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INVESTIGATING THE EFFECT OF CLIMATE CHANGE ON FOOD SECURITY IN ADAMAWA STATE, NIGERIA

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ABSTRACT

This study examined the effect of Climate Change on Food Security in Adamawa State, Nigeria, in which nine-teen (19) out of the twenty-one (21) local governments of Adamawa State were sampled. Thirty-five (35) copies of the questionnaire designed for the study were allocated and distributed to the farmers heads, household heads, and whole sellers of Agricultural products based on random and systematic sampling in which interview was restricted to only farmers' heads. Structural Equation Model (SEM) was employed in the study achievement of specific objectives. The findings of the study confirmed the evidence of pass-through effect of climate change on food security in Adamawa state as food stability, food accessibility, and food utilization significantly reduce as a result of the decrease in food availability caused by changes in climate. This implies that, high rate of climate change contributes to food shortages, consequently, individuals will not have access to food due to its instability thereby leading to absent of nutritional well-being. The study concludes that, climate change significantly affects the four dimensions of food security. The magnitude of the effect of climate change on food stability as one of the dimensions of food security is higher than that of the remaining two dimensions. This implies that, due to the shortage of food caused by climate change food is not stable in Adamawa State. The study therefore, recommends that, proper measures should be taken to reduce the effect of climate change such as adaptation and mitigation and government should intervene in food production to ensure food stability, affordability, and utilization.

Keywords: Investigation, Effect, Climate Change, Food Availability, Food Stability, Food Accessibility, Food utilization.

1.0 Introduction

The significant effect of climate change has encouraged global concern on investigating the measures that can be applied in addressing the challenges. As it is generally known that, eradication of hunger and ensuring food security as well as improving nutrition are among the Sustainable Development Goals (SDGs) agenda, but the consequences of climate change constitute significant threat to human life as its place disruption in the goal. Climate change is therefore a long term change in the statistics of weather distribution patterns over a long period of time that range from decades to millions of years. It may be a change in the predominant weather conditions or a change in the distribution of weather events with respect to an average. Climate change may be limited to a specific region or may occur across the earth. At the root of climate change is the phenomenon known as the greenhouse effect - the term scientists use to describe the way that certain atmospheric gases "trap" heat that would otherwise radiate upward, from the planet's surface, into outer space (Garba *et. al*.,

2023). According to the report of FAO (2016) the effect of climate change on our ecosystem are already widespread and therefore, ensuring food security at the present of climate change is difficult. About 800 million people in the world are chronically undernourished, 161 million under five years old are estimated to be stunted, 500 million people are obese and 2 billion people lack essential micronutrients they need to lead a healthy life. Furthermore, climate change is expected to put additional 132 million at risk of hunger by 2050 (IFAD 2009). ACF (2014) also reported that climate change has contributed to the serous food insecurity which make about 842 million people suffering from hunger.

Agriculture is an economic activity which is aimed at food production. Consequently, the current and future food security of the globe depends on the success of these activities (Hatab *et al*, 2019; Rizal and Anna, 2019). Climate change and increasing temperature are therefore, the main factors that directly affect agriculture and water resources resulting to food insecurity. This is as a result of the fact that the all component of food security must be affected. Ughaelu (2017) pointed out that the change in environmental condition caused by climate change affect the six vegetative zone of Nigeria differently. It reduces rainfall, drought and increases desertification in the semi-arid Sudan and arid-sahel Savannah region. In Northern and Southern Guinea Savannah climate change causes late arrival of rainfall and longer dry seasons. But it brings about delays in rainfall onset, prolonged dry season, heat waves and flooding along the coastal lines. In the case of mangrove swamp, climate change led to flooding of usually dry pains and persistent rise in sea level which significantly affect the farming activities, increasing water temperature and consequently affect fishing negatively.

Anti, Anyika and Mutambara (2022) explained that climate change is the changes in the mean variability properties of the climate which persist over an extended period of time typically within decades or longer. According to Devendra (2012), climate change is a relatively new science and is generally as an unprecedented man-created calamity that required more than immediate action and response to solution. It is a complex problem that involves different interaction between the environment, natural resources and people.

It has been discovered that human activities which includes industrial revolution, agricultural activities, animal husbandry, explosion e.t.c, increase greenhouse gases such as CO_2 mathane (CH_4), water vapor (H_2O), and nitrous oxide (N_2O) (Wecking 2021; & Jogdand, 2020). The causes of climate change according to Mirzaei, Kahrizi and Hassan (2021) is classified into two: Natural and human causes. Natural causes include Volcanoes, Earth's axial tilt and Ocean current. On the other hand, human causes include industrial revolution agricultural sector, Nuclear weapon e,t,c. Pettersson et al, (2020) explain that the cause of climate change is either natural or human which normally contributes to the changes in temperature, precipitation pattern, Ocean warming and acidification, or even diversion in wind pattern that can alter the transport of pollutant.

Food security refers to access to basic nutritious food (Anti, Anyika and Mutambara 2022). On the other hand, food security exists when all people, at all times have physical and economic access to sufficient, safe and nutritious food that meet their dietary need and food preference for an active and healthy life (World Food Summit 1996). Food security is an important

element of poverty, and embraces production, supply, processing, distribution and market access.

According to FAO (2009) food security involve four dimensions:

i. Availability: that is, enough quantities of food of appropriate quality, supplied through domestic production or imports.
ii. Accessibility: that is affordability by individuals to food (entitlements) for a nutritious diet.
iii. Utilization: that is, adequate diet, clean water, sanitation and healthcare to reach a state of nutritional well-being where all physiological needs are met.
iv. Stability: that is, constant and frequent supply and distribution of food without seasonal fluctuation or shortage.

The study therefore, will assist government officials as well as policy makers in taking measures on climate change and formulating policies on food system upon which food security depend. It will also help the non-governmental organizations agencies, NGOs/Donor agencies and other relevant stakeholders in increasing their effort toward improving the dimensions of food security for ensuring food security. The study will equally contribute significantly to the achievement of Sustainable Development Goals agenda (i.e. hunger eradication).

Statement of the Problem

In spite of the effort made and policies embarked upon for ensuring food security, fluctuation in climate become a major thread on food security in Adamawa State. All the dimensions of food security (availability, stability, accessibility, and utilization) are therefore, seriously affected which on the other hand translated into social and economic consequences, as it led to changes in agricultural income, food market prices and trade pattern as well as investment pattern. The magnitude however, of the response of each food security component (as the component are what constitute food security) to climate change varies to one another. This has not been taken into account by the previous studies reviewed. This is because, Focuses are much given on the general response of food security to climate change by the previous study, which may lead to wrong findings and conclusions. Hence, studies on climate change and food security have not been adequately conducted in respect to Adamawa state. These previous studies include: Ani, Anyika and Mutambara (2022), Mirzaei, Kahrizi, and Hassan (2021), Atitsogbey, Steniner-Asiedu and Ansong (2018), Dinko (2017). Therefore, this study aims at examining the impact of climate change on food security in Adamawa State, Nigeria.

Objectives of the study

i. To determine the effect of climate change on food availability
ii. To determine the effect of climate change on food stability.
iii. To ascertain the effect of climate change on food accessibility.
iv. To determine the effect of climate change on food utilization.

Research Questions

i. How does climate change affect food availability?
ii. What is the effect of climate change on food stability?
iii. How does climate change affect food accessibility?

iv. What is the effect of climate change on food utilization?

Hypotheses

The following hypotheses were formulated from the objectives of the study, thus:

v. H_0: There is no significant relationship between climate change and food availability
vi. H_0: Climate change has no significant pass-through effect on food stability.
vii. H_0: There is no significant pass-through effect of climate change on food accessibility.
viii. H_0: There is no significant pass-through effect of climate change on food utilization.

Methodology

Research Design

The study under investigation is quantitatively design to examine the impact of climate change on food security in Adamawa State, Nigeria. The design on the other hand, is correlation in nature as it accounts for cause-effect nature of relationship between variables. Primary data was used and analyzed with the use of Structural Equation Model (SEM).

Method of Data Collection

The instruments that were used for collecting the data were questionnaires and interview in the selected local governments in the senatorial zone of Adamawa State.

Population of the Study

The population of the study will be all farmers heads, household heads, and whole sellers of Agricultural products (Rice and Maize which are the major dominant and consumable crops) of the entire twenty-one **(21)** Local Governments of Adamawa State.

Sampling Techniques and Sample Population

Nineteen (19) out of the twenty-one (21) Local Governments of Adamawa State will be sampled based on the sample size developed by Sakaranj (2003). From which farmers heads, household heads, and whole sellers of Agricultural products will further be sampled on the basis of random and systematic sampling. Hence, thirty-five (35) questionnaires will be allocated and distributed to the relevant respondents of each sampled local government (i.e 19 LGA) and interview will be restricted to only farmers heads. In order to ensure reliability and accuracy of the data and to eliminate the chances of bias in the selection of the sample, percentage of local government in each senatorial zone is divided by the total number of local governments of the entire state (21) multiplied by the number of sampled Local Government (19):

Table 1: Sampling Procedure

S/N	Senatorial/Z	Total No. of LGAs	Sampled LGAs	No. of Respondents
1	**Central Zone**	7	6	210
2	**Southern Zone**	9	8	280
3	**Northern Zone**	5	5	175
	Total no. of sampled LGAs	**21**	**19**	**665**

Source: Generated by the author

Method of data Analysis

Structural Equation Model (SEM), which is a statistical technique developed for analyzing the inter-relationship among variables will be used in this study. The model Therefore, will be employed for the achievement of the entire research objectives of the study as shown in model specification and figure 1(Path Diagram) below:

3.6 Model specification

$Y^* = X^*\beta^* + \varepsilon^*$ ----------(1)

Where:

Y^*=Endogenous variables, which include: FAV, FST, FAC, and FUT

X^* = Exogenous variable (X_1) which is CCh

$\beta^* = \beta_1, \beta_2, \beta_3, \beta_4$, (parameter estimates)

$\varepsilon^* = \varepsilon_1, \varepsilon_2, \varepsilon_3, \varepsilon_4$ (Error Terms)

FAV = Food Availability, FST = Food Stability, FAC = Food Accessibility, FUT = Food Utilization, and CCh = Climate Change

The Structural Equation Model (SEM) can therefore be expressed further as:

$Y = X_1\beta_1 + X_1\beta_2 + X_1\beta_3 + X_1\beta_4 + \varepsilon_1 + \varepsilon_2 + \varepsilon_3 + \varepsilon_4$ ---------- (2)

With four (4) dependent variables (endogenous variables) DVs and one (1) independent variable (exogenous variable) IV, Structural Equation Model (SEM) is the best. This is because, the model is capable of incorporating more DVs and a single IV.

Results and Discussion

Measurement Model

The FAV= (food availability), FST=(food stability), FAC=(food accessibility), FUT=(food utilization), are used as a dependent variables, whereas, CCH=(climate change) is the independent variables. As such, five (5), relevant questions for each variable under the study were theoretically raised to stand for a latent construct of the food availability, food stability, food accessibility, food utilization and climate change. However, the latent constructs satisfied the series of pre-estimation test of model fitness, reliability and validity as shown in Table 4.5. The entire factor loadings are significantly higher than 0.6. This shows that all the factor loadings are within the acceptable range based on the decision rule.

Table 1: Individual Confirmatory Factor Analysis CFA (Model Fit) and Reliability Test

Variables	RMSEA	GFI	AGFI	CFI	TLI	NFI	CHISQ/DF	PV	Cronbachα
Food availability	0.061	0.987	0.905	0.911	0.948	0.919	2.569	0.036	0.773
Food stability	0.092	0.911	0.911	0.956	0.941	0.919	2.422	0.0064	0.712
Food accessibility	0.056	0.909	0.947	0.982	0.917	0.983	3.326	0.0237	0.821
Food utilization	0.082	0.939	0.967	0.912	0.914	0.939	5.511	0.0015	0.733
Climate change	0.081	0.927	0.945	0.961	0.948	0.989	4.439	0.014	0.813

Source: Generated by the author using Amos, version 22

Table 1 presented the results which were obtained through Confirmatory Factor Analysis (CFA) to provide support for the issue of unidimentionality, validity and internal reliability. The result for the CFA shows relatively a reasonable fit of the five factors model on the basis

of a number of fit statistics. The table shows that the models are of good fit: the ratio of Chi-square to degree of freedom, RMSEA, GFI, AGF, CFI, TLI and NFI are all within the acceptance range.

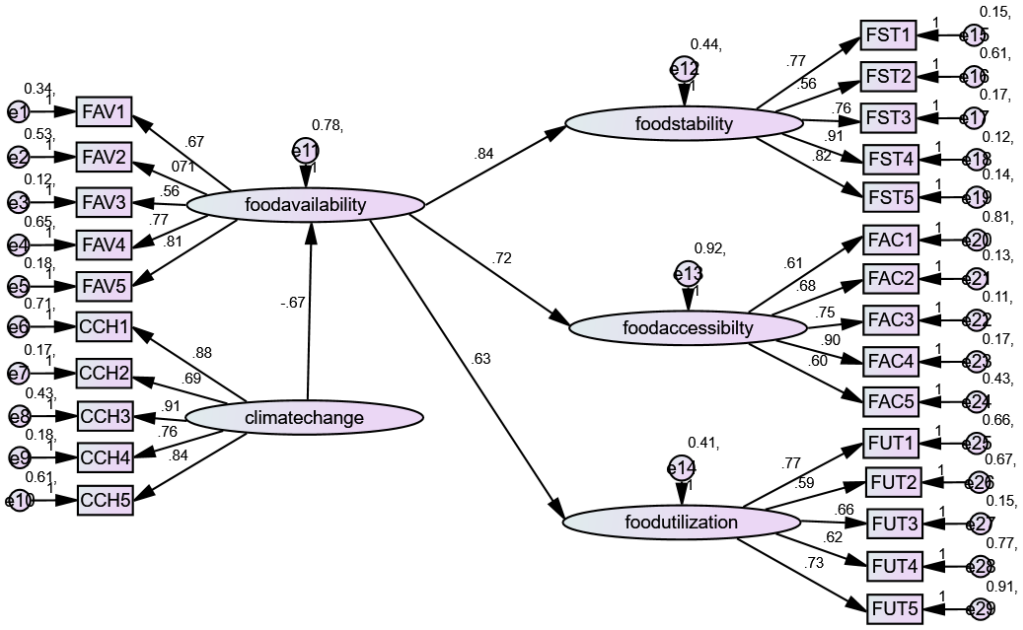
The factor loading for all latent constructs were all above 0.6 and the Cronbach Alpha as indicated in table 4.1 for the FAV=(food availability), FST=(food stability), FAC=(food accessibility), FUT=(food utilization), and CCH=(climate change) were 0.773, 0.712, 0.821, 0.733, and 0.813. All the Cronbach Alpha exceeds the minimum value of > 0.7. Model fitness results were also clearly indicated in Table 4.1 showing RMSEA=0.061 for FAV, 0.092 for FST, 0.056 for FAC, 0.082 for FUT, 0.081 for CCH.

GFI=0.987, 0.911, 0.909, 0.939, and 0.927 for FAV, FST, FAC, FUT, and CCH respectively. While the AGFI=0.905, 0.911, 0.47, 0.967, and 0.945, for all the variables. The CFI for the variables are 0.911, 0.956, 0.982, 0.912, and 0.961. The TLI for the all variables were 0.948, 0.941, 0.917, 0.914 and 0.948. The NFI and the (CHISQ/DF) for the all variables were also satisfy the requirement of acceptance level as indicated in the Table 1

Structural Model

The structural models in regard to this study are first of all subjected to the stated hypotheses.

Base on the objectives of the study which were subjected to the stated hypothesis above, Structural Equation Model (SEM) is introduced as shown in Figure 1 in order to determine whether null hypothesis statement would be accepted or not.



Source: Generated by the author using Amos, version 22

Figure 1: Structural Model on the Relation between the Dependent Variables and the independent variables.

Figure 1 shows that food stability, food accessibility, and food utilization which are the proxy to food security are significantly affected by climate change through food availability.

Furthermore, the Figure 1 also confirm the reliability of the latent variables for each of the latent construct.

The value of the parameter estimate of climate change to food availability is -0.67. that is, I unit increase in climate change, food availability reduces by 67%. This implies that climate change significantly affects food availability. Consequently, Food Stability, Food Accessibility, and Food Utilization, significantly affected. Based on the finding of the study due to decrease in food availability caused by climate change, food stability, food accessibility, and food utilization reduces by 84%, 72% and 63%. It has been observed from the result of the study that, food stability carries high magnitude of the effect of climate change than that of food stability and food utilization.

The study therefore, confirmed the evidence of pass-through effect of climate change on food security in Adamawa state as food stability, food accessibility, and food utilization significantly reduces as a result of the decrease in food availability caused by changes in climate. This implies that, high rate of climate change contributes to food shortages, consequently, individuals will not have access to food due to its instability thereby leading to absent of nutritional well-being.

The present study finding is similar to the following previous study findings: Ani, Anyika and Mutambara (2022), Mirzaei, Kahrizi, and Hassan (2021), Atitsogbey Steniner-Asiedu and Ansong (2015).

Conclusion

The study examined the effect of Climate Change on Food Security in Adamawa State, Nigeria, in which nine-teen (19) out of the twenty-one (21) local governments of Adamawa states were sampled based on the sample size developed by Sakaranj (2003). From which farmers heads, household heads, and whole sellers of Agricultural products were further sampled on the basis of random and systematic sampling. Hence, thirty-five (35) questioners were allocated and distributed to the relevant respondents of each sampled local government (i.e 19 LGA) and interview was restricted to only farmers heads. The study therefore, concludes that climate change significantly affect the four dimensions of food security in Adamawa state. But the three dimensions (food stability, food accessibility, and food utilization) of the food security were affected by climate change through food availability. The study also concludes that, the magnitude of the effect of climate change on food stability as one of the dimensions of food security is higher than that of the remaining two dimensions. This implies that, due to the shortage of food caused by climate change food is not stable in Adamawa State.

Recommendations

The following recommendations were made on the basis of the findings of the study:

i. As confirmed from the findings of the study that high rate of climate change contributes significantly to food shortages, consequently, individuals will not have access to food due to its instability, the study therefore, recommends that, proper measures should be taken to reduce the effect of climate change such as adaptation and mitigation.

ii. The study also recommends that in order to enhances food availability government should intervene in food production to ensure food stability, affordability, and utilization.

iii. The study on the other hand recommends that preventive measures should be taken with respect to causes climate change.

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