in yields and food insecurity threats due to climate change effects, amongst which are: enterprise and geographical diversification, irrigation and drainage, shift to foreign foods and change of diets, even skipping meals.

Key words: Agriculture, Climate Change, Food Security

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Introduction

Globally, agricultural food production processes are dependent on climate and the recently changing climate has also become a threatening issue across the globe to the sustenance of food production. Increase in environmental temperature is projected to have significant effects on conditions necessary for agricultural practice; and these include temperature, carbon dioxide, glacial run-off, precipitation and the interactions of these elements as well as shifting seasons (Challinor, Ewert, Arnold, Simelton, and Fraser, 2008). The vulnerability of agriculture to climate variability and change is an issue of major importance to the international community, a concern which is reflected in Article 2 of the United Nation Framework Convention on Climate Change (UNFCCC). The Convention called for the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent serious anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, ensure that food production is not threatened sand enable economic development to proceed in a sustainable manner.

Agricultural practice in Tropical Africa is heavily dependent on rainfall and temperature. Increase in temperatures eventually could encourage weeds, diseases and pests proliferation and reduce yields of crops. On the other hand, changes in rainfall pattern will increase the likelihood of crop failures and decline in production. The overall impacts of climate change on agriculture are expected to be negative, threatening global food production and food security. The changes would have serious impacts on the four dimensions of food security: food availability, food accessibility, food utilization and food system stability (CCMIN, 2009), and can put millions of people in developing countries at greater risk of poverty, hunger, and malnutrition. Possible effects would be felt in food markets, and are likely to be particularly significant in rural areas where agriculture is their primary occupation. Negative impacts will be felt in locations where supply chains are disrupted, market prices augment, and assets and livelihood opportunities are lost; leading to fall in purchasing power, human health endangering and inability of victims to cope.

The possible impacts of climate change on agriculture and food security are to be viewed with great concern especially in tropical Africa where rain-fed agriculture is still the primary source of food and income. For most farmers, either subsistence or commercial in Nigeria, production operations are dependent on rainfall, temperature and other climatic conditions. It is therefore obvious that any change in these climatic conditions would likely impact on their production, and such, the adoption of risk management measures and adaptation strategies that strengthen preparedness

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and resilience seemed the only option for their livelihood security. However, available literature in the context of Nigeria shows a gap in information on effect of climate change on food production and food security that can inform policy on strategies for sustainable food production and food security in Nigeria. This study seeks to fill this fissure using the case of food crop farmers in Ondo West LGA of Ondo State, Nigeria.

Aim and Objectives

The aim of the study is to explore the impact of climate on food production and food security in Nigeria. The specific objectives were to:

i. Examine the incidence of climate change outcomes and their probability of occurrence on food production,

ii. Assess the changing trends in the yield levels of farmers;

iii. Identify farmers' access to the right dietary and healthy food;

iv. Assess climate change outcomes on the household food insecurity situation of food crop farmers; and

v. Identify the farmers' coping strategies of climate change and food security threats.

Research Hypothesis

H_0: Climate change outcome variables (flooding, drought, pests and disease outbreak, erratic rainfall and increase in temperature) do not have significant impact on food insecurity situation of food crop farmers' households.

Methodology

The target population for the study were all food crop farmers in the Ondo municipal who had being in the farming business for not less than twenty (20) years of continuous farming seasons. These farmers were then contacted and assisted in identifying others who form part of the target population through snow-ball technique to obtain the sample frame. Sampling of respondents was done using simple random sampling technique (the lottery method). The study involved fifty (50) food crop farmers. Data were collected from the farmers using structured interview schedule which was pre-tested before the main survey. Data collected were analyzed using both descriptive and inferential statistics. Frequencies, percentages, means, standard deviations, and loggit regression model were used. The loggit regression model was adopted to ascertain quantitative contribution of climate change outcome variables in explaining household food security situation of the food crop farmers. This model estimation technique has been used in a number of studies (Dadzie and Dasmani, 2010; Nhemachena, Hassan, and Chakwizira, 2009) to obtain satisfactory and credible results. In the modeling, the influence of

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some socio-economic characteristics of farmers which were assumed to also have significant effect in explaining household food security situation of the farmers was considered. The model was estimated to examine the percentage variation in farmers' household food security situation that is explained significantly by the climate change outcome variables (Pallant, 2001; and Gujarati, 1992). The determinants of household food security were specified as follows:

$$\text{Log}\left[{}^{Pi}/_{(1-Pi)}\right] = X\beta + u$$

Where:

P_i = the probability that a particular condition occurs
X = the matrix of observations of the explanatory variables
β = the column vector of the coefficients
u = the vector of disturbances

The above theoretical model was used to specify the model to estimate how household food security situation of food crop farmers was affected by climate change outcome variables. The tests of the beta coefficients in the model equation were used to draw conclusion on the research hypothesis based on the following loggit model:

$$\text{Log}\left[{}^{Pfs}/_{(1-\text{Pfs})}\right] = \beta_0 + \beta_1 D_1 + \beta_2 D_2 + \beta_3 D_3 + \beta_4 D_4 + \beta_5 D_5 + \beta_6 A_g + \beta_7 S_e + \beta_8 F_e + \beta_9 H_s + \beta_{10} E_d + \beta_{11} F_a + \beta_{12} E_{4x} + u$$

Where:
P_{fs} = probability that food insecurity situation occurs
D_1 =1 if high probability of flooding occurs; = 0 if otherwise
D_2 =1 if high probability of drought occurs; = 0 if otherwise
D_3 = 1 if high probability of pests outbreaks occurs; = 0 if otherwise
D_4, =1 if high probability of disease outbreaks occurs; = 0 if otherwise
D_5 = 1 if high probability of erratic rainfall occurs; = 0 if otherwise
A_g = age of farmer
S_e = 1 if farmer is male; = 0 if female
F_e = farming experience in years
H_s = household size
E_d = years of formal education
F_a = farm size
E_x = contact with extension agents

Results and Discussion

Incidence of Climate Change, Crop Yields and Food Security Situation of Food Crop Farmers

Based on the experience of the food crop farmers, the incidence of flooding, pests and diseases outbreaks, drought, high temperature and erratic rainfall are the commonest events they have been battling with due to climate variability and change. This finding is in line with the revelation of Sagoe (2006) on climate change and root crop production. She revealed that climatic factors are stressors to root crops, specifically unreliable, irregular and unpredictable rainfall. Duration of rain shortened and it is either too much (flooding) or too little (drought). She reported that prolonged drought 'increases the population of

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variegated grasshoppers which destroy cassava. In this study, the probabilities of occurrence of the identified eventualities due to climate change were assessed as presented in Table 1 below. From Table 1, p>0.5 implies high probability of an event's occurrence; 0.3<p<0.5 implies moderate probability of an event's occurrence; and p<0.3 implying low probability of event's occurrence. Farmers were able to estimate how often they had experienced the identified climate change outcome variables in the twenty (20) years of continuous cropping seasons in the immediate past; and this was used to compute the probabilities. The frequencies and percentages in Table 1 indicate how many of the food crop farmers encountered a particular climate change event. The results show that more than half (i.e. 60% - 96%) of the food crop farmers assessed all the identified climate change eventualities with high probabilities of occurrence. The possible devastating effects of these high risk parameters on the production activities of the affected farmers confirm that food crop production in sub-Saharan Africa for that matter Nigeria is at high risk of being negatively affected by climate change. Recent studies suggest that agricultural crop productivity in Africa will be adversely affected by any warming above current levels (Kurukulasuriya et al., 2006; Seo & Mendelsohn, 2008; and Nhemachena, Hassan, & Chakwizira, 2009).

Table 1: Climate change outcome variables and their probabilities of occurrence

Outcome variable	P>0.5		0.3≤P≤0.5		P<0.3	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Flooding	35	70	10	20	5	10
Pests outbreaks	32	64	12	24	6	12
Disease outbreak	35	70	9	18	6	12
Drought	30	60	15	30	5	10
Erratic rainfall	40	80	7	14	3	6
High temperature	48	96	1	2	1	2

Key: p>0.5 — high probability; 0.3 <p <0.5 — moderate probability; P<0.3 — low probability
Source: Field survey, 2022.

Given the high probability of climate change variable outcomes occurrence in the study area and the suggested devastating impact of these climate change factors on agricultural production in literature, the study further investigated the changing trends in yield levels in the last twenty continuous cropping seasons of the farmers. Fig. 1 indicates the results of the observed changing trends in the yield levels of food crop farmers in the study area. The results show that majority (85%) of the food crop farmers had consistently experienced a decreasing trend in the yield levels of their food production. A trend, which according to ILO (2008) put sub-Saharan Africa at risk of vulnerability to food insecurity. Interestingly, only few farmers did not experience significant change

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(10%) or who had consistent increase (5%) in their yields. The differences in the effect of climate change observed amongst the farmers might be due to differences in the adaptation strategies being used by the farmers such as use of resistance varieties, change in crop type to sustain their production, a view supported by the literature ((Brown and Crawford, 2007; Mendelsohn, 2000). For example, Mendelsohn (2000) found in an agronomic study that yields of agricultural produce could fall quite dramatically in the absence of costly adaptation measures.

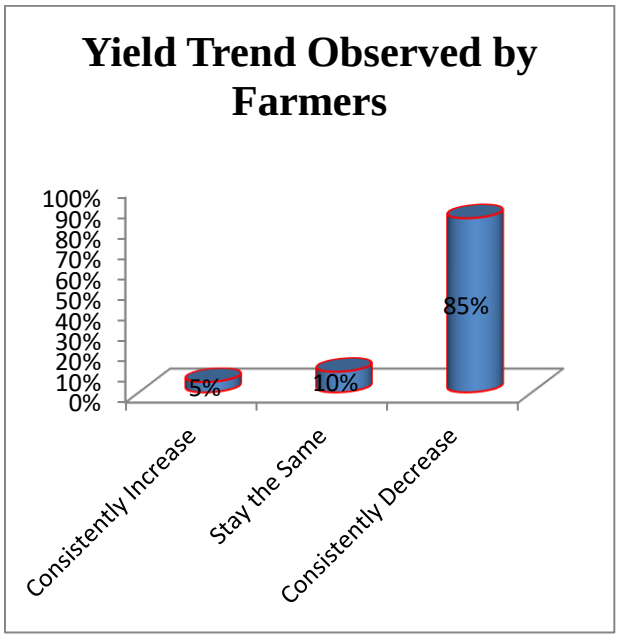

Figure 1: Observed Changing Trends in Yield Levels of Farmers.
Source: Field Survey, 2022

Trends in Yield Changes

Considering the possible consequences that climate change effect on yields can have on the income of the households of the affected farmers, the study investigated farmers' ability to afford right dietary and nutritious food. The results indicate that only 5% of the farmers had observed increased change in their ability to afford right dietary and nutritious food whereas 87% had experienced a decreased change in their ability to afford right dietary and nutritious food to feed their households (Fig. 2). This suggests that food security in the study area is under threat from unpredictable changes in rainfall and more frequent extreme weather. This is not surprising because the devastating effect of climate change negatively affected majority of the farmers' food crop production (Fig. 1) and consequently, affect their households' livelihoods. This tends to support the FAO (2003) position that increasing food production in developing countries would be the basis on which to build their food security.

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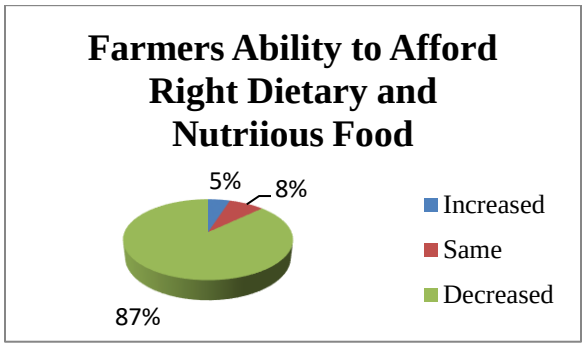

Figure 2: Observed Changes in the Farmers Ability to Afford Right Dietary and Nutritious Food Source: Field Survey, 2022

Food Security Situation in Farmers' Household

The study also assessed the food security situations of the farmers' households. The results show that only 6% of the farmers interviewed households were food secured (Table 2). 7% of the households interviewed were found to be food insecured without hunger while half (50%) of the households were food insecured with hunger. On the other hand 15% were severely food insecured. The results suggest that majority of the farmers' households in the study area experience high degree of food insecurity threat posed by climate change effects on their production activities. According to Bilinsky and Swindale (2007) climate change can create periods of inadequate household food provisioning especially between the periods of lean season (stock depletion) and the next bumper harvest. The results tend to support the Ghana Dietary and Health Survey (2003) report that about 13 percent of the population as at 2002 (about 2.5 million people) had dietary composition below minimum level, with child-malnutrition at about 22 percent, 30 percent stunted, 7 percent underweight and 22 percent wasted due to lack of food security. Food security is when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO, 1996). Kidane, Maetz and Dardel (2006) indicated that food security comprises four dimensions namely: adequacy of food availability, stability of supply, physical and economic accessibility of food, and quality and safety of food.

Table 2: Classification of Farmers Households Based on Food Security Situations

Food security situation	Frequency	Percent (%)
Food secured	3	6
Food insecured without hunger	7	14
Food insecured with hunger	25	50
Severely food insecured	15	30
Total	**50**	**100**

Source: Field Survey, 2022

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Impact of Climate Change on Food Security Situation of the Food Crop Farmers

Food security situation was measured on ordinal level as a dummy where 1 was assigned if a farmer's household is food insecured and 0 if otherwise. The result of the analysis in Table 3 indicates that Nagelkerke R Square was 0.424. This implies that 42.4% of the variation in food security situations of food crop farmers was explained by the climate change effects in agricultural production and other socio-economic variables. The chi-square test of the regression model was significant at alpha level of 0.01 and this means that these variables in the model have significant composite effect in explaining food security situation of farmers. From the result, the test of beta coefficients of the predicting variables in the model shows that, flooding, disease outbreak, and age were significant at 0.01 alpha level in explaining the food security situation of the farmers (Table 3). Drought, pest outbreaks and farming experience were also significant at 0.05 alpha level. Farming experience was found to be inversely related to food security situation of the farmers. This implies that the less experienced a farmer is, the more the likelihood of that farmer's household becoming food insecured. The result shows that other variables found to have significant influence had positive and direct influence on food security. This implies that the more there were conditions of flooding, disease and pest outbreaks, increase in temperature and drought due to climate change in the study area, the more food insecure the food crop farmers will become. It buttresses the result in Table 2 where most of the farmers are food insecure at various degrees. Farmers might become food insecure due to climate change effects as a consequence of their devastating effect on production activities and yields (Brown & Crawford, 2007; Nhemachena, *et al* 2009)

Table 3: Impact of Climate Change and Its Determinant of Food Insecurity Situations of Farmers' Household (Loggit Regression)

Explanatory variables	β coefficient	Wald
Constant	1.692	6.722**
Pests outbreaks	0.407	0.956*
Disease outbreaks	0.685	2.967**
Drought	0.398	0.634*
Flooding	0.836	4.215**
Erratic rainfall	-0.118	0.095
High temperature	0.014	0.041
Age	1.006	5.115**
Sex	0.142	0.471
Farming experience	-0.579	1.689**
Household size	0.093	0.130
Education	-0.351	0.475
Extension workers' contact	-0.024	

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Model Summary

Cox & Snell Rsquare	0.381
Nagelkerke R-square	0.424
Chi-square	36.89**
Sig. (p-value)	0.000

****; *: significant at 0.01 and 0.05 alpha levels respectively**

Source: Field survey, 2022

Farmers' Coping Strategies of Climate Change

From the result in Table 4, none of the farmers use crop insurance policy as a climate change coping response to address the risk of loss. This was also the case in the study of Dadzie and Acquah (2010). The farmers explained that they did not know of any insurance package which they could patronize to assist them in situation of 'bad' uncertain occurrence of adverse weather effects such as drought, flooding, high temperature, and high incidence of disease and pest infestation. The confidence which farmers could have gained to invest in production through insurance policy to cushion their financial position in case of 'bad' happening might be lost as well (Harwood, et al, 1999). The result shows that more than half (58%) of the farmers use irrigation and drainage measures as a management strategy to deal with risk of drought and floods resulting from climate change. It was realized that some of the farmers (42%) either lack the technical know-how or adequate funds to invest in even simplest irrigation system. Irrigation and drainage as a coping strategy has a major impact on output through its support with multiple cropping and improved seeds during cultivation (Ellis, 2000). Another response strategy that seemed to help is the use of improved and resistance variety. Significant numbers of farmers (60%) were found to use this strategy. Majority of food crop farmers used enterprise diversification strategies. These included mixed farming (94%) and crop rotation (80%). However, all the farmers use mixed cropping (100%) while 92% of the farmers used geographical diversification (shifting cultivation) as coping mechanism. These buttress the fact that with inadequate fund to invest, coupled with lack of confidence due to fear of risk through past experience in food crop farming business, farmers would only adopt subsistent measures to ensure that their families at least have something to feed on all year round (Owusu-Acheampong, 1996).

Table 4: Climate Change Copping Strategies for Food Crop Production

Coping strategies	Use		Not use	
	Frequency	Percent (%)	Frequency	Percent (%)
Mixed farming	47	94	3	6
Crop rotation	40	80	10	20
Mixed cropping	50	100	-	-
Shifting cultivation	46	92	4	8
Irrigation and drainage	29	58	21	42
Crop insurance	-	-	50	100
Use of resistant varieties	30	60	20	40

Source: Field survey, 2022

The farmers sampled produce mainly for subsistence reason and yet, their food reserves were low. These farmers were either not able to produce enough to last throughout the year or were unable to store enough produce for home consumption throughout the year. The question now is "how do their households survive in the food insecurity period?" The answer to this question is presented in Table 5 below. The farmers' households, during food insecurity periods, use a wide range of coping mechanisms. The food insecurity strategies adopted by most of the farmers were to

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change of diet (56%), skip meals (30%), consume less preferred food (40%) and search for foreign food (56%). Other strategies given by few of the farmers reduce food intake (60%), borrow money from friends and relatives to feed (74%), buy some food items on credit (80%) and selling non-productive assets (20%).

The results implies that one of most pressing way by which the farmers obtain food when run out of stocks was to either buy them on credit or borrowed from friends and relatives. This confirms the finding of Quaye (2008). Another way was to ration food intake. Some households decided to reduce food intake by reducing the number of meals per day whiles others did food rationing by reducing the quantity/amount of food during meals. This conforms to the study of Nyanteng and Asuming-Brepong (2003). They reported that household strategies to sustain food security include shifting to less expensive and less preferred foods, borrowing food or money to buy, purchasing food on credit, seeking assistance from friends and relatives and purchasing street food. They also concluded that in periods of food stock depletion, some households limit portion size at mealtimes, limit intake by adults for children to get enough, reduce the number of meals per day and skip whole days without eating.

Table 5: Food Insecurity Strategies Adopted by Farmers Households in Times of Food Shortage

Strategies	Frequency	Percent (%)
Changed diet	28	56
Skipped meals	15	30
Consumed less preferred food	20	40
Searched for foreign food	28	56
Reduced food intake	30	60
Borrowed money from friends and relatives to feed	37	74
Buy some food items on credit	40	80
Sold non-productive assets to buy food	10	20

Source: Field survey, 2022

Conclusion

Based on the findings of the study, it could be concluded that flooding, pests and diseases outbreaks, drought, increased temperature and erratic rainfall are the common incidence of events that can confront food crop production and food security in the study area with uncertain seasonal shifts due to climate variability and change. There is a high probability of climate change occurrence in the study area. Food crop farmers in the study area consistently experience a decreasing trend in the yield levels of their food produce; consequently, it has decreased their ability to

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afford right dietary and nutritious food to feed their households.

Also that majority of the farm households in the study area were food insecure with more than half of them facing hunger and severe food insecurity. Farm households' food insecurity situation was found to be explained positively and significant by the climate change effects in agricultural production. Flooding, disease and pests outbreak, drought, age and farming experience were variables in the estimated regression model that made significant influence on food insecurity situation of the farm households This study conclude that food crop farmers use enterprise diversification (mixed farming, mixed cropping, and crop rotation), geographical diversification (shifting cultivation), and improved and resistance variety management strategy to cope with the risk of drought and floods that occur due to climate change. The study also concludes that food crop farmers in the study area have not used crop insurance policy as a climate change coping response to address the risk of yield loss. The use of irrigation and drainage systems by farmers as a management strategy to deal with risk of drought and floods that occur due to climate change is also a practice in the study area. The food insecurity strategies adopted by majority of the farmers were borrowed food and money from friends and relatives, searching for foreign food (collection of wild foods), reduced food intake, and change in diet even buying food items on credit. The study also concluded that some farmers consumed less preferred food, selling non-productive assets to feed, and skipped meals during the periods of food stock depletion in their households.

Recommendations

Therefore, based on the findings, the following recommendations were made:

1. Government and concerned bodies should strengthen scientific research through provision of grants for agricultural research, agricultural knowledge systems, and applied climate research for policy actions.
2. Government and private insurance companies should consider developing insurance product for food crop farmers to patronize and use as shock absorbers against uncertain events.
3. Farmers are encouraged to use their existing adaptation strategies to address climate change effects in food production whilst looking up to policy actions by the government and agricultural policy makers.
4. Farmers are also encouraged to consider investing in irrigation and drainage techniques as management strategy to deal with risk of drought and floods that occur due to climate change.

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5. Farmers should seek for information which would enable them makes informed decision on food security issues. There is the need to involve more farmers and other stakeholders in setting priorities for investments in food security programmes.

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