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Perceived Challenges and Mitigations of Climate Change on Sorghum Farmers in Zuru Area of Kebbi State, Nigeria

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ABSTRACT

The study assessed challenges and mitigations of climate change on Sorghum farmers in Zuru area of Kebbi State, Nigeria. A multi stage sampling technique was used to select a sample size of 103 respondents. Descriptive and inferential statistics were used to analyze the data collected. The result shows that 68% of the respondents were male with age bracket of 21 – 40 years which constitute 55.3%. Majorities (52.4%) of respondents were not formally educated while, 84.5% were married and 32% had off-farm income of below ₦100, 000 per annum. Perhaps, the respondents perceived that increased temperature, drought, high carbon dioxide, prevalence of pest and changes in precipitation are some of the determinants of climate change with mean values greater than a decision rule (weighted mean 3.00). Also, the result reveals that seed diversification, mixed farming, mixed cropping, drought resistant crops, early planting, early maturing varieties and use of irrigation are some of the coping strategies against climate change with mean values greater than a decision rule mean 3.00. Furthermore, the study indicates a significant influence of climate change on the farmers' yield using Ordinary Least Square (OLS). The study concludes that climate change had adverse effect on Sorghum production. The study recommends that farmers to be sensitize and encouraged on the use of effective coping strategies to mitigate the negative effect of climate change on Sorghum production.

Keywords: Climate change, Challenges, Mitigations, Sorghum, Farmers, Zuru.

INTRODUCTION: Aside from its primary function of producing food and fiber, agriculture also serves other purposes such as managing renewable natural resources, creating and maintaining landscapes, conserving biodiversity, and helping to maintain socioeconomic activities in remote and marginalized areas. Climate change may have an impact on agriculture's multifaceted functions as well (Klein *et al*., 2013). One of the industries most impacted by climate change is agriculture. Climate change is the term used to describe changes over time to the earth's climate (Isik and Devadoss, 2006). Additionally, it is possible to define climate change as modifications to the atmosphere over the surface of the globe caused by the release of specific gases as a result of both natural and human-caused events (FOA, 2008). The issue of climate change has become more dangerous to the sustainable development of socio-economic and agricultural activities in any nation, as well as to the entirety of human existence (Adejuwon, 2004). As a result, the totality of the agricultural sector is considered low. Nigeria is increasingly becoming an arid environment at a very fast rate per year, caused by a fast reduction in the amount of surface water, flora, and fauna resources on land (Patrick, 2012).

Recent food shortages in Nigeria serve as a reminder of the area's ongoing susceptibility to climatic fluctuations. This is a result of a lack of institutional capacity, a constrained expansion of environmental and adaptation challenges, and a lack of local knowledge validation (Ikeme, 2001). There are, however, still comparatively few studies that evaluate the adoption rates as well as the likelihood of effectiveness of potential response measures to climate change on agricultural production. This research was developed against this background to evaluate the perceived challenges and mitigating effects of climate change on sorghum farmers in the Zuru area of Kebbi State, Nigerians

Objectives of the Study : The objectives of this study are to:

a) describe the socioeconomic characteristics of the respondents in the study area;

b) determine the extent to which respondents perceived the impact of climate change on sorghum production;

c) assess the extent of coping mechanisms used by respondents in the study area; and

d) ascertain how climate changes affect respondents' production levels.

METHODOLOGY

Description of the study area: The Zuru Local Government Area it is roughly located between latitudes 11^{0}35’ and 11^{0}55’ north and 4^{0}25’ and 5^{0}25’ east of the equator, with a total area of around 1,220 kilometers square (Km^2). By 2022, the population of the area is projected to be 282,500, according to the National Population Commission [NPC] (2022).

The region has a subtropical savannah climate with 950mm of yearly rainfall. Temperatures range from 27 °C to 38 °C, with relative humidity varying from 40% in the dry season to 85% in the wet season. According to the Kebbi State Government (2022), Zuru community is an agricultural community with abundant fertile soil suitable for growing a variety of commodities, including cereals, legumes, vegetables, and tree crops.

Sample and Sampling Procedure : For sampling, Zuru Local Government Area consists of six administrative districts, which include Dabai, Senchi, Rikoto, Rafin-Zuru, Manga, and Ushe districts, respectively. A multistage sampling method was used for the study. At first, purposive sampling was used to select three districts out of the six districts in the study area. This includes Manga, Senchi, and Dabai, and at the second stage, simple random sampling was used in selecting two (2) villages from each district, which include Amanawa, Gali, Bahago, Kwere, Rumu, and Dabai Seme, respectively. Thirdly, proportionate (10%) sampling was used to select respondents from each village using simple random sampling techniques, making a total of one hundred and three (103) respondents the sample size of this study.

Data Collection Method: The primary data collection tool for this study was a structured questionnaire with both open-ended and closed-ended questions. Secondary data were gathered from other documented sources, including journals, newspapers, the internet, textbooks, and so on.

Data Analysis: To accomplish the study's objectives, descriptive (frequency count and weighted mean scores) and inferential (regression) statistics were used to examine the data gathered from the administered questionnaire.

Model specification

a) 5-point Likert Scale : Based on grand mean weight, a 5-point Likert scale of strongly agreed (5), agreed (4), undecided (3), strongly disagreed (2), and disagreed (1) was dichotomized. The average mean scored 3.0 served as the basis for the determination rule. As a result, a mean score of 3.0 or higher indicates agreement, whereas a mean score of less than 3.0 indicates disagreement regarding the perceived amount of anything.

b) Multiple regression

$$Y = f(X_1, X_2, X_3, X_4, X_n + e)$$

Where: Y (TFP) = Productivity

X_1 = Cost of Sorghum seeds used (naira)

X_2 = Farm size (hectare)

X_3 = Cost of fertilizer (naira)

X_4 = Labour (Man day)

X_5 = Capital (naira)

X_6 = Agrochemicals (naira)

X_7 = Age (years)

X_8 = Educational level (years)

X_9 = Sex (1= male, 0= female)

X_{10} = Notice of rainfall pattern (1 =yes, 0 = no)

X_{11} = information on climate change (1 =yes, 0 = no)

X_{12} = Notice of temperature pattern (1 =yes, 0 = no)

b_o = Constant

$b_1 – b_{12}$ = Regression coefficient

e = Error term

RESULTS AND DISCUSSION

Socio economics characteristics of the Respondents : The research took into account gender, age, educational level, marital status, and income level. Socio-economic characteristics of respondents could be referred to as an economic and sociological measure of a person's work experience and of an individual's or family's economic and social position in relation to others.

Table 3.1: Socio-economic characteristics of Respondents (n=103)

Variables	Frequency	Percentage
Gender		
Male	70	68
Female	33	32
Age (Years)		
Below 21	15	14.7
21 - 40	57	55.3

41 – 60	30	29.1
61 and above	1	0.9
Educational Status		
Non formal	54	52.4
Formal	49	47.6
Marital Status		
Single	16	15.5
Married	87	84.5
Divorce	0	0
Widow	0	0
Income level (Naira) per annum		
10,000 - 100,000	33	32
100,001 – 200,000	25	24.3
201,000 – 300,000	19	18.4
301,000 – 400,000	15	14.6
401,000 and above	11	10.7

Source: Field Survey, 2021.

Results for gender, age, educational status, marital status, and income level of respondents are shown in Table 3.1. According to the respondents' gender distribution, there are 32 women and 68% men. The outcome suggests that sorghum farming is primarily done by men in the research area. According to Hamisu *et al*.'s (2023) results that men are frequently more energetic and may quickly be accessible for energy-demanding farming activities, the male dominance may be caused by the physical energy exerted in agricultural output. According to the respondents' age distribution, those between the ages of 21 and 40 make up 55.3% of the sample, followed by those between the ages of 41 and 60 with 29.1%, those under the age of 21 were 14.7%, and those 61 and older were 0.9%. The results suggest that more than half of the respondents had sufficient energy and could be categorized as physically fit for farming activities and that manual labor is frequently used in agricultural output, with age having an impact on the quality of this labor.

More than half of farmers, or 55.4%, were lacking in a formal education, while only 47.6% acquired formal education, according to the results on respondents' educational level; this suggests that lack of formal education as indicated by respondents' responses may affect their capacity to make wise decisions for farm operations, thereby reducing their tendency for increased productivity.84.5% of respondents were married, while 15.5% of respondents were single, according to the results based on marital status. This could be explained by the tendency for household sizes to grow, which might encourage family members to help out on the farm.

The results of the survey on off-farm income showed that 32% of the respondents made between ₦10,000 and ₦100,000 per year from other sources, followed by ₦101,001 to ₦200,001, ₦201,001 to ₦300,000, ₦301,001 to ₦400,000, and ₦400,000 or more for 10.7% of the respondents. This shows that, despite their contribution to the country's food security, farmers in the study area are neither wealthy nor well-off. As a result, their productivity would continue at a relatively subsistence level due to the low level of their off-farm earning status.

Perception of Respondents on the extent of climate change effect on sorghum production The findings in Table 3.2 demonstrated the magnitude of the impact of climate change on sorghum output. The perception assertions were divided into agreed and disagree categories based on how strongly they agreed, agreed, undecided, disagreed, and strongly disagreed with a statement. The decision rule was established using a mean score of 3.0 or higher as agree, while a mean score of less than 3.0, signifying disagreement.

Table 3.2: Farmers' Perception on the extent of climate change effect on sorghum production (n=103)

Variables	SA	A	UD	D	SD	WS	WM	Decision
Temperature	255	120	45	10	2	432	4.19	Agreed
Drought	125	250	2	10	10	397	3.86	Agreed
Atmospheric Co_2	186	202	40	4	2	434	4.21	Agreed
Insect Pests	90	200	60	10	13	373	3.62	Agreed
Rainfall	325	70	50	2	4	451	4.38	Agreed

Source: Field Survey, 2021.

NOTE: SA = Strongly Agree (5); A = Agree (4); UD = Undecided (3); D = Disagree (2); SD = Strongly Disagree (1); WS = Weighted Score; WM = Weighted Mean.

Based on the weighted mean scores, the results demonstrate that the respondents agreed with all perception statements describing the detrimental impact of climate change on sorghum output in the research area. Extreme events, especially flood and drought, can harm sorghum crops and reduce yields, according to the results, which show that rainfall had the highest weighted mean of 4.38, followed by atmospheric Carbon Dioxide at 4.21, rainfall at 4.19, and drought at 3.86, and prevalent insect pests at 3.62. Also, crops to be grown, the agricultural operations, and agricultural patterns are closely influenced by climate.

The outcomes also support the findings of Ibrahim *et al*. (2010), who hypothesized that crop planting may occur in an atypical order that could result in food shortages due to poor harvests due to uncertainty in the start of the farming season brought on by difficulties with rainfall patterns. Low or high temperatures, strong winds, and floods that destroy farmland might result in a fall in potential yields that is probably brought on by a shorter growing season and less water availability.

Extent of coping strategies adopted against climate effect by sorghum farmers in the study area: The study's findings, which are presented in Table 3.3, demonstrate how coping mechanisms have aided sorghum farmers in diversifying their crop. This was decided using a weighted mean score of 3.0 or higher, which implied how beneficial the tactics were to the production of sorghum farmers, while a weighted mean score of less than 3.0 implied disagreement.

Table 3.3: Extent of coping strategies used against climate change effects by sorghum farmers (n = 103)

Strategies	SA	A	UD	D	SD	WS	WM	Decision
Seed diversification	275	160	15	6	0	456	4.43	Agreed
Mixed Farming	100	90	130	20	8	348	3.38	Agreed
Mixed Cropping	175	140	60	3	10	388	3.77	Agreed
Drought Resistant crops	225	40	75	40	3	383	3.72	Agreed
Change of planting Date	75	240	60	0	8	383	3.72	Agreed
Information on Climate	100	80	0	100	18	298	2.89	Disagreed
Irrigation	300	40	90	6	0	436	4.23	Agreed

Source: Field Survey, 2021.

NOTE: SA = Strongly Agree (5); A = Agree (4); UD = Undecided (3); D = Disagree (2); SD = Strongly Disagree (1); WS = Weighted Score; WM = Weighted Mean.

A weighted mean of 3.0 or above indicates that respondents agreed that mitigation techniques enhanced their level of productivity, with the exception of climate change knowledge, where a weighted mean of 2.89 denotes disagreement. The findings also showed that the mitigation tactics used by the respondents to raise their production level included seed diversification (4.43), mixed farming (3.38), the use of drought-resistant crops (3.72), changing the planting date (3.72), and irrigation (4.23), all of which were above the decision rule of 3.00 weighted mean scores.

Effect of climate change on sorghum farmers productivity : Table 3.4 displays the findings of the OLS multiple regression analysis that was used to examine how climate change affects the production of sorghum producers.

Table 3.4: Influence of climate change on sorghum farmers' yield

Variables	Regression Coefficient	T - values
Cost of sorghum seeds used (X_1)	0.1383	2.24**
Farm size (X_2)	0.8481	13.12***
Cost of inorganic fertilizer use (X_3)	0.0061	1.22
Labour (X_4)	0.0025	0.46
Capital (X_5)	0.0472	1.18
Agrochemicals (X_6)	0.0902	2.73***
Age (X_7)	-0.0836	1.02
Education (X_8)	0.0013	0.40
Gender (X_9)	0.0075	1.27
Rainfall Pattern (X_{10})	0.0728	2.77***
Information on climate change (X_{11})	0.0031	0.56
Temperature Pattern (X_{12})	0.0090	0.86
Constant	6.8594	26.09***
R^2	**0.8513**	
Adjusted R^2	0.8428	
F- Ration	99.54***	

Note: *** implies significant at 1% level; ** significant at 5% level; * significant at 10% level

Based on the R^2 value, predicted regression coefficients, and F- values, the Cobb Doughlas production function was selected as the lead equation. According to the value of R-squared (R^2), the factors account for about 85% of the variation in productivity. The sorghum seeds utilized, farm size, agrochemicals, and rainfall patterns all had significant and positive regression coefficients. This suggests that raising these variables while keeping other factors fixed will boost sorghum farmers' productivity.

CONCLUSION: However, the mitigation strategies adopted led to a significant increase in the output and yield of the sorghum farmers, leading to the conclusion that if more mitigation strategies are employed by the farmers in the study area, their production level will significantly increase and be sustained. The study's findings indicate that climate change had negative effects on sorghum production in the study area based on the weighted means.

RECOMMENDATIONS: The following suggestions were made based on the study's findings:

a) Advocacy activities to raise awareness of the effects of climate change so that sorghum producers can implement beneficial mitigating measures.
b) Promote the use of early-maturing crops among farmers in order to decrease losses and boost output.
c) Encourage significant research work for more viable coping strategies to meet up with the contemporary challenges of climate change.

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