International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 12 Dec. 2022, pp: 281-291 www.ijaem.net ISSN: 2395-5252

Sensitivity of Rice Production System to Climate Change in Northern Cross River State, Nigeria.

[1]UDUMA, Mecha Kalu (Ph.D); [1]AYANG, Fidelis Akwagiobe (Ph.D) & [2]ANAKE, Emmanuel Ushie

Department of Agricultural Education, Federal College of Education, Obudu, Cross River State, Nigeria.
[2]Department of Biology Education, Federal College of Education, Obudu, Cross River State, Nigeria.
Corresponding Author: Dr. F. A.Ayang

Date of Submission: 08-12-2022 Date of Acceptance: 16-12-2022

ABSTRACT
This study was primarily designed to investigate the sensitivity of Rice production system to climate change in Northern Cross River State, Nigeria. In carrying out this study, two research questions were posed and one hypothesis formulated to guide the study. A descriptive survey research design was adopted for the study and a structured questionnaire containing 40 items was administered to a sample of 350 registered rice farmers randomly selected from the five local government areas that make up Northern Cross River State. The researcher with the assistance of the trained research assistants administered the questionnaire to the sampled farmers in the study area. The data collected were analyzed using mean and standard deviation to answer the research questions while the null hypothesis was tested using ANOVA at 0.05 level of significance. The result of the study shows that Rice Farmers in the study area experience some climate change indicators and that rice production system shows sensitivity to climate change. Based on these findings and their associated implications, appropriate recommendations were made among which are: Government and NGOs should make budgetary provisions for incentives to be provided to rice farmers to cushion the effects of sensitivity of rice production system to climate change; and Agricultural extension personnel should be guided by the sensitivity of rice to climate change in exercising their advisory roles to rice farmers.

KEY WORDS: Climate change, Indicators of climate change, Climate change sensitivity.

I. INTRODUCTION

Rice is said to be the number one staple food in Nigeria and it generates more income for farmers in the country. Imolehin and Wada (2000) ranked it third after wheat and maize in terms of worldwide production while Hawksworth (1985) maintained that it is the most important staple food for about half of the human race.

Rice like many other crops has many species and varieties. Erebor (2003) reported that rice has two main varieties namely Oryza glaberima (which originated from West Africa) and Oryza sativa (the Asian type). According to Hardcastle (1959) Oryza glaberrima steud is indigenous to Nigeria and has been cultivated for the past three thousand, five hundred (3500) years. It therefore implies that Nigerians have been cultivating Oryza glaberima for the past 3563 years. Imolehin (1991) seemingly giving a historical account of rice production in Nigeria reported that the earliest cultivation of improved rice varieties (Oryza sativa L) started about 1890 with the introduction of upland varieties to the high forest zone in Western Nigeria. Consequently, by 1960, Oryza sativa had taken over from Oryza glabarima which is now limited to some deep flooded plains of the Sokoto Rima River basin and other isolated pockets of deep swamps all over the country.

Nigeria produced more rice in the last five years than any other time since the return of democracy in 1999. Data from the United Nations Food and Agricultural Organization (UN, FAO) shows that Nigeria maintained top spot among rice producers in Africa between 2014 and 2019. Between 2014 and 2016, Nigeria rice paddy production figures constantly rose from 6.0 to 6.2 and to 7.5 million metric tons (mmt). In 2017, rice production figures fell to 6.61 mmt but increased in 2018 to 6.81mmt and later dropped to 5.1 mmt in 2019 (Mojeed, 2020).

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 12 Dec. 2022, pp: 281-291 www.ijaem.net ISSN: 2395-5252

Importantly, rice is not only a key source of food but a major source of employer of labour and source of income for the rural poor and the government especially when there is increase in domestic production over domestic demand. Little wonder International Rice Research Institute (IRRI, 2013) stated that agriculture contributes about 35% to the GDP and employs about 70% of the total labour force in Nigeria. ThriveAgric (2020) also reported that Nigeria consumes almost 7 million tons of rice yearly with consumption per capita of 32kg. The author added that in the past decade consumption increased by 4.7%, almost four times the global consumption growth and reached 6.4 million tons in 2017. That as at 2011, rice accounted for 10% of household spending on food in Nigeria.

It is highly worrisome to note that rice production which employs about 70% of the total labour force in Nigeria will take as much as 10% of household spending on food for its consumption. It appears there is a gulf between rice production and consumption in the country and that this worrisome gulf is compounded by pendulous and wobbly rice annual output. This unhealthy oscillatory situation may have been responsible for George (2020) report that put Nigeria's rice output at 4.9 million tons in 2019 which was 60% increase from 2013 but well below local consumption of 7.million tons. In the same direction, Polycarp (2019) reported that the West Africa rice development Association (WARDA) estimated per capita rice consumption in Nigeria to have nearly doubled between 1980s and 2006, growing from 15.4kg/year to 25.4kh/year.

In a related situation, IRRI (2013) reported an average yearly per capita consumption of 15.8kg during 1981 to 1990 and that by 2009; it was estimated at 20.9kg. The author added that during 1990 to 2009, self-sufficiency in rice production reached a height of 87% but decline to 64% in 2009 while Caloric intake per day from rice increase from 7.3% in 1995 to 7.9% in 2009.

The above seemingly confusing data as presented by different authors has one common fact which is that there is a great gap between domestic rice production and consumption over the years. This gap has created room for a redirection and overhauling of agricultural policy formulation and implementation as well as importation of rice to bridge the said ugly and great gap. Little wonder, before the Nigerian border closure in 2019, the United State Department of Agriculture (USDA) ranked Nigeria as the second largest importer of rice (2mmt) behind China (5mmt) in 2016. Fortunately and happily also, "Nigeria became the 4th importer of rice in June, 2020 which according the Rice Farmers Association of Nigeria (RIFAN) is attributed to Anchor Borrower program introduced by Nigerian government in 2015" (Mojeed, 2020). According to IRRI (2013), rice importation had increased steadily; reaching 1.8 million tons of milled rice in 2009 and that 695 million dollars was used to import rice in 2006, which is well above the 2001 to 2005 average of 113 million dollars.

Arising from the above, it is NOT mind boggling and exciting to note that millions of dollars spent on rice importation by Nigeria government keep growing by leaps and bounds when she had imposed ban on rice importation in 1985 with the objective of increasing domestic production with the need to meet the increasing demand for the product. Mba (2021) lamented that despite the government ban on rice importation which has been in effect since 2019, an annual 3 million metric tones rice deficit is still either imported or smuggled into the country illegally.

That Nigeria is the continent's leading consumer of rice, one of the largest producers of rice in Africa and simultaneously one of the largest importer of rice in the world (as posited by ThriveAgric, 2020) indicates that there are some challenges with domestic production of the product. While the figure for rice consumption and importation keeps soaring very high, that of production is rapidly on a downward spiral and most annoyingly keep fluctuating unpredictably, thus leaving an alarming gap between local production and consumption.

Majority of Nigerians are bothered why there should be such an alarming gap or rice deficit running into millions of metric tones when rice was one of the five priority commodity value chains that the government started its agricultural transformation agenda with in 2011.Many are equally worried that more than 90% of rice in Nigeria is produced by resource –poor small scale farmers and that there is a very large untapped potential for developing irrigated rice in the country.

Experts have attributed the worrisome, pendulous and wabbly rice output to many factors among which are government disjointed agricultural development programs; weak, uncoordinated and porous agricultural extension service delivery program; high level of corruption in policy and programs implementation; high rural –urban migration; and the effect of climate change on agriculture and food production.

Ghotge (2008) saw climate change (otherwise known as climatic extremes) as one of

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 12 Dec. 2022, pp: 281-291 www.ijaem.net ISSN: 2395-5252

the most serious long term challenges facing farmers and livestock owners around the globe today. Expectedly, Nigeria is not an exception to climate change occurrence as Tobrise (2008) maintained that flood hazards in Nigerian cities have more than doubled in the last ten years. Olanrewaju (2003) lamented that the climatic situation in Kwara State was no longer supporting the growth of melon and that there was a confirmed change in the climate of Kwara State toward aridity in 2003. Variation in precipitation in Kwara State manifest in high frequency of late onset, early cessation and reduction in length of growing season (LGS). Eze (2008) reported that between year 2003 and 2007, a total of twenty lives and fifteen houses were claimed by street flooding in Calabar Metropolis. Also, a study conducted by Utang, Akintoye and Wucox (2008) revealed that the intra annual flow regime in Aya Basin (a tributary catchments of the Cross River Basin) is highly variable and unreliable. This is significantly a function of the interaction of climatic factors and that variable peaks have implications for flood recession agriculture which the people are adept at. Ayang (2016) lamented that the effects of climate change are generally felt by all and sundry (human race, plants, animals and the environment) but farmers are said to have the worst of it because their crops; animals; agricultural resources (land/soil, streams/river, forest e.t.c); production practices and processes such as tillage, planting, harvesting, processing, storage as well as others; and above all, themselves are all affected by the negative impacts of climate change.

There are various definitions of climate change by different scholars, institutions and organizations. Ayoade (2004) defined climate change as a long term shift, alteration or change in the type of climate prevailing over specific location, region or the entire planet. According to United Nations framework convention on climate change (UNFCCC) as reported in Intergovernmental Panel on Climate Change (IPCC, 2001), climate change is a change of climate 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 comparable time period.

It is obvious from both definitions that change is an inherent attribute of climate, which is caused by both human activities (anthropogenic) and natural factors. Importantly, when the said change is caused by anthropogenic factors, it is most appropriately termed climate change while that caused by natural factors is referred to as climate variability. Consequently, human activities enormously and sometimes wantonly carried out on the environment make the pace of climate change much faster than climate variability and with grievous impact on the environment, agricultural resources and production, human health and other sectors of the economy across the globe.

Determinants of impacts of climate change are the frequency and magnitude of climate change indicators (climate change exposure), sensitivity and adaptive capacity. In other words, magnitude and the rate of climate change are important in determining the sensitivity, adaptability and vulnerability of a system.

Sensitivity and susceptibility to climate change refers to the degree to which individuals or populations are affected by the impacts of climate change. While everyone will be impacted by the effects of climate change, factors like sex, age, income, education etc contributed to an individual's sensitivity and susceptibility to climate change. According to Intergovernmental panel on climate change (2014), climate change sensitivity is the degree to which a system, asset, or species may be affected, either adversely or beneficially when exposed to climate variability or change or geophysical hazards. Also Babu (2019) explained that climate cha nge sensitivity is the degree to which a system is affected by the exposure to risk. In a recent publication, Cook (2022) views climate sensitivity as the estimate of how much the earth's climate will warm in response to the increased greenhouse effect when the amount of carbon dioxide is doubled in the atmosphere. This includes feedbacks which can either amplify or dampen that warming. It implies that when sensitivity is low, the planet will warm slowly and we will have more time to react and adapt whereas if it is high, then the planet will warm very fast and we will not have time to react and adapt to it. Also Rekacewicz and Boumay (2022) see sensitivity as the degree to which a system is affected, either adversely or beneficially by climate related stimuli which encompass all the elements of climate change, including mean climate characteristics, climate variability and the frequency and magnitude of extremes. The effect may be direct (e.g. a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g. damage caused by an increase in the frequency of coastal flooding due to sea level rise.

There are two ways of working out climate sensitivity. The first method is by modeling which uses prediction and estimation while the second method is by calculating climate sensitivity

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 12 Dec. 2022, pp: 281-291 www.ijaem.net ISSN: 2395-5252

directly from physical evidence by looking at climate change in the distant past.

According to Colman and Braganza (2013), determining climate sensitivity helps in the understanding of future risks as well as planning for future climate change. The authors added that there are two types of climate sensitivity namely transient climate" and equilibrium climate sensitivity. That the transient climate response (TCR) or sensitivity measures how the climate will get warm when it is still being pushed by human activities while equilibrium climate response or sensitivity (ECS) measures the end result in climate warming in hundreds of years down the track.

Exposure and sensitivity to climate risks results in the climate impact on the system in question. Exposure is defined as the contact between a system and climatic expression and it is external to the system. Climatic expression in other words implies various indicators about the change in climatic elements. According to Babu (2019), climate change indicators are factors such as change in the length of the growing season, onset of spring, chilling hours over the winter, increased heat stress for livestock. United State Department of Agriculture (2020) explained that indicators are measurements or calculations that tell the status of a system of interest. Climate change indicators provide information about the magnitude, timescale, and effects of environmental changes relative to historical information. These indicators may be derived from changes in direct measurement of temperature, precipitation, heat waves, nighttime air temperature, soil moisture, humidity, weed range and infestation intensity, crop pathogens, insect infestation in crops among others.

Assessment of climate change indicators provides a signal of the impact of climate change on different systems. This will certainly be beneficial to the development of strategies for effective adaptation practices.

Very few researchers have investigated farmers' perception on indicators as well as sensitivity of climate change to agricultural production in general and on rice production to be more specific. Kashenge and Makonide (2017) studied the Perception and Indicators of Climate Change, Its Impacts , Available Mitigation Strategies in Rice Growing Committees Adjoining Eastern Are Mountains, Tanzania. Also Babu (2019) researched on Exposure, Sensitivity and Adaptive Capacity: Understanding Climate Change while Rekacewicz and Bournay (2022) studied "Climate Change: Sensitivity, Adaptability and Vulnerability. The paucity of empirical studies on indicators as well as sensitivity of climate change to rice production most importantly in the study area created a research gap which this study was designed to fill. Specifically, provision of answers to the following research questions and testing a related hypothesis respectively was the focus of this research study.

R.Q.I. What are the climate change indicators that rice production is exposed to in Northern Cross River State, Nigeria?

R.Q.II. How sensitive is rice production system to climate change in Northern Cross River State, Nigeria?

Ho: Years of experience in rice farming has no significant influence on the responses of farmers on sensitivity of rice production to climate change in Northern Cross River State, Nigeria?

II. METHODOLOGY

This study adopted a descriptive survey research design and was carried out in Northern Cross River State, Nigeria. A sample of 350 rice farmers drawn (using random sampling technique) from a population of all rice farmers in the five Local Government Areas (i.e 70 rice farmers per Local Government Area) that make Northern Cross River State responded to a structured questionnaire which contain 40 items out of which 12 items were on personal or demographic characteristics of respondents and agronomic practices adopted in their rice farms. Prior to administration of the questionnaire by trained research assistants, its draft was validated by 3 experts drawn from the Department of Agricultural Education, University of Nigeria Nsukka. .Data generated for this study was analyzed using mean and standard deviation to answer research questions, and ANOVA to test hypothesis at .05 level of significance since the hypothesis had more than two groups

III. RESULTS.

The results of the study were generated from the research questions and hypothesis answered and tested respectively after data analyses

Research Question One: What are the various climate change indicators that rice production system is exposed to in Northern Cross River State?

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 12 Dec. 2022, pp: 281-291 www.ijaem.net ISSN: 2395-5252

Table I
Mean ratings of responses on climate change indicators that rice production system is exposed to in Northern Cross River State.

S/N	various climate change indicators that rice production system is exposed to	X	S.D	RMKs
13	Increased temperature during the cultivation period	3.04	0.94	A
14	Very low amount of rainfall during the cultivation period	2.68	1.01	A
15	Late commencement of rainfall	2.92	0.80	A
16	High solar radiation or sun rays during the cultivation period	2.58	1.04	A
17	Excessive rainfall during rice production season	2.82	0.98	A
18	Early commencement of rainfall	2.74	0.87	A
19	Very short rainfall period	2.78	0.99	A
20	High amount of water in the air during rice production season	2.92	0.98	A
21	Early cessation of rain (Rainfall stopping very early)	2.86	1.02	A
22	Flood or water submerging rice farm for a long period of time	2.78	0.97	A
23	Late cessation of rain (Rainfall stopping very late)	2.72	0.85	A
24	Stoppage of rainfall at critical stage in rice production	2.64	1.01	A
25	Early commencement of harmattan	2.76	0.95	A
26	Heavy rain followed by intensive sun on the same day.	2.10	0.92	D
CLUSTER		2.73	.43	A

Source: field survey /Data analysis
Keys: X = Mean, S.D. = Standard Deviation, Rmks = Remarks, A = Agreed, D = Disagreed

Table I above presents mean rating of respondents on various climate change indicators that rice production system is exposed to in Northern Cross River state. The analysis revealed that thirteen out of fourteen items had their mean ratings ranged from 2.58 to 3.04 which is above 2.50 branch mark on a four point rating scale. This indicates that respondents agreed that the thirteen items were various climate change indicators that rice production system is exposed to in the study area. Also a cluster mean of 2.73 which is above 2.50 cut-off point implies that all the fourteen items are climate change indicators that rice production system is variously exposed to in the study area. The findings also showed that the standard deviation of the fourteen items ranged from 0.80 to 1.04. This implies that the responses were tightly clustered around the mean and thus shows little variability. This is an indication of homogeneity in agreement and hence pointing to the fact that greater number of the respondents agreed that all the items were climate change indicators that rice production system is exposed to in Northern Cross River state.

Research Question Two: How sensitive is rice production system to climate change in the study area?

Table II
Mean ratings of responses on sensitivity of rice production system to climate change in Northern Cross River State.

S/N	Sensitivity of rice production to climate change.	X	S.D	RMKs
27	Rice plant is highly sensitive to shortage of rainfall.	3.22	0.73	A

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 12 Dec. 2022, pp: 281-291 www.ijaem.net ISSN: 2395-5252

28	Rice production system depends solely on rainfall.	2.66	0.99	A
29	Varieties of rice in our areas cannot cope when there is shortage of rainfall and soil water.	3.38	0.63	A
30	Upland rice is greatly affected by shortage of rainfall.	3.32	0.81	A
31	Rice has high water requirement	3.38	0.66	A
32	Some varieties of rice can't cope when covered completely by water for some days.	3.36	0.66	A
33	Rice can't produce well if there is no enough sunshine.	2.86	0.85	A
34	Germination of rice seed requires high temperature.	2.70	0.90	A
35	Growth rate of rice will be reduced when temperature exceed the optimum level.	3.30	0.58	A
36	Rice flowering time and maturity period depends on amount of rainfall.	3.02	0.86	A
37	Our swamps do not hold enough water for rice cultivation.	2.80	1.02	A
38	Our swamps become very hot with little sunshine.	2.32	0.95	D
39	Our rice plots are easily eroded or washed away.	2.70	0.83	A
40	Our rice plots are not easy to work on.	2.62	0.85	A
CLUSTER		2.97	0.36	A

Source: field survey /Data analysis
Keys: X = Mean, S.D. = Standard Deviation, Rmks = Remarks, A = Agreed, D = Disagreed

Table II above presents mean ratings of respondents on sensitivity of rice production system to climate change in Northern Cross River state. The analysis revealed that thirteen out of fourteen items had their mean ratings ranged from 2.62 to 3.38 which is above 2.50 branch mark on a four point rating scale. This indicates that respondents agreed with the thirteen items as expression of sensitivity of rice production to climate change in the study area. Also a cluster mean of 2.97 which is above 2.50 cut-off point implies that all the fourteen items expressed sensitivity of rice production to climate change in the study area. The findings also showed that the standard deviation of the fourteen items ranged from 0.58 to 1.02. This implies that the responses were tightly clustered around the mean and thus shows little variability. This is an indication of homogeneity in agreement and hence pointing to the fact that greater number of the respondents agreed that all the fourteen items expressed sensitivity of rice production system to climate change in the study area.

Hypothesis one: Years of experience in rice farming has no significant influence on rice farmers' responses on sensitivity of rice production system to climate change in Northern Cross River State.

The Data for testing the hypothesis is presented in table 3.

Table III
Analysis of variance (ANOVA) statistics on mean ratings of responses of rice farmers by years of experience in rice farming on sensitivity of rice production to climate change in Northern Cross River State. N1 = 56, N2 =140, N3 =98, N4 =56.

Source of difference	Sum of square	Df	Mean square	F ratio	p-Val.	Rmk
Between groups	9.796	3	3.265	32.572	0.000	N.S
Willing groups	34.687	346	.100			

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 12 Dec. 2022, pp: 281-291 www.ijaem.net ISSN: 2395-5252

Total	**44.48**	**349**				

Source: field survey /Data analysis

Table III presents summary of analysis of variance statistic for the responses of rice farmers by years of rice farming experience on the sensitivity of rice production to climate change. From the table, the F-ratio of 32.57 with a p-value of .000 at 3 and 346 degrees of freedom is greater than 0.05. This indicates that there is no significant difference in the mean responses of the four groups of respondent (rice farmers with 1-10; 11-20; 21-30; and above 30 years of rice farming experience) on sensitivity of rice production to climate change. Thus, the null hypothesis is upheld. This implies that respondents do not differ significantly in their opinion on sensitivity of rice production system to climate change in the study area.

IV. FINDINGS

The following findings emerged from the study based on the research questions answered and the hypothesis tested.

a. Results on the various climate change indicators that rice production is exposed to in Northern Cross River State showed that respondents agreed that rice production in the study area is exposed to various climate change indicators. Out of the 14 items (indicators) listed, the only indicator not accepted by the respondents was "heavy rain followed by intensive sun on the same day".
b. Results on sensitivity of rice production system to climate change in Northern Cross River State showed that respondents agreed that rice production is sensitive to climate change. Out of 14 items on suggested aspects of sensitivity of rice production system to climate change, the only item rejected by respondents was that our swamps become very hot with little sunshine.
c. The result of hypothesis one showed a non-significant difference in the mean responses of rice farmers by years of rice farming experience on sensitivity of rice production system to climate change. This showed that years of rice farming experience has no influence on farmer responses as they were unanimous in their opinion on sensitivity of rice production system to climate change

V. DISCUSSION OF RESULT

The findings of the study are discussed in sections in line with the research questions/hypothesis for the study viz:

i. What are the climate change indicators that rice production is exposed to in Northern Cross River State, Nigeria?
ii. How sensitive is rice production system to climate change in Northern Cross River State, Nigeria?
iii. Years of experience in rice farming has no significant influence on the responses of farmers on sensitivity of rice production to climate change in Northern Cross River State, Nigeria?

Climate change indicators that rice production is exposed to in Northern Cross River State

The findings as presented in table 1 showed that respondents agreed that rice production in the study area is exposed to various climate change indicators. These findings are in consonance with the conclusion of United State Department of Agriculture (2020) that climate change indicators are measurements or calculations that tell the status of a system of interest. Climate change indicators provide information about the magnitude, timescale, and effects of environmental changes relative to historical information. These indicators may be derived from changes in direct measurement of temperature, precipitation, heat waves, nighttime air temperature, soil moisture, humidity, weed range and infestation intensity, crop pathogens, insect infestation in crops among others. Little wonder, Shah and Ameta (2008) decried that agriculture in the world's dry lands is being seriously threatened by rising temperatures, changes in rainfall patterns or increased drought as a result of climate change. That, this is directly linked to reduced soil productivity and a higher incidence of pests and diseases. Also Agyei (2008) reported "erratic rainfall patterns, too much heat, disappearance of the forest cover with its animals and plants, drying up of streams, rivers, loss of soil fertility and more erosion in Ghana. Similarly, Bayani (2008) reported that farmers in Malawi were already experiencing climate change. According to the author, a farmer in the northern district of Rumphi lamented that "rains these days are unpredictable …, one year they start in November, another year in December and then we have dry spells at the critical stages of crop growth…as well as prolonged and more frequent droughts, changes in the overall rainfall distribution, more storms and other extreme weather events". In addition to the foregoing, these

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 12 Dec. 2022, pp: 281-291 www.ijaem.net ISSN: 2395-5252

findings on climate change indicators agrees with Olanrewaju (2003) position that the climatic situation in Kwara State (Nigeria) was no longer supporting the growth of melon and that there was a confirmed change in the climate toward aridity in 2003 with variation in precipitation manifesting in high frequency of late onset, early cessation and reduction in length of growing season.

Sensitivity of rice production to climate change in Northern Cross River State.

The findings as presented in table 1I showed that respondents agreed that rice production system is sensitive to climate change in the study area .These findings are in agreement with the position of Saud et al (2022) that in recent decades, thermal resources have increased during the rice growing season, while solar radiation resources have decreased and precipitation heterogeneity has increased. That the increasing frequency of high-temperature stress, heavy rainfall, drought, and flood disasters may reduce the utilization efficiency of hydrothermal resources. Also that climate change has resulted in a significant northward shift in the potential planting boundaries of single and double-cropping rice production systems, which negatively affects the growth duration of single-early-, and late cropping rice. Additionally, Wassmann et al (2009) report that rice is highly sensitive to salinity which often coincides with other stresses in rice production, namely drought in inland areas or submergence in coastal areas support this current findings. Little wonder pickson and Boateng (2022) maintained that rice is the most sensitive to climate variability over its growing season among other cultivated crops. As such, over reliance on climate conditions for rice farms calls for a wide range of strategies critical to curtailing the adverse impacts of climate change on rice production. These findings are also in consonance with the conclusion of Stuecker, Tigchelaar and Kantar (2018) that rain fed upland rice production systems are more sensitive to soil moisture variability than irrigated paddy rice.

Years of experience in rice farming has no significant influence on the responses of farmers on Sensitivity of rice production system to climate change in Northern Cross River State

Test of hypothesis as presented in table III shows that respondents were unanimous in their opinion on sensitivity of rice production to climate change in Northern Cross River State. This findings agrees with the position of Ayang (2016) who lamented that the effects of climate change are generally felt by all and sundry (human race, plants, animals and the environment) but farmers are said to have the worst of it because their crops; animals; agricultural resources (land/soil, streams/river, forest e.t.c); production practices and processes such as tillage, planting, harvesting, processing, storage and others; and above all themselves are all affected by the negative impacts of climate change.

VI. CONCLUSION

Based on the findings of the study, the following conclusions were drawn:

1. Rice production in Northern Cross River State is exposed to various climate change manifestations or indicators.
2. Rice production in the study area is highly sensitive to climate change.
3. Years of experience in rice farming does not significantly influence rice farmers responses on the sensitivity of rice production system to climate change

IMPLICATION OF THE FINDINGS

The findings of this study have the following far reaching educational implications.

There is an urgent need for government and NGOs to develop and implement climate change mitigation and adaptation programme for rice farmers. This will enable rice farmers who are already aware of many climate change indicators and sensitivity of rice production to climate change to learn and as well adjust their farming practices in other to cushion effects of climate change and thereby improve the production of rice.

The identified climate change indicators that rice production is exposed to will provide a guide on the intensity and frequency of climatic extremes. Agric extension personnel, NGOs and government will use the knowledge of such climatic extremes and planned and implement a programme that will mitigate the intensity and frequency of such indictors. It will also guide stakeholders in rice production in planning and implementing adaptation measures with a view to boost rice production.

Rice farmers will be guided by the sensitivity of rice production system to climate change in taking major decisions on agronomic practices that will help mitigate the impact of climate change on rice production. It will also guide them in deciding adaptation measures that will equally reduce the impact of climate change on rice production.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 12 Dec. 2022, pp: 281-291 www.ijaem.net ISSN: 2395-5252

VII. RECOMENDATIONS

On the basis of the findings, discussion and conclusion of the study, the following recommendations were made:

Experts developing agricultural extension programmes on climate change should involve rice farmers who are already aware of climate change indicators for meaningful contribution and active participation in the programme development process.

Agricultural extension agents should identify rice farmers who are already aware of the sensitivity of rice production system to climate change for agricultural input supply and other palliatives including subsidies. This will encourage such farmers to continue or expand the cultivation of rice irrespective of challenges posed by sensitivity of rice production system to climate change.

Government and NGOs should make budgetary provisions for incentives to be provided to rice farmers to cushion the effects of sensitivity of rice production system to climate change.

Agricultural extension personnel should be guided by the sensitivity of rice to climate change **in** exercising their advisory roles to rice farmers.

Incentives that will enhance the adoption of climate change copping strategies (climate change mitigation and adaptation measures) by rice farmers should be provided by stakeholders in Agriculture, food security and environmental protection. This will not only increase rice production but also make such production sustainable.

APPRECIATION: Special gratitude to TETFUND, Nigeria for funding this research (Federal College of Education, Obudu, Cross River State 2019 Institutional Based Research)

REFERENCE

[1]. Agyei (2008). Mangoes to the rescue: A local response to climate change' in LEISA Magazine, 24(4)20.

[2]. Ayang, F.A (2016). Development of Farmer Learning Programme for Climate

[3]. Change Mitigation and Adaptation in Cross River State, Nigeria. An unpublished Ph.D dissertation submitted to Vocational Teacher Education Department, U.N.N.

[4]. Ayoade, J.O. (2004). Climate Change. Ibadan: Ventage publishers.

[5]. Babu, B. (2019). Exposure sensitivity and adaptive capacity understanding climate change.

[6]. Bayani, E.K. (2008 December). Malawi's initiatives in response to climate change. LEISA Magazine pp 34-35., vol 24 no 4

[7]. Colman, R &. Braganza, K. (2013) .The Conversation Explainer: What is climate sensitivity? Retrieved from https://theconversation.com/explainer-what-is-climate-sensitivity-18815 on 25/11/2022

[8]. Cook, J. (2022). Skeptical Science: How Sensitive is our Climate? Retrieved from https://skepticalscience.com/climate-sensitivity.htm on 25/11/2022

[9]. Erebor, O. (2003). Comprehensive agricultural science for senior secondary schools. Surulere Lagos A. Johnson Publishers.

[10]. Eze, E.B (2008). Topography and urban expansion as twin factors of street flooding in Calabar Municipality, Cross River State. In F E Bisong (ed), Geography and the millennium Development Goals: Translating Vision into Reality in Nigeria. 50th Annual Conference of Association of Geographers 'Book of Proceedings ' (415-422). Department of Geography and Regional Planning, University of Calabar, Calabar.

[11]. George, L. (2020). A growing problem: Nigerian rice farmers fall short after border close. Reuters commodities news. Retrieved from www.reuters.com/article/us-nigeria-economy-riceHard Castle, J.E. Y. (1959). The development of rice production and research in the federation of Nigeria. Tropical agriculture (Trinidal) 36:76-95.

[12]. Ghotge (2008 December). Integrated Local Systems for mitigating Climate Change. LEISA Magazine, 24 (4), 2[illegible]

[13]. Hawksworth, D.L. (1985). Forew[illegible]i in S.H. Ou,.ed,rice diseases. (M) [illegible]gh, UK, CAB 380 pp.

[14]. Hardcastle J.E.Y (1959). The development of rice production and research in the federation of Nigeria. Trop. Agric. Grinidad), 36:79-95

[15]. Imolehin, E.D. (1991). Rice improvement and production in Nigeria: A paper presented at WARDA upland breeding task-force Norkshop, Bauake, coted'ivoire, 4th Oct, 1991.

[16]. Imolehin, E.D. & Wada, A.c. (2000). Meeting the rice production and consumption demands of Nigeria with improved technologies.

[17]. Intergovernmental panel on Climate Change (IPCC) (2001). (TAR) Working Group 1: Combridge: Cambridge University Press.
[18]. Intergovernmental panel on climate change (IPCC) 2014), Climate Change Impacts,
[19]. Adaptation and Vulnerability. Contribution of working groups to the fifth assessment report of IPCC/ retrieved from http://www.ipc/chreport/ar5/wgt on 1st September, 2022.
[20]. International Rice Research Institute (IRRI ,2013). Rice Almanac Fourth Edition.IRRI Books. (IRRI) number 164484. Retrieved from https://ideas.repec.org/6/ags/irricg/164484.html on 26/11/22
[21]. Kashenge, S & Makonide, E. (2017). Perception and Indicators of Climate
[22]. Change, its Impacts available Mitigation Strategies in Rice Growing Committees Adjoining Eastern Area Mountains, Tanzania Universal Formal of Agricultural Research 5(5) 2067-279. Retrieved from http://uyarz-10409310(1)pdf on 26-11-2022.
[23]. Mba, C. (2021). Nigeria milled rice production over 20 years. Retrieved on 21/02/2022. From http://www.dataphyte.com/latest-report Nigeria milled-rice[production-over-20-year..
[24]. Mojeed, A. (2020). How Nigeria has fared in Rice production since 1999.Premium Times
[25]. July 14 2020. Retrieved from premiumtimesng.com/hownigeriahas fared in rice production since 199 on 01/03/2022
[26]. Olanrewaju,n R.M. (2003). 'The Preliminary study of climate variable on the growth of melon in Kwara State.' Journal of the Nigerian Meteorological Society, 5(1): 1-7.
[27]. Pickson, R.B. & Boateng, E. (2022). Impact of climate change,. Environmental research communications 4. 075011. Retrieved from www.pickson-2022.environ-res.commun-4-075011 on 1st September, 2022.
[28]. Polycarp, M. (2019). Analysis of producers price of rice in Nigeria. The international journal of science and technology. 3(10) 90-96. Retreieved from http://www.researchgate.net/publication/335391957 on 22/12/202.
[29]. Rekacewicz, P. & Bournay, E. (2022) Climate Change: Sensitivity, Adaptability
[30]. and Vulnerability. UNEP/GRID – Arendal. Retrieved from grid@grida. No/climate change on 26/11/2022.
[31]. Saud, S. Wang., D. Fahad, S., Alharby, H.F., bamagoos, A.A., Mjrashi, A. Alahdallah, n.M. Alzahrani, S.S., Abdelgawad, H.; Adnan, M. Sayyued, R.Z. Ali, S. & Hassan, s. (2022). Frontiers in microbiology Retrieved on 25/11/2022 from https://www.ncbi.ncm.nih.gov/pmc/articles/PMC9300054.
[32]. Shah, R. & Ameta N. (2008). Adapting to change with a blend of traditional and improved practices in LEISA Magazine 24(4) 9-11.
[33]. Stueker, M.F. Tigchelaar, M.; Kantar, M.B. (2018) climate variability impacts on rice production in the Philippines Plos one 13(8) retrieved from https://doi.or/10.1371/joinal,pone0201426 or 26/11/2022.
[34]. Thrive Agric. (2020). Statistics: Rice Production in Nigeria. Retrieved on 22/02/2022.
[35]. Tobrise, E.E. (2008). Perception of flooding problems in Benin City. In F E Bisong (ed), Geography and the millennium Development Goals: Translating Vision into Reality in Nigeria. 50th Annual Conference of Association of Geographers 'Book of Proceedings, (pp 284-295) Department of Geography and Regional Planning, University of Calabar, Calabar.
[36]. United States Department of Agriculture (USDA, 2020) Climate Indicators
[37]. for Agriculture. USDA Technical bulletin 1953. Washington DC http://doi.org/10.25673/10217/21430. Retrived from https://www.usda.gov/site/defaytklf/files/documents/climate indicators for agriculture.pdf. on 1/9/22
[38]. Utang, P.B, Akintoye, O, A & Wilcox, Rogers I (2008). Implications of climate variability in the intra-annual and maximum stream flow for flood recession agriculture in AYA basin, South Eastern, Nigeria. In F E Bisong (ed), Geography and the millennium Development Goals: Translating Vision into Reality in Nigeria.

50th Annual Conference of Association of Geographers 'Book of Proceedings, (71-79) Department of Geography and Regional Planning, University of Calabar, Calabar.

[39]. Wassmann, R. Jagadish, S.V.K., Heuer, S., Ismail, A.M. Redona, E.D. Serraj, R. Singh, R. Howel, G., Pathak H. & Sumfleth, K. (2009). Climate change affecting rice productions. The physiological and agronomic basis for possible adaptation strategies. Advances in agronomy volume 101 pp. 59-122 retrieved from https://www,scienceirect.com.science/inte cle . 50065-2113(08) 00802-X.