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Vulnerability of Rice Farmers to Climate Change in Kwara State, Nigeria

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ABSTRACT

Climate unpredictability and weather extremes are being projected as capable of presenting additional challenges for farmers currently engaged in the low-technology based food production systems in sub-Saharan countries like Nigeria. This study assessed rice farming households' vulnerability to climate change in Kwara State, Nigeria. Primary data, collected from 150 respondents using simple random sampling procedure were analysed employing descriptive statistic was use to describe the coping strategies adopted and Human Development Index (HDI) was created to assess vulnerability of rice farmers to climate change. Statistical analyses indicated a vulnerability assessment index of 0.3001, pointing to a fact that the zone is prone to the adverse effects of climatic variability. For this reason, the study empirically underscores the need for farmers to adopt and adapt the planting of drought tolerant and/or early maturing varieties of rice. Importantly, the capacities of the local communities needs to be strengthened vis-à-vis the relationship between climate change and crop production. Capacity building at the farm level is crucial for improving crop, soil and water management, enhancing the demand for and use of better and more efficient production inputs. Tied to farm-level capacity building is the need to refocus public agricultural-based institutions towards exposing the rice farmers to effective mitigation strategies in the wake of climate change, provision of agricultural inputs, expansion of irrigation, efficient and effective extension service delivery, market development and other forms of necessary support.

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Introduction

The Nigerian Meteorological Agency recorded remarkable changes in the country's weather pattern from 1941 to 2018 rainfall in the northern parts had been on a steady decline since the early 1970s while that of the southern areas fluctuated year in, year out. Correspondingly, the temperatures in the north had also increased over the same period, with an average increase of between 1.4-1.9^{o}C; scientists have warned that it could further increase to between 2.0-5.0^{o}C before the century ends, if no drastic action is taken (Nwajiuba, 2013). These sets of data on changes in weather patterns are signposts ongoing changes in Nigeria's climate. Farmers in the country are in a major part subsistent in practice, many of which also into rain-fed agricultural practice.

Two theories that resonate with the concept of climate change and vulnerability of farmers to its effect were considered for this particular study. The first is the theory of Climate signal. The climate signal has to do with the long–term changes in average climate conditions, as well as the changes in climate inconsistency vis-à-vis changes in the timing, intensity and duration of precipitation and extreme weather events, like droughts and floods (Smithers and Smit 1997). They stated that the coping strategy adopted by most persons at the receiving end largely depends on the characteristics of the climate stimulus vis-à-vis the level of exposure to the stress and the scale and magnitude of the event.

The second is the theory of 'context of vulnerability' which posits that the effect of climate change on the well–being of individuals, households, and communities and their ability to respond to those changes depends on the context in which climate change occurs (Adger et al., 2009). The context includes all the factors that determine an individual's, households, groups, or community's vulnerability to climate change.

Agriculture in sub-Saharan Africa is largely weather dependent and any change in climate may lead to downshift in productivity; thus, poor and unpredictable yields is occasioned and thereby making farmers more vulnerable (UNFCCC, 2007). One crop that is has been caught up in the devastating effect of climate induced environmental tragedy is rice. The rice crop is a staple food of virtually every household in Nigeria, both the rich and poor consume large quantity of rice every day. (Uba, 2013) noted that 70% of a total projected population of Nigeria feed on rice.

Nigeria is said to be Africa largest producer of rice among the top 15 globally. Processed rice grain consumption was up by more than three-fold from 9.2Mt to 31.5Mt during the period of 1990 to date in SSA (United States Department of Agriculture, 2018). Research revealed that between 2003 and 2013, Nigeria imported 17,206,077 tons of rice with an average import at 1,564,188 million (United States Department of Agriculture, 2018). Table 1 below shows rice production trends in Nigeria from (2010 – 2018).

Table 1. Rice Production Trends in Nigeria from 2010-2018

Year	Production	Unit of Measure	Growth Rate (%)
2010	2818	(1000 MT)	26.14
2011	2906	(1000 MT)	3.12
2012	3423	(1000 MT)	17.79
2013	3038	(1000 MT)	-11.25
2014	3782	(1000 MT)	24.49
2015	3941	(1000 MT)	4.20
2016	3780	(1000 MT)	-4.09
2017	3780	(1000 MT)	0.00
2018	3780	(1000 MT)	0.00

Source: United States Department of Agriculture (2018)

The adverse effect of variations in the seasonal weather conditions is already manifesting across a wide range of natural and human activities. The changing rainfall patterns and rising temperatures of the earth were particularly ranked as major contributors to the now rampant disasters like droughts, floods and forest fires (Zoellick, 2009). These environmentally-induced challenges have made many farmers, whose livelihood depends majorly on agricultural production, become more and more susceptible to climate risk.

Recently, Nigeria witnessed some devastating floods that were reported to have been worst of its kind in Nigeria; thousands of farmers were not only displaced from their homes but large quantities of food crops were also swept away, thereby threatening food security status of the nation (Punch newspaper, 2018).

One of the crops worst hit by the flooding is rice which is a major staple crop in the country. Rice is an important crop in Patigi, Lafiagi, Tsonga and their surrounding areas in Kwara State, Nigeria. These areas which lie within the flooding vulnerable zone had certainly aroused the interest to carrying out this study.

The open questions therefore are, "to what extent are rice farmers in the study area aware of climate change?" "How vulnerable are the rice farmers to climate risk?" and "How do the farmers respond to climate induced shocks?"

Although farmers manage at multiple scales, their adaptation decisions are primarily driven by private benefits reaped in the here and now (Jackson et al., 2010). Instances of adaptation of agriculture to the impacts of climate change might include adjustments in planting dates, crop varieties, drainage systems, and land management regimes to maintain yields and soil fertility. Over time, shifts in annual averages and seasonal patterns of precipitation, temperature, and humidity, as well as more erratic and extreme weather events leading to increased risk of floods, drought, and fire are anticipated for the future (Coumou and Rahmstorf, 2012; Hatfield et al., 2011).

It is pertinent for farmers to be aware of climate change, behavior change is influenced by perceptions of the risks associated with a given natural hazard, which are mediated by beliefs about the existence of the hazard and its characteristics. Perceived risk among individuals or group of people, while a critical determinant of willingness to prepare for or mitigate natural hazards, is often at odds with objective assessments of risk (Nigg and Mileti, 2002). In other words, perceptions of risk are socially constructed and transmitted, differences in worldviews, personal experiences, expectations about technology, trust in institutions, and other factors can influence awareness and understanding of hazards and decisions and actions (or inaction) in response (Slovic, 2009). Studies on vulnerability of rice farmers to the effects of climate change are still in the budding stage in Nigeria, this exploratory study, therefore, will be of benefit to the farming households in general and rice farmers in particular, in helping them to take necessary mitigation measures. Students as well as researchers will also benefit from the study as it will contribute in filling the existing gap in the study of risk management among farming households in the locality.

Material and Methods

Study Area

The study was carried out in Kwara State, Nigeria which is located between latitudes 8º30' and 8º50'N and longitudes 4º20' and 4º35'E of the equator. The wet season straddles the months of March to November and the annual rainfall varies from 1000 mm to 1500 mm, attaining its peak around September to early October (KWADP, 2018).

Also, the mean monthly temperature is moderately high throughout the year. The daily average temperature is 25ºC in the month of January, 27.5ºC in May and 22.5ºC in September (KWADP, 2018).

The common vegetation type found in the state is derived Savannah with riparian forest along banks of rivers. The major occupation of the people in the state is farming and various crops are cultivated at subsistence level which they consume by farmers' families. Rice is one of the common crops cultivated and it is largely weather

dependent. Other crops cultivated by farmers in the State include sorghum, cassava, maize, yam, beans and sweet potatoes are the major crops; a few farmers also grow cash crops like cashew and oil palm (KWADP, 2018).

Sampling Techniques and Methodology

The sampling frame was developed from the list of rice farmers in the Ministry of Agriculture and Rural Development, Kwara State, Nigeria. A random selection of 150 rice farmers was undertaken and questionnaire was administered on them to obtain relevant data. The analytical tools employed for this study include descriptive statistics, Vulnerability Assessment and a 5-point Likert-type scale that was employed in ranking the coping strategies adopted by the rice farmers.

Vulnerability Assessment

Normalization of indicators using functional relationship was adapted from the Human Development Index (HDI) used by United Nation Development Programme, (UNDP, 2006) and Organization for Economic Co-operation and Development, (OECD, 2008) – this involves ensuring that all the indicator values are comparable and congruent such that they are standardized to fit within the range zero (0) to one (1) - adopting linear normalization:

$$Zij = \frac{Max\{X_{ij}\} - X_{ij}}{Max\{X_{ij}\} - Min\{X_{ij}\}} \quad (1)$$

Where
Z_{ij}= normalized value of indicator i
X_{ij} = value of indicator i
$Max\{X_{ij}\}$ = highest value
$Min\{X_{ij}\}$ = lowest value

Aggregation of indicators: This is a linear summation aggregation method. Index (I) of the indicator Y for a farming community/village (i) was calculated by multiplying its weight (Wy), by its normalized value (N_{yi}) which is the standardized value of the indicator.

$$I_{yi} = W_y \times N_{yi} \quad (2)$$

Where
I_{yi} = Vulnerability index of i household
W_y = Weight of the indicator
N_{yi} = Standardized value of the indicator

The Vulnerability Index (Iv) of each component of vulnerability (Exposure, Susceptibility and Capacity) was computed as the arithmetic mean of the values of all indices of the component for farmers. Given a component of vulnerability with indicators Y, measured for a farmer/farming community/village (i), then the Vulnerability Index (Iv) of the component of vulnerability in that particular farmer/farming community/village (i) is given by:

$$I_v = \frac{\sum(W_y \times N_{yi})}{n} \quad (3)$$

Where n = number of indicators of the component of vulnerability. Vulnerability increases with exposure and susceptibility but reduces with capacities. The vulnerability index so computed lies between 0 and 1, with 1 indicating maximum vulnerability and 0 indicating no vulnerability at all.

Rice Farmer's Coping Strategy Index

$$RFSUI = \frac{(N_1 \times 3) + (N_2 \times 2) + (N_3 \times 1)}{M} \quad (5)$$

Where
RFSUI= Rice farmers adaptation strategy use index
N_1 = Number of farm that constantly use a particular CS;
N_2 = Number of farm that occasionally use a particular CS;
N_3 = Number of farm that rarely use a particular CS;
M = n × 3;
n = Total number of respondents

Results and Discussion

Socio-economic Characteristics of the Rice Farmers

Table 2 indicates that majority of the respondents are between the ages of 30 years and above; respondents found in age 26 years and over accounted for two-thirds (68.0%) of the rice farmers. This signifies ageing among rice farmer, finding shows that 59.3% of the respondents were males while 40.6% were females. Although more males involved in rice farming but with these findings it also confirmed a widely held notion that reasonable numbers of female farmers were fully involved in rice farming.

A majority (58.7%) of the respondents interviewed in the study area were married and the modal family size is between 4-6 people - the family size is a good indicator of potential family labour that is rampant especially among smallholder farmers.

Table 2 also shows that majority 70.0% of the respondents have primary education which is the highest among other categories of education in the study area. It was confirmed by the majority 62.7% of the respondents that they do not belong to any association while only 37.3% claimed to belong to one association or the other. Large number of the respondents 64.7% claimed to have access to extension service while only 35.3% confirmed not having access to extension service. For those that have access to extension service the record shows that the highest number of visits was between 1-5 within one farming season.

Table 2 shows that over average 57.3% of the respondents claimed that farming is not their primary occupation. [indicate other things that they do in addition]. About a half of the respondents (50%) have between 1-5 hectares of land for their rice farming. The highest frequency for years of farming is ranges between 5-10 years with about 27.3% of the respondents stated to have up to this number of years of farming experience.

Level of Awareness about climate elements by Rice Farmers

Table 3 categorizes the responses of the rice farmers to some pertinent questions that have to do with the adverse effect of climate on rice production. Majority (87.1%) affirmed awareness of the effect of climate change while only 12.9 claimed not to be aware of the changing climate pattern.

Table 2. Socio-economic Characteristics of the Rice Farmers

Variables	F	P
Age		
16-20	15	10.0
21-25	33	22.0
26-30	46	30.7
+30 years	56	37.3
Gender		
Male	89	59.3
Female	61	40.6
Marital Status		
Single	44	29.3
Married	88	58.7
Divorce	18	12.0
Family Size		
1-3	12	8.0
4-6	88	58.7
7-10	29	19.3
10+	21	14.0
Education Status		
No Formal Education	28	18.7
Primary Education	105	70.0
Secondary & Higher School	17	11.3
Membership of Association		
No	94	62.7
Yes	56	37.3
Extension Service		
No	53	35.3
Yes	97	64.7
No of Contact		
0	53	35.3
1-5	79	52.7
6-10	11	7.3
>10	7	4.7
Primary Occupation		
Farming	64	42.7
Non- Farming	86	57.3
Years of Farming		
< 5	4	2.7
5-10	41	27.3
11-15	38	25.3
16-20	35	23.3
>20	32	21.4
Farm Size (Ha)		
<1	52	34.7
1-5	70	46.7
6-10	11	7.3
>10	17	11.3

F: Frequency, P: Percentage (%), Source: Field Survey

Most of the respondents (75.9%) confirmed to have been affected by climate change in the course of production of rice while 24.1% claimed not to be affected by the climate change. Their perceptions of climate change were explored in a series of questions, responses to which are provided hereafter.

In an area where agriculture is mostly rain-fed, and water very important especially not for the dry paddy variety, the predictability of rain water is important for the rice farmers agronomic. One of the pertinent questions asked therefore was whether the rainfall is predictable and fewer respondents (40.7%) claimed that rainfall has predictable. Predictability of water availability is important for practices on-set of planting, gestation, and harvesting. It impinges on quality of rice produce depending on how much or how less water is available. This has a roll-on effect on harvests and income potentials, which invariably indicate eventual incomes for farmers whose farming practices are not diversified or mixed with other farming activities

Another important aspect of the question is that has to do whether they have ever experience flooding in their community and a larger percentage 66.7% claim to experience flood. The respondents' perception was compared with figures of temperature and rainfall that were obtained from the meteorological station.

Level of Perception of Farmers on Climate Change Effect

The most perceived climate change element among others is reduction in crop productivity which has to do with the quantity produced not measuring up to the size of the land in use. Their perception of this particular element was based on the resultant yield which does not match up with the financial and physical outlay during the farming period, probably due to adverse effect of the climate variations.

As shown in table 4, reduction in crop productivity has the highest mean score of 4.30; here, an average number of the rice farmers strongly agreed that the reduction in crop productivity was evident.

The other most negatively perceived elements of climate change were its effect on farmers' income and crop health with respect to pest infestation and disease outbreak - these two turned up with mean scores of 4.14 and 4.13 respectively.

Vulnerability Assessment Index Score

The vulnerability assessment index of 0.3001 (a measure of the exposure, susceptibility and resilience/capacities of rice farmers) indicates that the study area is prone to the adverse effect of climate; this could be adduced to the problem of constant flooding occasioned by proximity to the river Niger. This high value has a negative effect on their livelihood as their livelihood is threatened. The high value might be because they are highly exposed and susceptible to climatic induced hazards coupled with low adaptive capacity. The results of the different indices is shown in tables 5, 6 and 7.

The vulnerability assessment index of 0.3001 indicates that the zone is prone to the adverse effect of climate The Composite Vulnerability Index (CI_v) of rice farmers was calculated as follows:

$$CI_v = W_e \times I_vE + W_s \times I_vS - W_c \times I_vC$$

Where

CI_v = Composite Vulnerability Index of the farmer's

W_e = exposure weight = 1;

W_s = susceptibility weight = 0.5

W_c = capacity weight = 0.5

I_vE = vulnerability index of rice farmers due to exposure

I_vS = vulnerability index of rice farmers due to susceptibility

I_vC = Index of resilience/capacities of rice farmers in the study area.

$$CI_v=1.0\times0.4497+ 0.5\times0.0689-0.5\times0.3681$$
$$CI_v=0.4497+0.0345-0.1841$$
$$CI_v=0.4842-0.1841$$
$$CI_v=0.3001$$

Table 3. Awareness about climate elements

Awareness	Categories	Percentage
Are you aware of climate change?	Yes	87.1
Have you for once been affected by climate change?	Yes	75.9
Is there a change in the amount of rainfall?	Yes	92.5
Is there a change in the timing of the rain?	Yes	80.3
Is rainfall predictable?	Yes	40.7
Is there late cessation of rain?	Yes	66.7
Is there any noticeable change in the timing of the raining season?	Yes	80.4
Is there any change in the length of the raining season?	Yes	75.7
Have you experienced flood in your community?	Yes	66.7
Is there increase in the length of temperature?	Yes	79.6
Is there decrease in the length of temperature?	Yes	54.6
Are you affected by the extreme temperature?	Yes	75.7

Source: Field Survey, 2019

Table 4. Perception of Farmers on Climate Change Effect

Perception	Mean score	Rank
Reduction in crop productivity	4.30	1st
Farmers' income seriously affected	4.14	2nd
Crop pest infestation and disease outbreak	4.13	3rd
Increase in price of food	4.03	4th
High temperature	3.98	5th
High occurrence of flood	3.86	6th
Delay in rainfall	3.83	7th
Food shortage/insecurity	3.49	8th
Reduction in amount of rainfall	3.29	9th
Rural urban migration	3.23	10th
Reduction in livestock productivity	3.22	11th
Reduction in crop production	3.18	12th
Reduction in forest resources	3.04	13th
High mortality rate of livestock	2.95	14th

Source: Field Survey, 2019

Table 5. Exposure index according to variation in yield, pest infestation, flood disaster, drought, extreme temperature and bush burning

Exposure indicators	Variance Value of indices (X)	Normalized value of exposure indices	Weight of exposure (Wy)	Index of Exposure indices (Wy×Ny)
Variation in rainfall	2.055	0.191	1	0.191
Pest infestation	3.279	0.590	1	0.590
Flood occurrence	4.537	1.000	1	1.000
Drought	2.175	0.230	1	0.230
Extreme temperature	3.583	0.689	1	0.689
Bush burning	1.471	0.001	1	0.001
Sum of Indices				2.698
Exposure Indices =sum of indices/no. of indicators				0.450

Source: Field survey, 2019

Table 6. Susceptibility index according to soil condition, crop yield, access to information, access to credit loan and average income

Susceptibility indices	Variance Value of indices (X)	Normalized value of susceptibility indices	Weight of susceptibility (Wy)	Index of Susceptibility indices (Wy×Ny)
Soil condition	0.159	-0.057	0.5	-0.029
Crop yield	0.231	0.015	0.5	0.008
Access to information	0.239	0.023	0.5	0.012
Access to credit loan	0.245	0.029	0.5	0.015
Average income	0.895	0.679	0.5	0.340
Sum of Indices				0.345
Susceptibility Indices =sum of indices/no. of indicators				0.069

Source: Field survey, 2019

Table 7. Capability index according to income diversification, insurance scheme, use of improved seed, improved practices and agro-forestry

Capacity indicators	Variance Value of indices (X)	Normalized value of capacity indices	Weight of capacity (Wy)	Index of Capacity indices (Wy×Ny)
Income diversification	1.468	0.823	0.5	0.412
Taking up insurance	1.255	0.990	0.5	0.495
Use of improved seeds	2.524	0.001	0.5	0.001
Improved practices	1.412	0.867	0.5	0.434
Agro-forestry	1.242	1.000	0.5	0.500
Sum of Indices				1.841
Capacity Indices = sum of indices/no. of indicators				0.368

Source: Field survey, 2019

Coping Strategies Adopted

Figure 1 shows that majority of the farmers despite being vulnerable to climate change claimed not to have adopted any coping strategies. With a mean score of 0.89, the first on the ranking indicated: "not to do nothing when it comes to coping practices other than trust God and that there will be no flooding". The second on the ranking with mean score of 0.78 stated that "they engaged in (planting trees) forestry in preventing flooding", while some other respondents claimed to have "taking up insurance in the eventuality of flooding"; a few of them "engage in construction of drainage system in order to channel water to appropriate quarters".

The why most of the farmers do adopt any coping strategies but by trusting in God is as a result of lack proper awareness. A multi-media enlightenment campaign of the effects and possible coping strategies of climate change should be adopted by all tiers of government and NGOs to reach the farmers using available extension structure on ground. Also, farming communities can run local disaster risk committees to encourage local adaptation measures as survival tactics for the purpose of ensuring food security.

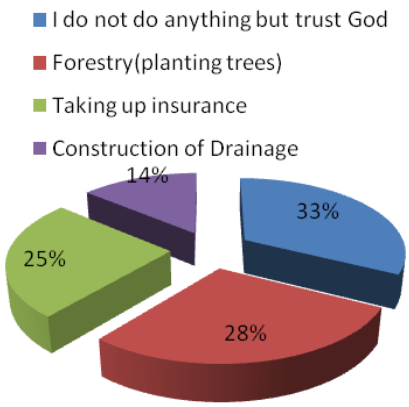

Figure 1. Coping Strategies Adopted by Rice Farmers.

Conclusion and Recommendations

The study found that rice farmers in Kwara State, Nigeria farmers are vulnerable to the adverse effects of climate. Majority of them affirmed that they were affected by this climate change in the course of rice production but do not possess adequate knowledge of management strategies. In order to mitigate the effect of climate change effect and consequent reduction in rice yield, some of the rice faming households engaged in tree planting, while few of them took up insurance in the eventuality of flooding, and construction of flood-control drainage system. Therefore, in the face of changing weather patterns, farmers should be trained on sustainable cultural and management practices that could help mitigate the loss of rice. The rice farmers should be enjoined to plant more drought tolerant and early maturing varieties of rice. Capacity building of the farmers should be done so as to strengthen their preparation against the effects of climate change and improve their production, and this is with a view of exposing the farmers to effective mitigation strategies.

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