International Journal of Agriculture and Forestry 2018, 8(2): 104-111
DOI: 10.5923/j.ijaf.20180802.09

Effects of Climate Change on Yam Production in Cross River State, Nigeria

Elijah Samuel T.[1], Osuafor Ogonna O.[2,*], Anarah Samuel E.[2]

[1]Department of Agricultural Economics, University of Nigeria, Enugu State, Nigeria
[2]Department of Agricultural Economics and Extension, Nnamdi Azikiwe University Awka, Anambra State, Nigeria

Abstract Climate change is critically affecting agricultural productivity and food security in developed and developing economies of the world. Developing countries like Nigeria often depend on rainwater for crop production. However, Unpredictable changes in the onset of rains in the last 10 years have led to situations where crops planted with the arrival of early rains get smothered in the soil by an unexpected dry spell; resulting in harvest failures in Nigeria and other ecosystems that rely on rain-fed agriculture. These challenges therefore pose questions like: to what extent has climate change affected crop productivity? What are the activities of the farmers that exacerbate the effect of climate change? The broad objective of the study was to examine the effect of climate change on root crops production in Cross River State, Nigeria. To achieve this, the specific objectives were to: determine the effects of climate change on yam production; identify the activities of the farmers that exacerbate the effect of climate change. The study employed a survey design. A multi-stage sampling technique was adopted to select 150 respondents (farmers) for the study. The yam output was proxied by farmers' income in the study area and was therefore regressed against the independent variables. Ordinary Least Square analysis, Likert rating scale and descriptive statistics were employed to actualize the objectives while t-test was employed to test the hypothesis. The results show that the effects of climate variability and change on yam production is statistically significant at $P<0.05$. The prevalent farm practices in the area according to the order of intensity were; burning of firewood – 16%, burning of crop residues and household waste as well as burning of fossil fuel by automobile – 11%, deforestation and the use of fertilizer – 10%, bush burning, use of herbicide/insecticide and burning of fossil fuel by industries – 9%, continuous cropping – 8% and use of insecticide/pesticide – 7%. Recommendations were made based on the findings.

Keywords Climate change, Productivity, Food security

1. Introduction

Climate change is a subject that has attracted considerable attention in recent years due to its deleterious effects on ecosystem. Until recently, the effects of man's activities on climate variations were perceived as negligible and so climate change was generally taken for granted [1]. However, it is palpably established that climate change is no longer a trivial issue; it is a reality that is seriously affecting the earth already, especially challenging agricultural productivity and food security in both developed and developing economies of the world and thus requires urgent attention. Although, the impacts of climate change on agricultural productivity may be positive or negative; however, empirical studies show that the latter outweighs the former [2-6].

In the view of the International Panel on Climate Change [7], climate change is a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties and that persist for an extended period typically decades or longer. On the other hand, the United Nations Framework Convention on Climate Change (UNFCCC, 1992) views climate change as a change of climate (air temperature, windfall, wind speed), which is attributable directly or indirectly to human activity that alters the composition of the global atmosphere, and which is in addition to natural climate variability observed over a comparative time periods. In recent times, various countries have been threatened by changes in climatic conditions ranging from draught, delayed rainfall, continuous melting of the polar region causing severe flood in some countries and speculation about the acid rain [8].

In Africa as a whole and Nigeria in particular, the pattern of rainfall has already altered, affecting the commencement of the planting season and resulting in poor harvest yields. Although IPCC projections suggest rainfall in southern Nigeria will increase [9], the simultaneous increase in

* Corresponding author:
osuaforogonna@gmail.com (Osuafor Ogonna O.)
Published online at http://journal.sapub.org/ijaf

temperature may increase evaporation and potential evapo-transpiration, leading to a tendency towards droughts. Indeed, recent studies indicate a 10-25% decrease in precipitation in southern Nigeria since the beginning of the century. If this trend persists, rainfall in the humid regions of southern Nigeria may be about 50% to 80% of the 1900 values by 2100 [6]. Such periods of drought will have a drastic impact upon agricultural output in the region, particularly if there is no forest remaining to act as a buffer during times of food crisis.

Yam production in Nigeria seems to be the most vulnerable by the deleterious effects of climate change. Yam is an annual tuber and monocot plant. It belongs to the genus "*Dioscorea*" and the family "*dioscoreacea*". The food plant comprises of 600 species out of which ten species produces edible tubers and only six are cultivated in Africa [10]. As a root crop, the place of yam in the diet of the people in West Africa and in Nigeria in particular cannot be overemphasized. [11] observes that yam contributes more than 200 dietary calories per capita daily for more than 150 million people in West Africa while serving as an important source of income to the people.

In Nigeria, yam is becoming more expensive and relatively unaffordable in urban areas as production growth has not kept pace with population growth leading to demand exceeding supply [12]. Yam production in Nigeria is entirely dominated by small-scale farmers [13]. Furthermore, the production of this crop like every other crop is affected by factors varying from physical, economic to cultural [14]. Climate, one of the physical factors, is the most crucial factor, which determines the nature of the natural vegetation, the characteristics of the soils, the crops that can be grown, and the type of farming that can be practiced in any region [14]. The most important climatic elements for crop growth and yield are radiant energy, or solar radiation, temperature and water or rainfall [15]. Solar radiation in turn determines the thermal characteristics of the environment, namely net radiation, day-length or photoperiod, the air and soil temperatures [16]. Soil and air temperatures affect the developmental stages more than any other factor [17].

Statement of the Problem

Climate change can seriously affect agricultural production. Climate change brings about changes in weather patterns which in turn give rise to imbalances in seasonal cycles, harm to ecosystems and water supply affecting agriculture and food production, causing sea levels to rise. Extreme weather events such as floods, landslides and drought are caused by climate change. Climate change, including global warming and increased climate variability result in a variety of impacts on agriculture. [18] and [3] noted that unpredictable changes in the onset of rains in the last 10 years have led to situations where crops planted with the arrival of early rains get smothered in the soil by an unexpected dry spell that can follow early planting.

Climate change impacts the four key dimensions of food security – availability, stability, access, and utilization. Availability of agricultural products is affected by climate change directly through its impacts on crop yields, crop pests and diseases, and soil fertility and water-holding properties. It is also affected by climate change indirectly through its impacts on economic growth, income distribution, and agricultural demand. In addition, stability of crop yields and food supplies is negatively affected by variable weather conditions [19]. These challenges therefore pose questions like: to what extent has climate change affected yam production in Nigeria? What are the activities of the farmers that exacerbate the effect of climate variability and change in Cross River State?

There have been numerous studies of climate change, the bulk of these were conducted in temperate and highly industrialized countries [20]. Most of the empirical work to date on the effect of climate change on crop production has focused on Europe, the United States, Canada and Australia [21]. Worldwide little research has focused on developing regions such as those in the tropical rainforest where the poor who may be most vulnerable to adverse changes live. Scientists fear that the most adverse effects are likely to occur in this region [21]. Some of the studies in developing regions [22, 23, 6] considered the effects of one or two aspects of climate change on maize and other crops. None within the knowledge of the researcher has focused on yam production in the agro-ecological zones of many developing countries especially that of the rainforest zone of Nigeria where the most vulnerable group live; hence, the necessity for this study.

Objectives of the Study

The broad objective of this study is to examine the effects of climate change on yam production in Cross River State, Nigeria. Specifically, the study is meant to:

1. determine the effects of climate variability and change on yam production;
2. identify the activities of the farmers that exacerbate the effect of climate change in the study area.

Hypothesis of the Study

Climate change has no significant effect on yam production in the study area.

Theoretical Framework

According to [24], a theory is a set of reasoned ideas that are intended to explain facts or statement of the principles on which a subject is based. A theoretical framework guides your research, determining what things you will measure, and what statistical relationships you will look for [25]. In this context, the neo-classical growth model will be adopted to examine the effect of climate change on the yield of the selected crops. [26] argued that an appropriate framework to analyze the food crop output is the neo-classical growth model. The neoclassical growth model, also known as the Solow–Swan growth model or exogenous growth model, is a class of economic models of long-run economic growth set within the framework of neoclassical economics. Neoclassical growth models attempt to explain long run economic growth by looking at productivity, capital accumulation, population growth and technological progress.

How then can this model be linked to this study? Basically, the productivity (i.e. output) or weighted food crop yield proxied by income, is assumed to be a function of loss due to climate change, quantity of fertilizer used, quantity of pesticides, excess cost on disease prevention, excess cost of additional supply of yam and cost of excess rainfall. The general formulation of the production function is:

$$Q = A(t)\, f(K, L)$$

Where Q denotes the output (income), K and L are, capital (expenditure incurred) and labour respectively. The factor $A(t)$ measures productivity shifts over time which may be induced by technological progress or through adaption linked to changes in climatic conditions, as per land productivity is concerned.

2. Methodology

This study was carried out in Cross River State. Cross River State, lies between latitudes 5°32' and 4°27' North and longitudes 7°50' and 9°28' East, bounded in the North by Benue State, in the South-west by Akwa Ibom State, in the West by Ebonyi and Abia States. Cross River State has the largest rainforest covering about 7,290 square kilometers described as one of Africa’s largest remaining virgin forest harbouring as many as five million species of animals, insects and plants [27]. The climate of the area is controlled by two tropical air masses namely the equatorial maritime (MT) air mass, which originates from the South-West and the tropical continent (CT) air mass, which originates from North East [28], with average temperatures ranging between 15°C - 30°C, and the annual rainfall between 1300 – 3000mm. The high plateau of Obudu experience climatic conditions which are markedly different from the generalized dry and wet period in the rest of Cross River State. Temperatures are 4°C - 10°C lower due to high altitude than in the surrounding areas. Similarly, the annual rainfall figures are higher than in areas around them, particularly on the windward side [29].

Sampling Technique

Multi-stage sampling technique was used to select the respondents. This procedure considered the delineation of the study area into zones. The Cross River Agricultural Development Project (CRADP) divided the state into three agricultural zones namely Ogoja Zone, Ikom Zone and Calabar Zone [30]. Each of the agricultural zones comprises six (6) Local Government Areas. In the first stage, one (1) Local Government Area was selected randomly from each of the zones. In the second stage, five (5) farming communities were randomly selected from each of the Local Government Areas making a total of fifteen (15) farming communities. In the thirds stage, ten (10) respondents (farming households) were finally selected from each of the farming communities making a total of 150 farmers (respondents) for the study.

Only Primary data were used for the analysis. The primary data were collected with the aid of detailed and well-structured questionnaire administered to the selected yam crop farmers and was complemented by scheduled interview. The questionnaire was designed to capture information on socioeconomic and demographic data like age, gender, household size, size of land holding, etc. In this study, Objective 1 was realized using ordinary least squares (OLS) analysis, while objective 2 employed Likert rating scale and descriptive statistics. T-test was employed to test the hypothesis.

Model Specification

The multiple regression model was specified as:

$$Y_i = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, \ldots X_{14},) + e_i$$

Where $Y_i =$ yam yield (income)

X_1 = sex (male =1, 0 otherwise)
X_2 = years of education
X_3 = experience in yam production (years)
X_4 = belonging to an association
X_5 = household size (number of persons)
X_6 = age (years)
X_7 = losses from diseases due to climate change (₦)
X_8 = excess preservation cost due to excessive rainfall/sunlight (₦)
X_9 = excess cost on disease prevention
X_{10} = market access (yes =1, 0 otherwise)
X_{11} = cost of additional supply of yam
X_{12} = hired labour (man days)
X_{13} = quantity of fertilizer used (kg)
X_{14} = quantity of pesticide applied (ltrs)
e_i = error term

3. Results and Discussion

Objective 1: Effects of Climate Change on Yam Production

The multiple regression was used to investigate the effects of climate change on yam production which is the first objective of this study. The study used the proceeds (income) from yam to proxy yam production at the end of a season, while it employs the core variables for climate change to be loss from disease due to climate change, quantity of fertiliser used, quantity of pesticides, excess cost on disease prevention, excess cost of additional supply of yam and cost of excess rainfall. The results are presented on Table 1.

The results above show proof of a highly significant estimation as the general significance testing indices – Prob>F is not only less than 0.05 but is 0.0000. Also the results show that R-squared is 0.8918 that implies that 89.18% of the dependent variable – income is explained by the stated independent variables in the model. To further ascertain the predicting strength of the independent variables in the model, Figure 1 is used for the illustration.

Table 1. OLS Results of the Effect of Climate Change on Yam Income

Variable name	Coefficient	Standard Error	t-test	p- value
Gender	17705.91	10954.99	1.62	0.109
Years in school	3400.593	2221.65	1.53	0.128
Experience	3614.757	1182.997	3.06	0.003
Loss from disease due to climate change	-1.30626	1.209275	-1.08	0.282
Market access	26465.73	12420.81	2.13	0.035
Household size	13603.63	2938.993	4.63	0.000
Belong to association	2023.423	7297.488	0.28	0.782
Hired labour (number of days)	106.4758	58.35159	1.82	0.070
Quantity of Fertilizer used	298.423	79.78255	3.74	0.000
Quantity of pesticide used	3485.5	2426.643	1.44	0.153
Excess cost on disease prevention	0.7826564	0.5441572	1.44	0.1153
Cost of additional supply of yam	-0.5182472	1.144351	-0.45	0.642
Cost of excess rainfall	-0.3994985	0.8576652	-0.47	0.642
Constant	-5422.12	19387.6	-2.81	0.006
R-squared	0.8918			
Prob> F	0.0000			

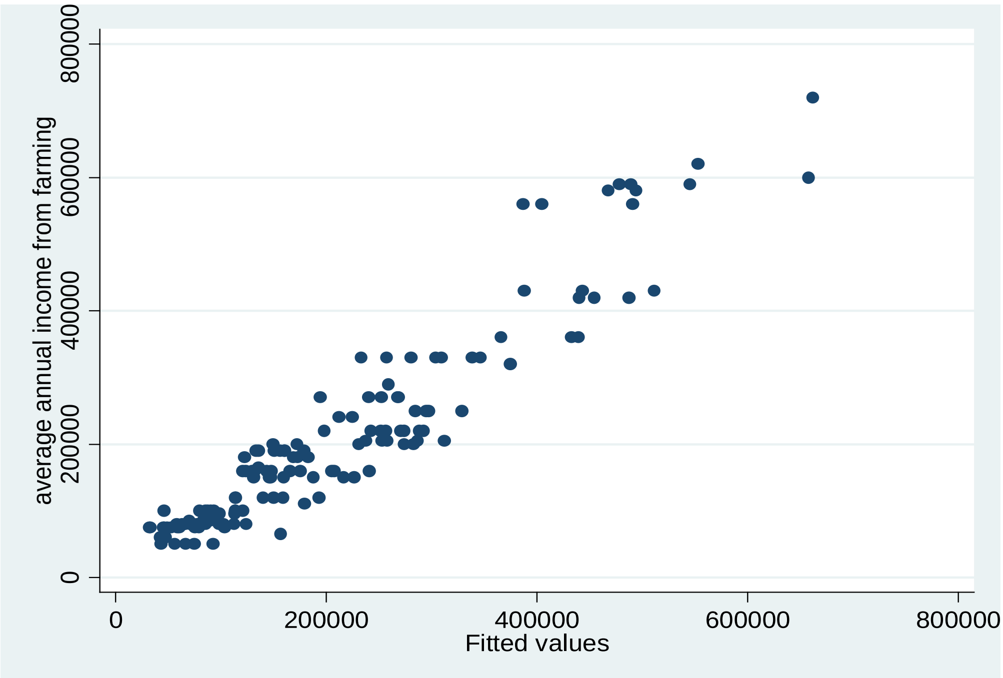


Figure 1. Predicting Power of the Explanatory Variables of Income

The figure above shows a strong predicting strength of the explanatory variables in the model as the scatter-diagram portrays a 45 degree pattern as expected. This therefore shows that the explanatory variables strongly determine the independent variable and therefore the omitted variables are not very significant in determining income. With this background therefore the study concentrates on the five independent variables that should reflect the influence of climate variability.

On the general scope, the results show that farmer's experience, market access, house hold size and the quantity of fertilizer used are significant and positive determinants of Income which is however, the expected *a priori*. They are said to be significant due to the fact that their p-values are all less than 0.05 and their t-values greater than the absolute value of 2, to this respect, house hold size is the most determinant factor as its p-value is zero. While gender, years in school, association participation, hire labour practice, use of pesticides and excess cost on disease prevention are all positively related with income but not significant in determining income as their t-value all lie below the absolute value of 2 and the probabilities (p-value) are all greater than

0.05. These results are also not very strange, given that if household size is significant in determining farmer's income, we expect that the farmers shouldn't hire a lot of labour since they make use of household labour. Also losses from disease due to climate change, cost of additional supply of yam and the cost of excess rainfall are all negatively insignificantly related with yam yield.

However, concentrating on the six variables that predict climate change variability we start with the losses from the diseases due to climate change. A unit increase in the loss from the disease decreases the farmer's income by 1.30626, thereby portraying a negative relationship with farmer's income. More importantly we find that the losses are not really significant in determining farmer's income. This shows that even though climate change has caused some losses due to diseases induced by climate change, it is not yet significant in affecting farmer's income negatively. Therefore there is need for the government and other non-governmental organisations to control the spread of these diseases now that it's not yet significant before it starts affecting farmer's income severely.

The quantity of fertiliser used is highly significant in determining income, and the fact that it is positively related is more enlightening as it contributes to the growth of the farmer's income. A unit increase in fertiliser used increases farmer's income by 298.423. This therefore means that even with the advent of climate change the use of fertiliser improves farmer's income which is rather encouraging. This is a call for policy makers to make fertiliser available for farmers to use as a boast to yam production and proceed in Cross River state of Nigeria. Considering the quantity of pesticides used the results show that it equally not significant in determining farmer's income. A unit increase in the quantity of pesticides used increases the farmer's income by 3485.5 which is expected as the pesticides prevent the Yam from harm and therefore permits it to grow and be ready for the market. However it is not significant in determining the farmer's income as the t-value is less than the magnitude of 2 (that is 1.4).

Excess cost of disease prevention appears not to be significant as well, given the t-test that is 1.44 which is good for the farmers as this does not significantly affects yam yield, however this must not go out of hand even though the current situation is mild since a unit increase in the cost of disease prevention increases income by 0.7826564. Also excess cost of additional supply of yam and cost of excess rainfall are relatively insignificant in determining farmer's yam yield with t-values that are as low as 0.45 and 0.47 respectively. They both have a negative and inverse relationship with farmer's yam income that connote that an increase in any of these expenditures decrease the amount of income. Fortunately the results do not show that this effect is significant, but just as discussed with the other independent variables there is need to be on the watch out.

Decision Rule

H_0: climate variability and change has no significant effect on yam production in the study area

H_1: climate variability and change has a significant effect on yam production in the study area

Based on the hypothesis test, the study uses the t-test statistic to conclude that for; loss from disease due to climate change, quantity of pesticides, excess cost on disease prevention, excess cost of additional supply of yam and cost of excess rainfall we do not reject the null hypothesis and therefore conclude that climate variability has no significant effect on yam yield. On the other hand quantity of fertiliser used is significant and we therefore reject the null hypothesis implying that based on fertiliser use climate variability has a significant effect on yam yield.

To conclude our result of objective one we state that, on the six count charge – six core independent variables just one of them is significant in determining the effect on yam yield and five are not. It therefore means that even though the effect of climate change has been significant in the production of many other crops in different areas, it is not yet significant in the production of yam yield in Cross River state of Nigeria.

Objective 2: Effect of Farmer's Activities Exacerbating Climate Change

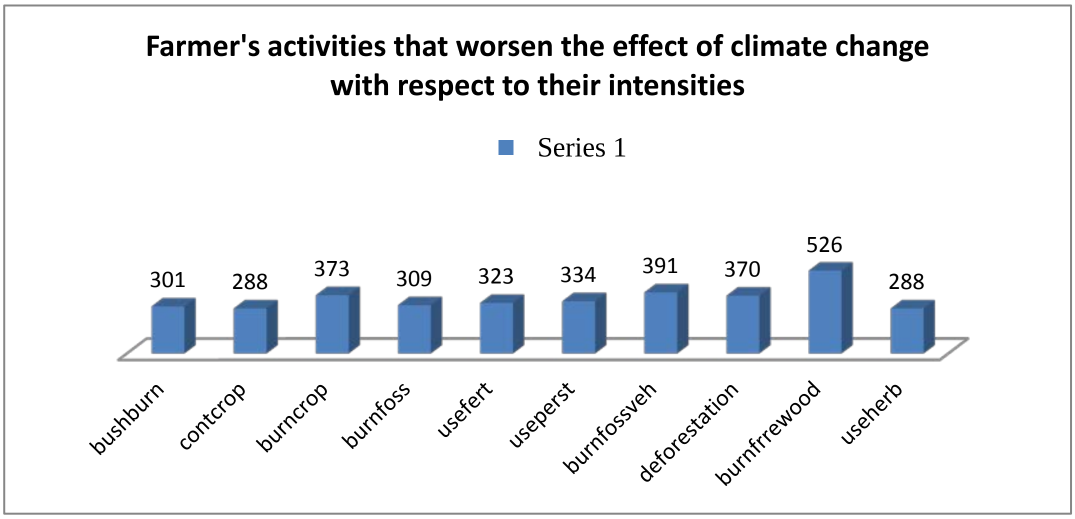
To capture objective two this study suggests the use of descriptive statistics in the form of frequencies, percentages, bar charts and pie charts. These analyses are illustrated below.

Table 2. Results of the Farmer's Activities Using Descriptive Statistics

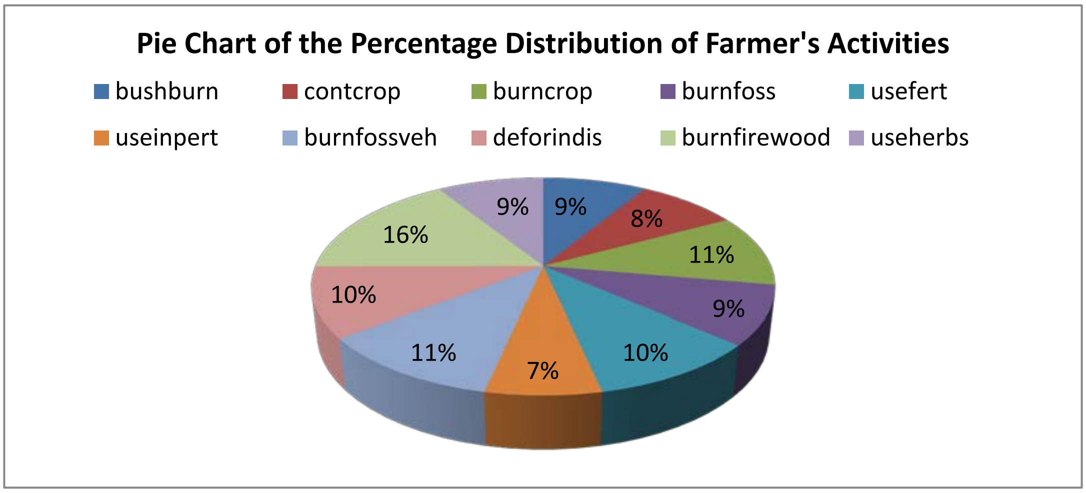
Variable Name	Very great extent (%)	Great extent (%)	Some extent (%)	Little extent (%)	No extent (%)
Bush burning	32.14 (45)	34.29 (48)	20.0 (28)	8.57 (12)	5.0 (7)
Continuous cropping	43.57 (61)	23.57 (33)	16.43 (23)	9.29 (13)	7.14 (10)
Burning waste	15.71 (22)	35.71 (50)	15.0 (21)	28.57 (40)	5 (7)
Burning of fossil fuel (industries)	34.29 (48)	25.0 (35)	26.43 (37)	14.29 (20)	0.0 (0)
Use of fertiliser	52.86 (74)	2.14 (3)	6.43 (9)	12.86 (18)	25.71 (36)
Use of insecticides	68.57 (96)	10 (14)	7.86 (11)	7.86 (11)	5.71 (8)
Burning of fossil fuel (automobile)	24.29 (34)	13.57 (19)	20.71 (29)	38.57 (54)	2.86 (4)
Deforestation	11.43 (16)	25 (35)	51.43 (72)	12.14 (17)	0.0 (0)
Burning of fire wood	0.71 (1)	7.86 (11)	6.43 (9)	51.43 (72)	33.57 (47)
Use of herbicide	62.14 (87)	0.71 (1)	6.43 (9)	10.71 (15)	20.0 (28)

The cross tabulation above indicates that of the 140 respondents or farmers that were interviewed 45 of them making a total of 32.14% said the used bush burning to a very great extent and 34.29% accepted the practiced bush burning and only 5% of them did not practice bush burning at all. This is rather high and calls for policy implementers to sensitise farmers on the practice of bush burning and its devastating consequences on the environment. Farmers that practiced continuous cropping to a very great extent amounted to about 43.57% which is expected however as most of them depend solely on farming and do not have enough land to practice crop rotation. Only 7.14% of the farmers did not practice continuous cropping, meaning up to 92.86% of them practiced continuous cropping at least to some extent.

About 95% of the farmers practiced waste burning as against 5% that did not, and out of the 95%, 15.71% of them practiced it to a very great extent, 35.71% to a great extent, 15% to some extent and 28.57% to a little extent. Therefore, suggesting a huge per cent of the farmer's that practice waste burning rather than more "clean" methods of wage disposal. Most of the farmers are fully involve in these activities that worsen climate change. The situation becomes even worse with activities such as burning of fossil fuel and deforestation as all the farmers testify to the presence of such activities that worsen the effect of climate change. However we note that the use of herbicides, use of fertilisers and the burning of firewood is not practiced by 20%, 25% and 33.57% respectively of the farmers. While the most practiced to a very great extent is the use of insecticides that amount to about 68.57%.



To have a clearer picture of the intensities of climate change the study illustrates the composite index of the intensities using bar charts. The composite index was gotten by summing up all the responses of the responses on farmer's activities by assigning 5 to a very great extent, 4 to a great extent, 3 to some extent and 2 to a little extent. Based on this therefore the figure above illustrates that the most intensively used is the practice of firewood burning with about 526 followed by the burning of fossil fuel by vehicles and then the burning of waste. While the least intensively practiced are the continuous cropping and the use of herbicides with a composite index of 288.



This could be further buttressed with a pie chart showing the intensities of the farmer's activities in percentages. The pie chart above suggest that based on the 10 farmer's activities that worsen the effect of climate change considered in the study, the greatest contributor is the burning of firewood 16%, 11% for the burning of crop and household waste as well as the burning of fossil fuel by automobile. Followed by deforestation and the use of fertiliser, burning of fossil fuel by industries and the least contributor is that of continuous cropping with only 8%. However, their contributions are more or less similar having only small margins among them.

4. Conclusions

The findings illustrate that climate change has no significant effect on the production of certain root crops in the study area. However, the study does not suggest that climate change and its variability has no impact on root crops generally, as the bulk of empirical review posits that climate change has critical impact on crop production. Little research in the subject of climate change and its impacts on agricultural productivity has been done in the area of study. Consequently, the rural farmers are to a large extent ignorant of the anticipated deleterious impact. It therefore calls for agricultural economists in the country to gear their research interests on the subject matter of climate change and its associated issues towards the area of study.

5. Recommendations

Based on the findings of this study, the following recommendations and policy implication are advocated as alternatives to curb the effect of climate change in the study area as well as the country at large:

1. More should be invested in research on more efficient measures to combat the nascent turbulence peculiar with climate variability and change in the study area and the entire planet.
2. Although, the findings of the study established that the effect of climate variability and change is insignificant on yam production; however, there is need to be on the watch to avoid untold devastating impediment to the agrarian economy.
3. Policies should be put in place to regulate anthropogenic practices that foster climate change and its variability.
4. One of the predominant challenges in the study area is lack of access to extension services. To redress this, the government should deploy more extension agents to the area of study.

REFERENCES

[1] Iheke, O.R. & Oliver-Abali, V.I. (2011). Farm size, climate variability and arable crop production in Abia State, Nigeria. *International Journal of Sustainable Agriculture,* 3(2), 58-64.

[2] Enete, A.A., Madu, I.I., Onwubuya, E.A., Onyekuru, A.N., Mojekwu, J.C. & Eze, F. (2011). Indigenous agricultural adaptation to climate change: Study of Southeast Nigeria. *African Technology Policy Studies Network* WORKING PAPER SERIES/ No. 53. Website: www.atpsnet.org.

[3] Nzeh, C.E. & Eboh, O.R. (2011). Technological challenges of climate change adaptation in Nigeria: Insights from Enugu State. *African Technology Policy Studies Network* Working Paper Series/ No. 52. Website: www.atpsnet.org.

[4] Enete, A.A. & Amusa T.A. (2010). Challenges of Agricultural Adaptation to Climate Change in Nigeria: a Synthesis from the Literature. *Field Actions Science Reports, 4*.

[5] Ziervogel, G., Nyong, A., Osman, B., Conde, C., Cortes, S. & Dowing, T. (2006). Climate variability and change: implications for household food security. *Assessments of Impacts and Adaptations to Climate Change (AIACC), Working Paper No. 20*. The AIACC Project Office, International START Secretariat, Washington DC, USA.

[6] 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 20-21 September 2004.

[7] Intergovernmental Panel on Climate Change (IPCC) (2007) Summary for Policymakers. 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. In M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. Van der Linden and C.E. Hanson, Eds.,* Cambridge University Press, Cambridge, UK, 7-22.

[8] Food, Agriculture and Natural Resources Policy Network (FANRPAN) (2010). Nigeria: Climate Change and Food Challenge. URL: *http://allafrica.com/stories/ 201004290231 .html*.

[9] Intergovernmental Panel on Climate Change (IPCC) (2001a). Climate change 2001: The scientific basis. *Report of Working Group I of the Intergovernmental Panel on Climate Change*, Geneva. http://www.ipcc.ch Accessed 10 December 2011.

[10] Musa, Onu, Vosanka & Anonguku (2011). Production efficiency of yam in Zing Local Government Area of Taraba State, Nigeria. Journal of Horticulture and Forestry, 3(12), 372-378.

[11] Babaleye, T. (2003). West Africa: Improving yam production technology. *African News Bulletin*, 463, 56–59.

[12] Kushwaha, S. & Polycarp, I.M. (2001). Economics of small scale yam production in Qua'an Pau LGA of Plateau. In M.M. Abubakar, T.A. Adegbola & I.S.R. Butswat (Ed). *The role of agriculture in poverty alleviation.* 69-74. Proceedings of 34th Annual Conference of Agriculture Society of Nigeria, held

15–19 October, 2001, Abubakar Tafawa Balewa University (ATBU), Bauchi, Nigeria.

[13] Odjugo, P.A.O. (2008). The effect of tillage systems and mulching on soil microclimate, growth and yield of yellow yam (*Dioscorea cayenensis*) in Midwestern Nigeria. *African Journal of Biotechnology, 17*(24), 4500-4507.

[14] Obiokoro, O.G. (2005). *Agrometeorology*. Onitsha: Dunkwu Publishers. pp. 24-30.

[15] Ekaputa, U.N. (2004). *Agricultural systems*. Port Harcourt: UNIK Publishers. pp. 126-134.

[16] Regina, H.Y.FU., Kikuno, H. & Maruyama, M. (2011). Research on yam production, marketing and consumption of Nupe farmers of Niger State, central Nigeria. *African Journal of Agricultural Research, 6*(23), 5301-5313.

[17] Ayoade, J.O. (2004). Climate Change. Ibadan. Vantage Publishers, pp. 45-66.

[18] Ejiogu A.O. & Ejiogu, B.C. (2010). Climate change compliant microfinance delivery in Nigeria. *Journal of Accounting and Taxation Vol. 2(3),* pp. 46-50. Available online at http://www.academic journals.org/JAT.

[19] Edame, G.E., Ekpenyong, A.B., Fonta, W.M. & Duru, E.J.C. (2011). Climate change, food security and agricultural productivity in Africa: Issues and policy directions. *International Journal of Humanities and Social Science, 1*(21), 205-223.

[20] Mendelsohn, R. (2000). Measuring the effect of climate change on developing country Agriculture: Two Essays on climate change on agriculture: *FAO Corporate Document Repository, www.fao.org/docrep/003/x8044e/x8044e03.htm#PO.O*.

[21] Molua, E. & Lambi, C. (2006). The economic impact of climate change on agriculture in Cameroon. *CEEPA Discussion Paper No. 17*, Centre for Environmental Economics and Policy in Africa, University of Pretoria.

[22] Deressa, T. T. (2011). Effects of climatic conditions and agro-ecological settings on the productive efficiencies of small-holder farmers in Ethiopia. Working paper 223.

[23] Deressa, T., Hassan, R.M. & Ringler, C. (2008b). Measuring Ethiopian Farmers' Vulnerability to Climate Change across Regional States. *International Food Policy Research Institute (IFPRI) Discussion Paper No. 00806*. Environment and Production Technology Division, IFPRI, Washington D.C.

[24] Deressa, T., Hassan, R.M., Alemu, T., Yesuf, M. & Ringler, C. (2008a). Analyzing the determinants of farmers' choice of adaptation methods and perceptions of climate hange in the Nile Basin of Ethiopia. *International Food Policy Research Institute* (*IFPRI) Discussion Paper No. 00798*. Environment and Production Technology Division, IFPRI, Washington D.C.

[25] Akpalu, W., Hassan, R.M. & Ringler, C. (2008). Climate variability and maize yield in South Africa: Results from GME (Generalized Maximum Entropy) and MELE (Maximum Entropy Leuven Estimator) Methods. *International Food Policy Research Institute (IFPRI) Discussion Paper No. 00843*. Environment and Production Technology Division, IFPRI, Washington D.C.

[26] Hornby, W. (2004). Case Studies in Streamlining Assessment, Centre for Enhancement of Learning and Teaching, The Robert Gordon University, Aberdeen.

[27] Borgatti, S.P. & Foster, P.C. (2003). The network paradigm in organizational research: A review and typology. *Journal of Management, 29*(6), 991–1013.

[28] Ahmed, E., Sulaiman, J. & Mohd, S. (2011). Wheat production and economics. *American Journal of Agricultural and Biological Sciences, 6*(3), 332-338.

[29] MOFINEWS (2004). Why Agriculture? Cross River State: Producing Milk and Honey for the Nation. A Bimonthly Journal of Finance Incorporated, Calabar, Cross River State, Nigeria. July- August 2004 3 (6): 4 – 5.

[30] Pant, K.P. (2009). Effects of Agriculture On Climate Change: A Cross Country Study Of Factors Affecting Carbon Emissions. *The Journal of Agriculture and Environment, 10.*

[31] Cross River State Government (CRSG) (2011). About Cross River State. *http:// kekerete.tripod.com/CRSG/about.html*.

[32] Adinya, I. B., Ibom, L.A., Ibekwe, H.A., Ayabie, S.A., Ukam, V.E., Meremikwu, V.N. & Gboshie, P. (2009). Analysis of socio-economic constraints militating against the profitability potentials of snail *(Archachatinamarginata)* production by small-scale snail farmers in Cross River State, Nigeria. *Continental Journal of Agricultural Economics 3*, 1-15.