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Analysis of the effect of climate variation on rice production in enugu state, Nigeria

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ABSTRACT

The study assessed the analysis of the effect of climate variation on rice production in Enugu state, Nigeria. The specific objectives of the study were to determine the effects of climate variation on rice production in Enugu State; identify how farmers perceive their production constraints arising from climate variation in rice production and management. Multistage sampling techniques were used to select 100 respondents for the study. Data for the study were collected through primary and secondary sources using structured questionnaire and interview schedule. Data collected were analyzed using descriptive and inferential statistics mean, multiple regression analysis, chi-square and likert rating scale. Rainfall x, relative humidity x_2 and sunshine x_5 was highly significant and has a positive correlation with rice production while temp max x6. Temp min x_4 are also significant but has a negative correlation in rice production in Enugu state while wind negatively affected rice production in Enugu state observed that farmers in the study areas suffered major constraints such as lack of improved seed, lack of access to water for irrigation, inadequate capital and inadequate farm mechanization. It was however recommended that given that the variations in rain fall pattern significantly influenced rice production in the state, proper source of water supply regime and irrigation system should be provided for regular and adequate water supply to rice farming as well as other farming activities in the state.

1.0 Introduction

Climate change is a term that refers to a significant and lasting change in the statistical distribution of weather patterns over periods ranging from decades to a million of years. The issue of climate variability has assumed a worldwide dimension cutting across the developed and developing nations. Throughout the world there has been significant concern about the effect of climate change and climate variability on agricultural production (Kaul, 2010). The United Nations framework Convention on climate change (UNFCCC 2017) argued that surface temperature increased from 1.4-4.8, while global sea levels rose by 9.88cm in 2008 and as a result there were changes in rainfall pattern, temperature, relative humidity, solar radiation, drought, flood, among others (spore, 2008). This has bordered researchers and administrators on the potential damages or benefits that may arise in future from these impacts on agriculture.

The climate factors are expressed by the amount of rain fall, sunshine hours, temperature, relative humidity and length of drought period result in year- to-year variability of crop production and is one of the major potential threats to national food security and sustainable agriculture for a county (Chamhuri, Mahmudul, Wahidand Abul, 2009). Intergovernmental panel on climate change (IPCC) (2007) reported that many African countries including Nigeria are likely to be affected by climate variability because they are highly dependent on agriculture that is mostly practiced in already hash climate conditions of high temperature, marginal environment and considerable water stress.
Food and Agriculture Organization (FAO) (2O07), noted

that frequent and more intense extreme weather has adverse impacts on food production, food distribution, infrastructure, livelihood and human opportunities in both rural and urban areas. Changes in mean temperatures and rainfall will lead to weather variability and mayaffect the suitability of land for different types of crops and pasture, the health of farm animals and their productivity. The incidences of pests and diseases, biodiversity and ecosystem, while the loss of arable land is likely to result due to increased acidity groundwater depletion and the rise in sea level. Pests and crop diseases migrate in response to climate variations (e.g. the tsetse fly has extended itsrange northward) and will potentially pose a threat to livestock in the drier northernarea. Food and Agricultural Organization FAO (2010) observed that climate variability and climate change are sources of risk to farmers because of the uncertainty surrounding the farm system planning and management. It therefore calls for measure to investigate so as to be incorporated into the farm plan in order to reducethe risk and uncertainty surrounding such farm plans. Rice is a staple food for more than 2.6 billion people of the world. On the global output, the Asian continent accounts for 29 percent production level, 5 percent for America and Caribbean, while only 3 percent production is attributed to Africa (spore, 2005). In African, FAO (2002) argued that apart from Egypt and Morocco which have attained self-sufficiency in local rice production, all other counties in sub-Sahara Africa have demand exceeding production. In 2002 alone, four out of six largest countries noted for rice imports in the world were from the continent of Africa, these countries were cote d'voire, Nigeria, Senegal and South Africa. Rice is the most popular of all the cereals grown and consumed in almost all the parts of Nigeria and has replaced in particular tuber and root crops as well as other grains (maize, millet and sorghum)in the food intake of most families in the country(Filani, 1980, and Lange 1997). They opined that since 1980s rice consumption in Nigerian has increased at average rate of 11(eleven) percent per year representing 1(one) percent of the total calories intake and 23 percent of cereal consumption. Odii and Nwosu (1996) stated that the decline in rice production in Nigeria is traceable to inefficient use of farm resources, labour shortage, poor crop management practices and poor capital base in a given climate environment. Ajetomobi, Abiodun, and Hassan, Hassan, (2010) argued that in spite of the availability of cultivable land area, the current demand for rice in Nigerian was about 5 million metrics tones which is more than twice the quantity produced (2.2 metrics tone). They stated that at present about 4.9 million hectares representing 39percent of the cultivable land are cultivated. One imagines then why production of rice has not been sustained to meet the increasing demand despite the available productive potentials that exist. Since to a large extent, there is a paucity of published information on the effect of climate variability on rice production in Enugu state it become expedient then that a study of this nature be conducted to investigate the effect of variability in climate parameters express in rice production in the area.

1.1 Statement of the Problem

In Nigeria, rice is the fourth major cereal crop after sorghum, millet and maize in term of cultivated land areas over the years but it has failed to realize its natural potential in the areas of local rice farming production and marketing (National bureau of statistics NBS, 2009).

According to food status report in 2008, Nigeria ranks 20th position on the global hunger index and 65 percent of our citizens were food insecure (Uzor 2010). They alerted that the significant imbalance between demand and supply of staple food crop like rice and other products will definitely continue to drive up prices of staple food crop if the productive constraints are not identified and tackled. Since the birth of civilization, mankind have expressed serious changes in the atmospheric environment with a recent mean global temperature rise of 0.6^0 c largely due to emissions resulting from human activities which substantially increased the atmospheric concentration of major greenhouse gases such as carbon dioxide, methane, chlorofluorocarbon
(CFCS) and Nitro oxide. IPCC (2017) argued that variation in rainfall, drought, flood, temperature, hurricane, excessive snowfalls, heat wave, frost bite and many others have greatly influenced agriculture, tourism, recreation, transport, industries, the general human economic activity and wellbeing. Moreover, Nigeria metrological agency noted that Nigeria is part of the global community and therefore not immune to the impacts of climate change. Just like the millennium development goals (MDGs), our vision 2050 may also be at risk if climate change adaptation and mitigation strategies are notput in place. Therefore, there is need for adequate understanding of the past, present and future climate trends to enable policy makers manage our changing climate and mainstream climate information into our national agricultural programs and global development plans. International institute for environment and development (IIED, 2010) predicted that by 2020 the influence of climate change and climate variability in Nigeria could result to 2-11 percent losses of gross domestic product (GDP) if there is no integrated model adaptations to handle their incidence. These assessments did not however highlight the important potential variation on the climate element responsible for these loses. More so their assessment did not specify their potential economic effect on the particular crop in question. These predictions need to be investigated empirically so as to ascertain the level of such losses if any, especiallyas it concerns rice production in the study areas in Nigeria. The magnitude and economic effect to which these relationships exist were not specified especially in South East in the area of rice production which indicate that there is a gap that need to be investigated. The problem of this study put in question form is: What is the effect of climate variation on rice production in Enugu state Nigeria?

Research Questions

How does the rice output vary as a result of climate change or climatevariation in the study area

What are the major climate variables that pose constraints in rice production in Enugu state?

Objectives of the study

The broad objective of this study is to determine the effects of climate variation on rice production in Enugu State.

The specific objective of this study were to:

determine the effects of climatic variables and other factors on rice output in Enugu state

identify how farmers perceive their production constraints arising from climate variation in rice production and management

Hypotheses of the Study

Based on the specific objectives of the study, one null hypothesis was tested

Ho_1: Rice output is not influenced by climate variables in Enugu state

2.0 Research Methodology

The Study Area

The study was carried out in Enugu State, Nigeria. The State which is one of the South Eastern States in Nigeria .Enugu State has seventeen (17) Local Government Areas and is divided into six agricultural zones in accordance with the three senatorial zones in the State (Adunuke, 2015) namely; Enugu zone, Nsukka zone, Enugu ezike zone, Udi zone, Agbani zone and, Awgu zone, with divided into six agricultural zones in accordance with the three senatorial zones in the State (Adunuke, 2015) namely; Enugu zone, Nsukka zone, Enugu ezike zone, Udi zone, Agbani zone, Awgu zone, with zonal office at Enugu zonal office at Enugu.

Ecologically, the State favours the cultivation of many types of tree and arable crops such as Beans, coco yam, oil palm, yam, cassava, rice, maize, plantain, banana, fruits and vegetables. The timing, cultivation and output of these crops in the State however depend on the seasonal variations and distribution of climatic variables such as, rainfall, temperature, relative humidity, sunshine and wind which varies with the sub climatic regions (mangrove swamp, tropical rainforest, and Guinea savanna). Both rain fed upland and lowland rice are cultivated by small scale farmers depending on the climatic conditions experienced in the given environment. This implies that the farming calendars of rice production in the State are dictated by the climate variables which are favorable or not. It is on this respect that this study was carried out to findout whether the variations in climate elements across the agro climate zones influence rice production differently in the state.

3.0 Results and Discussion

Objective 1; Effects of climatic variables and other factors on rice outputs in Enugu State

Table 1: Comparison of the FOUR regression Models
KEY

P-values (p) are written in parenthesis

* $p<0.05$ implies Statistically Significant values

Table 1: Comparison of the four regression Models
Summary of regression results

	LINEAR	SEMI LOG	DOUBLE LOG	EXPONENTIAL
CONSTANT	(2.764)**	(1.153)	(9.470)***	(23.897)***
RAINFALL X_1	.005	.021	.069	.110
	(.546)***	(.176)***	(.583)**	(1.974)***
RELATIVE HUMIDITY X_2	.032	.004	-.094	.090
	(423)**	(.026)	(.638)	.700)
TEMP. MAX X_3	.015	.022	.058	.044
	(-.320)**	(-.177)**	(-.479)***	(-.354)**
TEMP MIN X_4	-.050	-.034	-.044	-.071
	(-.409)	(-.298)	(-.384)	(-.599)
SUNSHINE X_5	.038	.117	.174	.066
	(.320)**	(.950)	(1.435)***	(-.574)
WIND X_6	.033	.027	,107	-.152
	(-.238)**	(-.178)	(-.710)	(-.287)
R	.791	.581	.610	.578
R^2	.625	.337	.372	.334
F- RATIO	.167	.243	.699	.680
S.E.E.	43193.51	43457.82	43410.57	43419.10
DURBIN WATSON	1.02	1.03	1.08	1.10

Source: Computation from survey data, 2021

Figures in parenthesis are‘t’ values. *** Highly significant, **Significant at 5%

**p<0.01 implies Statistically Highly Significant values p>0.05 implies Statistically NOT Significant values

According to table 1 the linear model was selected as the lead equation because it has the highest number of significant variables, the highest R^2 (62.5%) and the least standard error of the estimate (SEE). Rainfall X_1, relative humidity X_2, and sunshine X_5 were highly significant and have positive correlation with rice production (output). While Temp max x6, Temp min x4 and wind x6 were also significant but have negative correlation with rice production.

These findings agree with Ajemobi *et al, (2010)* and who observed that minimum temperature and maximum temperature may either exhibit a negative or positive relationship with rice output. This finding also aligns with the work of Cruz (2004) who noted that the amount of rain days during the growing periods of rice positively influence it output in Philippine

Preliminary analysis was conducted on the influence by climate variables in Enugu state. The following variables were identified.

Decreased rice crop yield

Enhanced food insecurity

Increased Pests, insects, weeds & diseases

Discourage farmers from rice production in the next season

Increased household poverty

Difficulty in meeting health needs

Increased cost of producing rice

Rural urban migration of Rice farmers

Shift from rice farming to other economic activitie

The Likert Scores are summarized using the average (mode) (Mogey, 2014; Sullivan &Artino, 2013), as shown below

Table 2: summary of Likert Analysis

Effects of climatic variables on rice outputs	**Strongly disagree 1**	**Disagree disagree 2**	**Undecided 3**	**Agree 4 4**	**Strongly Agree 5**	**(Total)**	**Average (mode)**	**Decision Conclusion (Based on Mode Values)**
Decreased rice cropyield	2.0% (2.0%)	2.3% (2.3%)	0.0% (0.0%)	40.0% (39.7%)	56.0% (56.0%)	100.0 100.0%	**5**	**Strongly Agree**
Enhanced food insecurity	1.3% (1.3%)	5.2% (5.2%)	0.0% (0.0%)	21.2% (21.2%)	72.3% (72.3%)	100.0 100.0%	**5**	**Strongly Agree**
Increased Pests, insects, weeds & diseases	2.26% (2.6%)	18.9% (18.9%)	0.0% (0.0%)	32.2% (32.2%)	46.3% (46.3%)	100.0 100.0%	**5**	**Strongly Agree**
Discourage farmers from rice production in the next season	3.3% (3.3%)	13.0% (12.7%)	0.0% (0.0%)	42.3% 42.3%)	41.7% (41.7%)	100.0 100.0%	**4**	**Agree**
Increased household poverty	2.3% (2.3%)	14.0% (14.0%)	0.0% (0.0%)	45.5% (45.9%)	37.8% (37.8%)	100.0 (100.%)	**4**	**Agree**
Difficulty in meeting health Needs	3% (2.9%)	21.2% (21.2%)	0.0% (0.0%)	40.0% 39.4%)	34.0% (36.5%)	100 100.0%	**4**	**Agree**
Increased cost of producing rice	2.0% (2.0%)	8.0% (7.5%)	0.3% (0.3%)	19.0 (18.6%)	72.0% (71.7%)	100.0 100.0%	**5**	**Strongly Agree**
Rural urban migration of Ricefarmers	20.0% (19.5%)	26.1% (26.1%)	0.7% (0.7%)	23.0% (22.8%)	31.0% (30.9%)	100.0 100.0%	**5**	**Strongly Agree**
Shift from rice farming to other economic activities	8.5% (8.5%)	16.3% (16.3%)	1.0% (1.0%)	50.0% (49.5%)	25.0% (24.8%)	100.0 100.0%	**4**	**Agree**

Source: Computation from survey data, 2021

From the table 2 above rice farmers across Enugu state Strongly Agree or Identify the following as the Effects of climatic variables on rice outputs

Decreased rice crop yield

Enhanced food insecurity

Increased Pests, insects, weeds & diseases

Increased cost of producing rice

Table 3: Binomial Test of proportion using Z-Approximation Climaticvariables on Rice Outputs in Enugu State

Effects of climatic variables on rice outputs	Category	n	Observed Prop. (p).	Test Prop. P).	Exact Sig. (2-tailed)
Decreases Rice Crop yield	Agree	87	.96	.50	**.000**
	Disagree	13	.04		***p*<0.01. Test is Highly**
		100	1.00		**Significant**
Increased food insecurity	Agree	80	.93	.50	***.000***
	Disagree	20	.07		***p<0.01. Test is Highly***
		100	1.00		***Significant.***
Increase Pests, insects, weeds & diseases	Agree	66	.79	.50	***.000***
	Disagree	34	.21		***p<0.01. Test is Highly***
		100	1.00		***Significant.***
Discourage farmers from rice production in the next season	Agree	51	.73	.50	***.000***
	Disagree	49	.27		***p<0.01. Test is Highly***
		100	1.00		***Significant.***.
Increased household poverty	Agree	57	.86	.50	***.000***
	Disagree	43	.14		***p<0.01. Test is Highly***
		100	1.00		***Significant.***
Difficulty in meeting health needs	Disagree	26	.24	.50	***.001***
	Agree	74	.76		***p<0.01. Test is Highly***
		100	1.00		***Significant.***.
Increased cost of producing rice	Agree	70	.90	.50	***.000***
	Disagree	30	.10		***p<0.01. Test is highly***
		100	1.00		***Significant.***
Rural urban migration of Rice farmers	Agree	58	.54	.50	*p=.209*
	Disagree	42	.46		*p>0.05. Test is NOT Significant.*
		100	1.00		
Shift from rice farming to other economic activities	Disagree	24	.26	.50	***.000***
	Agree	76	.74		***p<0.01. Test is Highly***
		100	1.00		***Significant.***.

Source: Computation from survey data, 2021

Rural urban migration of Rice farmers. In testing this hypothesis, in relation to data type, binomial test of proportion using Z- approximation was adopted to test if Rice Output is significantly influenced by climate change in Enugu state. Climate variables under consideration included:

Excessive rainfall

Short period of droughts

Crop failure

Pest and diseases infection

Ozone layer depletion

Bush fire

Flooding

Evapo-transpiration

The analyses of the effect of these Climate variables on Rice Output are presented in theT able below

Table 4. Effects of climatic variables and other factors on rice outputs across two agro-climatic zones of Enugu state

Effects of climatic variables and otherfactors	**Category**	**n**	**Observed Prop. (p).**	**Test Prop. P).**	**Exact Sig. (2-tailed)**
Frequency of flood has increased	**Agree**	**60**	**.80**	**.50**	.000 *p*<0.01. Test is Highly Significant
	Disagree	40	.20		
		100	**1.00**		
Increased cost of producing rice	Agree	70	.90	.50	***.000 p<0.01. Test is Highly Significant.***
	Disagree	30	.10		
		100	1.00		
Climate change has led to rural urban mitigation	Agree	54	.54	.50	***p=.209 p>0.05. Test is NOT Significant.***
	Disagree	.46	.46		
		100	1.00		
There has been a shift from rice farming to other economic	Disagree	79	.26	.50	***.000 p<0.01. Test is Highly Significant.***.
	Agree	21	.74		

Source: Computation from survey data, 2021

From the table 3, the results show that Rice output is significantly influenced by climate variables in Enugu state. Significant influence of climate variables on rice output manifested significantly on: decreases rice crop yield **(p=0.96; *p<0.01)***, increased food insecurity **(p=0.93; *p<0.01)***, increase pests, insects, weeds & diseases**(p=0.79; *p<0.01)***, discourage farmers from rice production in the next season **(p=0.73; *p<0.01)***, has increasedhousehold poverty **(p=0.86; *p<0.01)***, difficulty in meeting health needs**(p=0.76; *p<0.01)***, increased cost of producing rice**(p=0.90; *p<0.01)***, and a shift from rice farming to other economic activities**(p=0.74; *p<0.01)***. Nevertheless, there were no statistically significant evidence of rural urban migration of rice farmers **(p=0.54; *p=.209; p>0.05)***,

4.0 Conclusion

The study concluded that climate variation influences

rice production in the state as the climate parameters of rainfall was strongly and positively correlated with rice output in the study area, maximum temperature and relative humidity were positively correlated with rice output in the study area, maximum temperature and relative humidity were positively correlated with rice output in the study area while minimum temperature and relative humidity were negatively or positively correlated with rice output in the study area.

The variation in the climate parameters gave rise to variation in rice output in Enugu state.

Recommendations

Based on the findings of the study, the following recommendation were considered necessary.

Given that the variations in rain fail pattern significantly influenced rice production in the state, proper source of water supply regime and irrigation system should be provided for regular and adequate water supply in to rice farming as well as other farming activities in the state.

The study area found to be climatically friendly to produce rice should be intensified to produce more rice both for consumption and for income earning by farmers while other places not climatically favorable for rice production can be involve in other crops and livestock production.

Metrological information forecast on weather and climate forecasts should be made available to rice farmer in the state on regular basis so as to guide them on the trend in the climate and weather conditions in rice farming.

Improved rice seedlings tolerable to weather changes should be made available to the rice farmers for cultivation on regular bases.

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