EFFECTS OF CLIMATE CHANGE ON SELECTED ARABLE CROPS PRODUCTION IN NIGER STATE, NIGERIA: ITS IMPLICATION FOR AGRICULTURAL ENTREPRENEUR

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ABSTRACT
The study examined the effects of climate change on selected arable crops production in Niger State, Nigeria and its implication for agricultural entrepreneur. To achieve the study objectives, multi-stage sampling technique was used to select 184 farmers for the study. Validated instrument with reliability coefficient of 0.77 was used for data collection and data collected were analysed using descriptive and inferential statistics. Result showed that mean age of the respondents was 41 years. Result indicated that bush and charcoal burning (98.90%) was the causes of climate change most respondents were aware of. Some of the perceived effects of climate change on arable crops production by respondents were increase in cost of production ($\bar{x}$= 3.11) and stunted growth of arable crops ($\bar{x}$ = 3.00). Finding revealed that maize and rice were more severely affected by climate change. Further Analysis of Variance showed that there was significant difference (F= 2.19) in the severity of effects of climate change on the arable crops production. Mitigation/adaptation strategies adopted by all respondents to minimize the effects of climate change on arable crops production were crop diversification/rotation and cultivation of early maturing crops with 100.00% response rate each. Therefore, it was recommended that arable crops farmers should be encouraged by extension agents to adopt improved varieties of maize and rice that can withstand drought and other effects of climate change. It was also suggested that agricultural entrepreneur should mitigate the effects of climate change through agricultural insurance to provide succor against arable crops production risks.
Keywords: Adoption, Arable crops, Climate change, Effect, Strategies

INTRODUCTION

The threat of global climate change has caused concern among people as livelihoods of the smallholders could be severely affected by changes in the climate variables and agricultural production could be affected both globally and locally. Evidence showed that climate change are predominantly very large and far-reaching in the tropical zones of the developing countries with precipitation regimes ranging from semi-arid to humid (Cline,2007).

The contribution of crop production could lead to economic stability of agriculture dependent countries like Nigeria. Unfortunately, crop production to a large extent is affected by different

factors, both natural and man-made. One of such factor is climate change which is characterised by extreme temperature and rainfall that ultimately bring about frequent floods which often alternate with droughts. Also uncertainties in the onset of the farming season due to changes in rainfall pattern leads to unusual sequence of crop planting and replanting which results in high cost of production or crop failure. These effects have direct impact on agricultural entrepreneur specifically smallholder farmers, who are the main contributors of domestic food, most of whom rely on rain-fed agriculture for their production and have limited means of coping with these adverse weather variability (FAO, 2008). Although smallholder farmers have considerable experience in dealing with climate variability, the unprecedented levels of variability associated with long-term climate change are outside the realm of traditional coping strategies (Pettengell, 2010).

Thus, smallholder crop farmers are disproportionately vulnerable to the impacts of climate changes which lead to risk and uncertainties in farming seasons. Therefore, agricultural entrepreneur who primarily engaged in the production and marketing of agricultural products who also seeks to averse risk must be well informed on the dynamics of climate change in order to minimize their risk exposure. It is against this background that this study was carried out to provide useful information to the policy makers, extension agencies and agricultural entrepreneur to increase awareness and design appropriate extension programming on climate change issues. The specific objectives of the study are to:

i. describe the socio-economic characteristics of arable crop farmers in the study area;
ii. examine level of awareness of causes of climate change;
iii. ascertain farmers' perceived effects of climate change on arable crop production in the study area; and

iv. identify various mitigation/adaptation strategies adopted by the farmers in the study area.

METHODOLOGY

The study was carried out in Niger State of Nigeria. The State is located in Guinea Savannah ecological zone of Nigeria within latitude 8^0 22^1 N and 11^0 30^1N and longitude 3^0 30^1 E and 7^0 20^1E. The State experiences annual rainfall of between 1,100mm in the North and 1,600mm in the South. Its maximum temperature is usually not more than 35^{0c}. The main occupation of the people of the State is farming, the State is prominent for arable crops production and some of the animals reared include cattle, sheep, goat and poultry (Niger State Geographic Information Service, 2007). Multistage sampling technique was adopted for the study. The first stage involved random selection of one Local Government Area from each agricultural zone, making a total of three local Government Areas. The second stage involved random selection of eight farming communities from each of the three Local Government Areas selected, making a total of twenty four communities. The third stage involved random selection of 10% of arable crops farmers from each community as respondents for the study. In all 184 respondents were selected for the study from a sampling frame of 1840. Content validity of questionnaire and interview schedule was ensured through expert consultation. The validated data collection instrument which was subjected to Cronbach's Alpha reliability test (r=0.77) was used for data collection in December, 2015. Primary data were collected on socio-economic characteristics of respondents, awareness of causes of climate change, perceived effects of climate change on arable crops production and mitigation/adaptation strategies adopted.

Socio-economic characteristics such as age, education and farming experience were measured in years, while family size and extension contact were measured in the number. Co-operative membership was measured as dummy variable. Awareness of causes of climate change was

ascertained by asking the respondents to indicate the causes of climate change they are aware of. Perceived effects of climate change on arable crops production was measured using 4 points Likert type scale of very high effect=4, high effect=3, little effect=2 and no effect=1. After the measurement, the values of the scale were added up and the sum was divided by the number of values of the scale to get 2.5. Thus, any aspect with mean of 2.5 and above suggests that climate change have effect, while below 2.5 depicts no effect. Similarly, severity of effects of climate change on arable crops were measured using 3 points Likert type scale of very severe effect=3, severe effect=2 and not severe=1. In this case a mean of 2 was used as the decision point to determine the severity of climate change on the arable crops (i.e. 2 and above depicts severe effect while less than 2 was regarded as no severe effect). Strategies adopted by the respondents were determined by asking the respondents to indicate the mitigation/adaptation strategies they adopted. Descriptive statistics were used to achieve objectives one, two and four. While objective three was achieved using Analysis of Variance (ANOVA). The formula is stated as:

$$F = \frac{MST}{MSE}$$

Where: F = Anova Coefficient

MST = Mean Sum of Squares due to effect

MSE = Mean Sum of Squares due to error

RESULTS AND DISCUSSION

Socio-economic Characteristics of Respondents

Result in Table 1 showed that the mean age of the respondents was 41 years. This implies that majority of the farmers were within the active and productive ages which would facilitate adoption of practices that will enable the respondents to mitigate or cope with the effect of climate change. Similarly, mean household size of the respondents was 8 persons. This suggests

that the respondents had large family sizes which could supply needed labour for adopting strategies to mitigate the effect of climate change. Table 1 revealed that majority (68.50%) had one form of formal education or the other from primary to tertiary education. Higher level of education among the respondents will facilitate adoption to mitigate the effect of climate change on arable crop production, because education enhances farmers' ability to make precise decision on adoption of technologies and practices in the farms. Mean farming experience of respondents was 29 years. The involvement of respondents in agricultural activities for long period of time would familiarised them with climate condition prevalent in their area and be able to notice changes. In a related study, Agwu (2004) reported that farmers with long period of farming experience will be conversant with climate constraints to increase productivity.

Finding in Table 1 also revealed that 81.00% of the farmers belong to cooperative societies. This implies that majority of the farmers interact with each other and discuss issues that relates to their farming activities which can influence their awareness on the causes, effects and mitigation strategies of climate change. Table 1 further showed that 54.30% of the respondents had two contacts with extension agents, while 40.20% of the respondents had one extension contact per annum. On the other hand, 5.50% of the respondents had no extension contact. Considering the dynamic nature of climate change, extension contacts with the respondents was low in the study area because FAO (2008) stressed that regular extension services are required for awareness creation, knowledge brokerage on the issue of climate change and building resilience capacities among vulnerable farmers, communities and regions.

Table 1: Socio-economic characteristics of respondents

Characteristics	Frequency	Percentage	Mean
Age (Years)			
21-30	20	10.90	41

31 – 40	77	41.80	
41 – 50	57	31.00	
>50	30	16.30	
Total	184	100.00	
Household size			
1-5 persons	66	35.90	8
6 – 10 persons	71	38.60	
11 – 15 persons	33	17.90	
>15 persons	14	7.60	
Total	184	100.00	
Level of Education			
Quranic education	58	31.50	
Primary education	58	31.50	
Secondary education	55	29.90	
Tertiary education	13	7.10	
Total	184	100.00	
Farming experience			
1-10 years	8	4.30	29
11 – 15 years	19	10.30	
16 – 20 years	28	15.20	
>20 years	129	70. 20	
Total	184	100.00	
Membership association			
Yes	149	81.00	
No	35	19.00	
Total	184	100.00	
Extension contacts			
No contact	10	5.50	
One contact	74	40.20	

Two contacts	100	54.30

Source: Field survey, 2015

Awareness of Causes of Climate Change

Finding in Table 2 indicated that majority (98.90%) of the respondents were aware of bush and charcoal burning as one of the causes of climate change. This may be attributed to the high level of bush burning activities going on in the area at every onset of dry season. Also 75.00% of the respondents were aware that applications of inorganic fertilizer is another cause of climate change as a result of emission of gases such as methane and nitrous oxide which are trapped in the atmosphere, there by facilitating climate change. Other causes of climate change known by most of the respondents were excessive use of chemical on farmlands (67.90%), deforestation (54.90%), over grazing of farmlands by livestock (52.20%) and fossil fuel burning (14.10%). However, oil exploration and oil spillage which recorded 2.20% response rate each indicated that the respondents were not aware of them as causes of climate change. This may not be unconnected to the zero level of oil exploration activities in the area. Those findings are in line with that of Oisahom (2009) who observed that farmers in developing countries are aware of the causes of climate change and changes taking place in the atmosphere and have begun to adjust through long and short term coping methods.

Table 2: Awareness of causes of climate change

Causes	Frequency*	Percentage
Bush and charcoal burning	182	98.90
Application of inorganic fertilizer	138	75.00
Use of excess chemical on farmlands	125	67.90

Deforestation	101	54.90
Over grazing of farmlands by livestock	96	52.20
Fossil fuel burning	26	14.10
Oil exploration	4	2.20
Oil spillage	4	2.20

Source: Field survey, 2015
*Multiple responses

Perceived Effects of Climate Change on selected Arable Crops Production

Result in Table 3 showed that increase cost of production ($\bar{x}$= 3.11), stunted growth of arable crops ($\bar{x}$ = 3.00), lengthening of arable crops cycle ($\bar{x}$= 2.86), drying of arable crop seedlings after germination ($\bar{x}$= 2.84), decrease in yield of arable crops ($\bar{x}$= 2.82), increase weed infestation in arable crops farms ($\bar{x}$ = 2.80), increase spread of diseases and pests on arable crops ($\bar{x}$ = 2.67), destruction of arable crops in the field by heavy winds ($\bar{x}$ = 2.62), increase cases of flooding ($\bar{x}$= 2.54) and lost of farmlands to flooding ($\bar{x}$ = 2.53) were some of the effects of climate change on arable crop production perceived and observed by the respondents in the study area. This suggests that most of the rural farmers in the study area nowadays experience climate variability and have to cope with a degree of risk and uncertainty in relation to arable crops production. The perceived increase in the cost of production of arable crops was attributed to inconsistency of rains which necessitated replanting and several weeding by respondents, while stunted growth, lengthening of crops cycle and drying of seedlings after germination of arable crops were due to the observed drought. The respondents further stressed that increase in the spread of pests and diseases on arable crops were as a result of changes in seasonal temperature.

Also, the respondents reported that destruction of arable crops in the field and lost of farmlands were cause by flood and heavy wind.

The implications of those findings are that agriculture production will suffer great losses which will lead to reduction in farm produce and income from the sales of agricultural products specifically arable crops. This result is in consonance with the finding of Cline (2007) who stressed that increase in temperature and rainfall differences favour proliferation of insect pests, rising incident of diseases, crop failure, environmental degradation and conflict in many regions of the world. The findings also agreed with the report of Rudolf and Herman (2009) that there is a remarkable decline in agricultural productivity arising from severe drought that experts linked with climate change.

Table 3: Farmers' perceived effects of climate change on arable crop production

Variables	Very high effect	High effect	Little effect	No effect	Mean	Std. dev.	Remark
	Freq. (%)	Freq. (%)	Freq. (%)	Freq.(%)			
Change in taste of arable crops	14(7.60)	79(42.90)	27(14.70)	64(34.80)	2.23	(1.016)	NP
Drying of arable crop seedlings after germination	49(26.60)	57(31.00)	78(42.40)	-	2.84	(0.818)	P
Increase spread of diseases and pests on arable crops	14(7.60)	95(51.60)	75(40.80)	-	2.67	(0.613)	P
Ineffectiveness of agro-chemical usage due to delayed rainfall	20 (10.90)	77(41.80)	49(26.60)	38(20.70)	2.43	(0.938)	NP
Destruction of field crops by wind	44(23.90)	57(31.00)	52(28.30)	31(16.80)	2.62	(1.027)	P
Decrease in yield of arable crops	55(29.90)	52(28.30)	65(35.30)	12(6.50)	2.82	(0.975)	P
Change in storage quality of crops	10(5.40)	54(29.30)	17(9.20)	103(56.00	1.84	(1.025)	NP
Stunted growth of arable crops	67(36.40)	70(38.00)	27(14.70)	20(10.90)	3.00	(0.975)	P
Lengthening of arable crops cycle	61(33.20)	63(34.20)	33(17.90)	27(14.70)	2.86	(1.041)	P
Increase cases of flooding	31(16.80)	79(42.90)	32(17.40)	42(22.80)	2.54	(1.024)	P
Increase production cost	70(38.00)	72(39.10)	34(18.50)	8(4.30)	3.11	(0.855)	P
Increase weed infestation	39(21.20)	78(42.40)	59(32.10)	8(4.30)	2.80	(0.819)	P
Unstable planting date	14(7.60)	104(56.50)	23(12.50)	43(23.40)	2.48	(0.935)	NP
Lost of farmlands to flood	53(28.80)	49(26.60)	24(13.00)	58(31.50)	2.53	(1.209)	P
Premature ripening of crops	43(23.40)	52(28.30)	16(8.70)	73(39.70)	2.35	(1.224)	NP

Source: Field survey, 2015.
*Multiple response
P= Perceived effect
NP= No perceive effect

Severity of Effects of Climate Change on selected Arable Crops

The result in Table 4 showed that maize had the highest mean of 2.29, followed by rice and yam with the mean figures of 2.01 and 1.97 respectively, while guinea corn had least mean of 1.77. This result implies that maize experienced more effect of climate change than rice and yam in the study area, while guinea corn witnessed the least effect of climate change. This may be attributed to the high level of sensitivity of maize and rice to climate variability and stress. However, the severity on yam and guinea corn is minimal. This may be as a result of their physiological tolerance to climate change. Further analysis of ANOVA with F-value of 2.19 and probability value of .0001 showed that there was significant difference in the severity of effects of climate change on the arable crops. This result affirms the finding of Apata *et al*. (2009) who reported that maize and rice are some of the arable crops which farmers experience reduction in their yields as a result of effect of climate change.

Table 4: Level of severity of climate change effects on selected arable crops and ANOVA result

Selected crops	Very severe effect	Severe effect	Not severe	Mean (Std)	Ranking
	Freq. (%)	Freq. (%)	Freq. (%)		
Maize	54(29.30)	130(70.70)	-	2.29 (0.457)	1st
Rice	35(19.00)	115(62.50)	34(18.50)	2.01 (0.614)	2nd
Yam	38(20.70)	102(55.40)	44(23.90)	1.97 (0.669)	3rd
Guinea corn	10(5.40)	121(65.80)	53(28.80)	1.77 (0.538)	4th

Source	Df	sum of square	mean square	f-value	p-value	Decision
Model 1	186	14.000000	06129032	2.19	0001*	Signifiant

Error	549	155.9510870	0.2804209
Corrected total	735	267.9510870	

Source: Field survey, 2015
Multiple responses

Mitigation/Adaptation Strategies Adopted by the Respondents

Table 5 revealed that crop diversification/rotation and use of organic manure were highly adopted with 100.00% response rate each. Other strategies with high level of adoption were changing of land under cultivation (92.40%), use of tolerant and resistant crops varieties (92.40%) and cultivation of early maturing crops (91.80%). However, riverside/bank cultivation (46.70%) and engagement in complimentary/diverse livelihood (35.9%) had low adoption levels. This result suggests that the first three strategies adopted by the respondents were mainly indigenous knowledge and traditional adaptive techniques. Adoption of those strategies may not be unconnected to their simplicity and cheapness in terms of application. These results are in line with those of Molua and Lambi (2007), Rudolf and Herman (2009) and Apata *et al.* (2009) who reported that strategies for reducing climate risk is diversification of production and livelihood systems.

Table 5: Mitigation/adaptation strategies adopted by respondents

Strategies	Frequency*	Percentage
Crop diversification/rotation	184	100.00
Cultivation of early maturing crops	184	100.00
Use of tolerant and resistant crop species	170	92.40
Change land under cultivation	170	92.40
Use of organic manure	169	91.80

Practice mixed farming	154	83.70
Irrigation practice	135	73.40
Change in planting and harvesting dates	132	71.70
Shading/shelter tree planting	114	62.00
Soil conservation	96	52.20
Riverside/bank cultivation	86	46.70
Engagement in complimentary/diverse livelihood	66	35.90

Source: Field survey, 2015
*Multiple responses

CONCLUSION

Based on the findings of this study, it was concluded that most of the farmers were aware of bush and charcoal burning as a cause of climate change. Increase cost of production and stunted growth of arable crops were some of the perceived effects of climate change on arable crops production in the study area. The severities of effect of climate change on the selected arable crops were in this order: maize, rice, yam, guinea corn. Strategies adopted by the respondents to mitigate and cope with the effects of climate change on arable crops production were diversification/rotation and cultivation of early maturing crops.

RECOMMENDATIONS

The result of the finding showed that extension contacts were not adequate for most of the respondents. Therefore, deployment of well trained, remunerated and motivated extension agents to the villages by agricultural extension agencies should be undertaken, in order to provide relevant, current and timely information to rural farmers on climate change issues.

Formation of climate change awareness associations by agricultural entrepreneur in the study area should be encouraged by extension agents. This will facilitate their access to information

on mitigation strategies and credit facilities that will enable them to mitigate the effects of climate change on arable crops production.

Efforts should be made by research institutes and researchers to come up with more innovations on indigenous knowledge and traditional adaptive techniques for adoption that are simple and less costly to help mitigate the effects of climate change on arable crops production.

In view of the observed severity of effects of climate change on maize and rice, coupled with their importance as staple food, agricultural entrepreneur specifically arable crops farmers should be encouraged by extension agents to adopt improved varieties of maize and rice that can withstand the effects of climate change.

To minimize risk and uncertainties due to change in climate, enterprise diversification such as mixed cropping and crop rotation should be practiced by arable crops entrepreneur, while agricultural entrepreneur should be encouraged to mitigate the effects of climate change through agricultural insurance to provide succor against arable crops production risks.

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