PAT June, 2017; 13 (1): 18-25 ISSN: 0794-5213

Online copy available at www.patnsukjournal.net/currentissue

Publication of Nasarawa State University, Keffi

Climate Change Adaptation Strategies Among Sorghum Farmers In Niger State, Nigeria

***[1]Adedeji S.O, [1]Abubakar Umaru, [2]Opeyemi, G., [1]B. A. Sule,[2]Adenuga A. H,[1]A. Babasamore**

[1]Department of Agricultural Economics and Extension Services, Faculty of Agriculture, Ibrahim Badamasi Babangida University, Lapai, Niger State

[2]Department of Agricultural Economics and Farm Management, University of Ilorin, Ilorin

Corresponding Author *[1]Adedeji S.O

Email: Sharafa84@yahoo.co.uk

Abstract

Sorghum is a major cereal crop among farmers in Niger State, Nigeria. There had been insufficiency of empirical information in the area of adaptation strategies to climate change among sorghum production in Niger State, and to sustain the yields of sorghum, there is need to assess climate change adaptation strategies among sorghum farmers in the State. In view of the challenges pose by climate change, this study therefore, designed to identify the socio-economic characteristic of sorghum farmers, identify adaptation strategies to climate change used in sorghum production and identify the constraints to climate change adaptation strategies. Primary and secondary sources of data were used. The study drew a sample of one hundred and twenty (120) sorghum farmers identified through a multi stage random sampling techniques. Data collected were described using descriptive statistics (frequency, percentage and mean) and inferential statistics using Multinomial Logit Regression Model for the respective objectives. The study showed that use of pesticides (99%), seed treatment (98%), fertilizer application (97%), improved varieties (90%) and zero tillage (74%) were frequently used by sorghum farmers as adaptation strategies against climate change in sorghum production in the study area. Multinomial logistic regression result revealed that the farm experience is found to be significant indicating that it significantly influences the choice of adaptation strategy adopted by the farmer. Education and access to credit were positively related and significant to adaptation usage. The study recommends that there should be clear government policy on climate change and its adaptation strategies through the provision of credit and farmers education so as to not only help boost sorghum production but other crops in Nigeria.

Keywords: Climate change, Adaptation strategies, Sorghum and NAMDA

Introduction

Policy response to climate change can be divided into mitigation and adaptation. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climate stimuli or their effects to moderate harm or exploit beneficial opportunities (IPCC,2001). Adaptation has the potential to reduce adverse impacts of climate change and to enhance beneficial impacts. Climate change adaptation as well as climate change mitigation are necessary tools in dealing with climate change.

Agricultural production is inherently risky and producers have always been affected by a number of factors (e.g., weather, disease, pests) that can substantially affect output levels from year to year as well as price risks, both of which affect farm profitability and agricultural commodity markets. (Robert *et al*, 2010). According to Kim *et al*. (2008), Agriculture sector is extremely vulnerable to climate change and climate change is expected to negatively affect agricultural production. Climate change is likely to reduce agricultural productivity, especially in the tropical regions, and will directly affect poor people's livelihood assets—including health, access to water and other natural resources, homes, and infrastructure (World Bank, 2010). Moreover, increasing climatic variability—manifesting as more frequent and erratic weather extremes, or "weather shocks"—will likely make poor households even more

vulnerable, which could in turn exacerbate the incidence, severity, and persistence of poverty in developing countries.

Approximately, sixty five percent of Africans rely on agriculture as their primary source of livelihood. Small scale farmers are responsible for more than ninety percent of Africa's agricultural production, International Food Policy Research Institute (IFPRI, 2009).Agriculture is one of the important sectors of notable relevance in Nigerian economic development and growth. It contributes more than 30% of the labour force, accounts for over 70% of non-oil exports and provide over 80% of the food needs of the country (Adegboye, 2004).Nigeria, like all countries of sub-Saharan Africa is highly vulnerable to the impacts of climate change due to the dependence of the Nigerian Agriculture on weather.

Sorghum is one of the most important tolerant crops which have been globally cultivated due to its tolerant to water logging, high temperature and harsh environmental condition among cereals (Mwadalu and Mwangi, 2013). It is reported to be one of the viable staple food crops for the world's poorest and food insecure people; grown predominantly in arid and semi-arid areas of Africa.In Africa, production was estimated at 2.0 million tonnes with a yield of 861kg ha^1 while in Nigeria, production was at 0.8 Million tonnes with an average yield of 1,090kg ha^1 (FAO, 2003). Sorghum (*Sorghum bicolour*) occupies about 45-50 percent (%) of the total land area under cultivation in Nigeria and most of it is in savannah zone where it contributes the major food grain and occupies about a third of the cultivated land. The total world production in 2002 was put at 5.5 million tonnes with average yield of 1,280kg ha^1 (FAO, 2003).

The production of sorghum in the country is weather dependent and it is especially sensitive to erratic rainfall and temperature which makes the crop more susceptible to change in weather. A study conducted in Nigeria modelled worst case in climate change scenarios for maize, sorghum, rice, millet, and cassava in the 21st century (Enete and Amusa, 2010). The decreases in yield could be explained in terms of the very high temperature which lies beyond the range of tolerance for the current crop varieties and cultivars.

There has been paucity of empirical information in the area of adaptation strategies to climate change in relation to sorghum production in Niger State, Nigeria. Based on the researcher's knowledge, there is still insufficient research on the assessment of climate change adaptation strategies required for appropriate public policy and action for eliminating poverty, ensuring food security and endemic malnutrition. However, the little empirical information available had not examined the experience of sorghum farming households in Niger State, Nigeria. In view of the above, this study seeks to fill the gap in literature. This research paper, therefore, explore indigenous knowledge on adaptation and coping strategies to prevailing climate regime in the area of study for sorghum production. The information accrued from the study is expected to provide empirical information to the farmers, government, stakeholders, non-governmental organizations (NGOs) and policy makers to address issues related to climate change (CC) in similar agro-climate condition-Guinea savannah. It will also serve as guide and innovative tools for policy formulation and future predictions in climate change related issues.

Assessment of climate change adaptation strategies among sorghum farmers in Niger State, Nigeria, was the main objective of the study while the specific objectives includes:

i. Identified adaptation strategies to climate change among sorghum farmers in the study area;

ii. Examined the determinants of sorghum farmer's decision to adoption of adaptation strategies to climate change in the study area.

iii. Identified the constraints to the adoption of adaptation strategies against climate change in sorghum production in the study area.

Methodology

The Study Area

This study was conducted in Niger State, Nigeria. The State was created in 1976. It is located in Guinea Savannah Region of Nigeria which is suitable for sorghum production, and lies between latitude 6^0 8'E and $8^0$44' N of the equator. The state is boarded to the North by, Kaduna State and Federal Capital Territory (FCT), Kebbi State to the West, Kogi State to the South, and Kwara State to the south – West. Niger State has a common boundary with Republic of Benin along New Bussa, Borgu Local Government Area. This has given rise to common interred border between Benin Republic and Nigeria. The State covers land area of 74,244sq km of 7,424 million hectares covering 8% of the land area of the countries. It has a population of about 3,950,249 people (Male 2,032,725 and female 1,917,524) (National Population Commission, 2006).

The State experiences distinct dry and wet seasons with annual rain fall ranges from 1,100mm in the north to 1,600mm in the south and mean rain fall of 1350mm. the raining season last between 120 and 190 days and temperature ranges between 35 and $37,5^0$C with relative humidity between 60 and 80% in the month of July and 40 and 60% in January. The vegetation in the area is mainly short grasses and shrubs with scattered trees. The major occupations in the state are crop production, animal husbandry and fishing. The main crops grown in the state include sorghum, yam, maize, ground nut, guinea corn, cassava, millets, rice and sugar cane.

Methods of Data Collection

Primary data was used in this study. The primary data was collected from field survey through structured questionnaires.

Sampling Technique and Sample Size

The State is divided into 3 agricultural zones namely: Zone A, Zone B and Zone C Niger State Agricultural and Mechanization Development Authority, (NAMDA, 2014). Multi-stage sampling techniques was used in this study. The first stage involved purposive selection of two agro-ecological zones to save cost, two Local Government Areas (Lapai and Shiroro) were purposively chosen for the study , based on the prominence of sorghum cultivation in the study area. The second stage involved random selection of 3 Wards from each selected Local Government Area making a total of 6 wards. The third stage involved purposeful selection of 20 sorghum farmers in each of the selected villages. A total of 120 sorghum farmers were selected and interviewed for the study. Therefore, 120 sorghum farmers constitute the population base on the study. The sample outlay for the study is as presented in Table 1:

Table 1: Agric. Zone, LGA covered, Ward covered and Number of Sorghum Farmers

NAMDA ZONE	LGA in Zone A & B	Wards	No of Sorghum Farmers Selected
Zone A	Lapai	Gabas/Kudu	20
		Takuti/Shaku	20
		Duma/Zago	20
Zone B	Shiroro	Shei	20
		Pina	20
		Egwa-gwada	20
2	Total	6	120

Field Survey (2016)

Analytical Techniques

Data gathered for the study was analyzed using both descriptive and inferential statistics.The Descriptive Statistics that was used involved frequencies, percentages, and mean, while the Inferential Statistics that was used involved Multinomial Logistic Regression Analysis and Chi Square. Descriptive Statistics was used to evaluate adaptation strategies to climate change

in sorghum production and constraints to climate change adaptation strategies in the study area. Logistic Regression was used to identify the determinants of sorghum farmer's decision to the usage of climate change adaptation strategies.

Model Specification

Logistic Regression Model

Implicitly stated as:

$$Y = (X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9 + U_n)$$

Where Y is the Dependent Variable and denoted by 0, 1 and 2, Low, Medium and High Level of adoption of adaptation strategies respectively.

Where;

X_1 = Age (years); X_2 = Marital status; X_3 = Educational level; X_4 = Farming experience (years);

X_5 = Household size (number); X_6 = Farm size (ha); X_7 = Gender (1 = yes, 0 = otherwise);

X_8 = Access to credit facility (1 =yes, 0=otherwise); X_9 = Contact with extension officers (1=yes, 0=otherwise); U = Random error term

Explicitly form is stated below

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \text{ ---} \beta_9 X_9 + e$$

Where;

Y = Adaptation strategies of Climate change (Adaptation = 1, otherwise = 0)

α = model intercept; β_1 -β_9 = Coefficient of the independent variables; X_1- X_9 =Independent variables

e = Error term.

Results and Discussions

Socio-Economic Characteristics of Sorghum Farmers

Table 2 shows that 52 of the sorghum farmers which represent about 43.33% are between the ages of 21 – 40 years, 29 farmers are between 41 – 60 which represent 24.17% and 32 farmers are between the age of 61 – 80 which represent 26.86% while7 farmers are between the age of 81 and above which represents 5.83%. The mean age were observed to be 45 years. This shows that majority of the sorghum farmers are at the productive age. There exist a greater potential to increase sorghum production in Niger State. This is in consonance with Muna (2012) who reported that younger farmers are more likely to be willing to adapt to climate change as older farmers may be less willing to adapt.

Further results showed that male and female genders were both involved in sorghum farming. However, the number of male (90%) is more than that of female (10%). Thus, most of the respondents are male. This could result from the fact that the male are more capable of carrying out laborious activities. This confirms the study conducted by Bolaji *et al.* (2010) that arable crop productions were mostly carried out by men. This result agrees with Opeke (2006) who revealed that, female were usually engaged in farming as helpers or suppliers of labour in light farm operation such as planting, weeding, harvesting, processing and marketing and not involve in tedious labour demanding activities such as threshing, farm clearing and digging among other activities.

The result of the marital status of the respondents indicated that 95% of the respondents were married. This implies that the respondents have family labour to assist in farming activities as this would likely save cost. This finding confirms Baiyegunhi, (2010) who observed that, married farmers had responsibilities that must be reflected in their farming activities.

The result on Educational status of respondents indicated that majority of the respondents had no formal Education. A total of 40.8% of the respondents had no formal education, 17.5% had only quranic education, and 17.5% had secondary education while 13.3% had primary

education. Maccarty and Vlek (2012) argue that education reduces the probability that no adaptation is taken. Mabe *et al*, (2012) revealed that, education is one of the potential factors affecting farmers' decision to adapt to climate change.

Most of the farmers have 1 - 20 years of farming experience which represent about 53.33%. The mean farming experience was observed to be 23 years. Study conducted by Maddison (2006) indicates that, more farming experience increases the probability of a farmer to adopt adaptation strategies to climate change. Similarly, Hassan and Nhemachena (2007) found that, it is farming experience that matters more than merely the age of the farmer when it comes to adaptation to climate change. This suggests that the respondent in the study area would have knowledge about climate change and adaptation strategies.

Table 2: Distribution of Socio-economic characteristic of Sorghum Farmers

Characteristics	Frequency	Percentage
Age (Year)		
21 – 40	52	43.33
41 – 60	29	24.17
61 – 80	32	26.66
81 – 100	7	5.83
Total	**120**	**100**
Mean	**45**	
Gender		
Male	109	90.8
Female	11	9.2
Total	**120**	**100**
Marital Status		
Single	18	15.0
Married	95	79.2
Widow	7	5.8
Total	**120**	**100**
Level of Education		
No Formal Education	49	40.8
Quranic Education	21	17.5
Adult Education	1	0.8
Primary Education	16	13.3
Secondary Education	21	17.5
Tertiary Education	12	10.0
Total	**120**	**100**
Occupation		
Farming	74	61.7
Others	46	38.3
Total	**120**	**100**
Farming experience (years)		
1 – 20	64	53.33
21 – 40	48	40.00
41 – 60	6	5.00
61 - 80	2	1.70
Total	**120**	**100**
Mean	**23**	

Source: Field survey, (2016)

Table 3: Adaptation Strategies Used by Sorghum Farmers

Adaptation strategies N=120	Frequently Used Frequency	%	Occasionally Used Frequency	%	Rarely Used Frequency	%
Improved varieties	108	90.00	9	7.50	3	2.50
Fertilizer application	117	97.50	3	2.5	0	0
Zero tillage	91	75.80	23	19.20	6	5.00
Seed treatment	118	98.30	2	1.70	0	0
Used of Pesticides	119	99.20	1	0.80	0	0
Crop rotation	78	65.00	34	28.30	8	6.70
Alley Cropping	9	7.50	51	42.50	60	50.00
Ploughing Across the Slope	34	28.33	36	30.00	50	41.67

Source: Field survey (2016)

Table 3 reveals that use of pesticides (99%), seed treatment (98%), fertilizer application (97%), improved varieties (90%) and zero tillage (74%) were highly adopted as adaptation strategies among sorghum farmers in the study area, while alley cropping (50%) and ploughing across the slope (40%) were not prominently used by the farmers. About 50% and 60% of the sorghum farmers did not use alley cropping and ploughing across the slope as adaptation strategies respectively. Only 28% of the farmers used crop rotation occasionally while ploughing across the slope is not common in the study area. This may implies that the farmers used more of the strategies they are familiar with and use less of others. Enete and Amusa (2010) indicated that farmers may find it difficult to change or modify the traditional practices they are accustomed to even if such practices have serious implications as climate change adaptation measures.

Table 4: Constraints faced by sorghum farmers (n=120)

S\No	Constraints	VGE	GE	SE	LE	NA	Total	Mean	Rank
1	Use of stubble to control Erosion	38	31	17	13	21	412	3.43	8th
2	Low level of Awareness	44	59	5	7	5	490	4.08	4th
3	Poor Extension agent visit	33	58	19	3	7	465	3.88	5th
4	No Subsidies on Planting Materials	5	23	8	42	42	267	2.23	9th
5	Absence of Water Management technique	29	60	19	5	7	459	3.88	6th
6	Lack of Access to Information	61	40	8	5	6	505	4.21	2nd
7	Limited Knowledge on adaptation measure	54	48	5	5	8	495	4.13	3rd
8	Cultural influence	1	13	29	31	46	252	2.10	10th
9	Low institutional capacity	26	59	19	9	7	448	3.73	7th
10	Absence of Government policy on climate change adaptation measure	78	32	2	2	6	534	4.45	1st

Source: Field survey (2016)
VGE = Very Great Extent, **GE =** Great Extent**, SE =** Some Extent, **LE =** Little Extent and **NA =** Not at All

Table 4 showed the constraints to the adoption of adaptation strategies. Absence of government policy on climate change adaptation copping strategies ranked highest (1st position). Lack of access to information, limited knowledge on adaptation measure and low level of awareness on climate change adaptation strategies were rated 2nd, 3rd and 4th

respectively. While cultural influence is rated the least with 10th position. There is therefore need to have clear government policy on climate change and adaptation strategies. Also, there is the need to provide adequate means of disseminating information.

Determinants of Choice of Adaptation Strategies among Sorghum Farmers in the Study area

Result on table 5 showed the determinants of sorghum farmers' decision to the usage of adaptation strategies to climate change in the study area using Multinomial Logistic regression model. The parameter estimates in the table summarizes the effect of predictor. Parameter with significant negative coefficients decrease the likelihood of that response category with respect to the reference category; while the parameters with positive coefficients increase the likelihood of that response category. The farm experience is positively correlated with climate change adaptation strategies. This would result from their familiarity with adaptation measures due to their experience of farming.

From the result of analysis, it was observed that at low level adaptation strategies usage, education and access to credit are positively related and significant to adaptation usage at 1%level of significant. The implication of this is that as educational status and access to credit increases, the adaptation strategies also increase. Age of the farmers was found to be negatively significant at 5%. This means that as age decrease, the adaptation strategies adoption increases. The implication of this is that the young farmers are prone to the adoption of adaptation strategies than the older farmers.

Table 5: Multinomial Logistic Regression Results of Determinants of Sorghum Farmers' Decision to the Usage of Adaptation Strategies to Climate Change in the Study Area.

Adaptation Strategies	Coefficient	Standard Error	t- VALUE
1. Low level of usage			
Intercept	-4.805	3.054	0.116
Age	-.018**	0.014	0.184
Education Level	0.089***	0.245	0.715
Farming Experience	0.147*	0.084	0.080
Farm Size	-2.592	1.692	0.126
Access to Credit	0.213***	0.946	0.822
Extension Contact	0.072	0.775	0.926
2. Medium Level of Usage			
Intercept	-3.539	2.071	0.087
Age	0.005***	0.013	0.685
Education Level	- 0.307**	0.139	0.027
Farming Experience	0.165*	0.061	0.007
Farm Size	-0.057	0.515	0.912
Access to Credit	- 0.185**	0.680	0.785
Extension Contact	-0.526	0.555	0.343
***Significant at 10%**			

Source: Field Survey, (2016)

Cox and Snell = 0.834; Nagelkerke = 0.942; McFadden = 0.830; Chi-Square = 261.783;

0 represents Low level of adoption; 1 represents Medium level and 2 represents High level of Usage.

The Reference Category is: High Level of Usage of Adaptation Strategies.

Conclusion

Climate change has adverse effect on sorghum production in the country. Sorghum is a major cereal crop among the crop farmers in Niger State. In view of the weather dependent nature of sorghum production in the state, climate change dictates in advance the production (yield) and availability of sorghum in Nigeria. The entire respondents were not only aware of climate but also made use of adaptation strategies to changes in climate. The study concluded that farm experience, educational level, age and access to credit significantly affect the various

strategies used in the adaptation to climate change. Multinomial logistic regression result revealed that the farm experience is found to be significant indicating that it significantly influences the choice of adaptation strategy adopted by the farmer. Education and access to credit were positively related and significant to adaptation usage. The study recommends that there should be clear government policy on climate change and its adaptation strategies through the provision of credit and farmers education so as to not only help boost sorghum production but other crops in Nigeria.

References

Adegboye, R.O (2004): "Land, Agriculture and food Security in Nigeria". Faculty of Agriculture Lecture delivered at the University of Ilorin on 25th of Februrary, 2004.

Baiyegunhi, L.J.S., Fraser, G.C.G and Adewumi, M.O (2010): 'Resource Use Efficiency in Sole Sorghum Production in Three Villages of Kaduna State, Nigeria' African Journal of Agricultural Research, 5 (5): 172 - 177.

Enete, A.A and Amusa, T.A (2010) Challenges of Agricultural Adaptation to Climate Change in Nigeria: a Synthesis from the Literature, Field Action Sciences Reprts [Online], Vol. 4/2010, Accassed on 12th January 2015.

Food and Agriculture Organisation (2003). State of the Worlds Forests. Retrieved May, 20, 2011 from http//www.fao.org/DOCREP/003/X6953E/X695302.htm.

Hassan and Nhemachena (2007): "Climate Change and Development Links. "Gatekeeper Series 123. International Institute for Environmental Development.

IFPRI (2009): "Agricultural Critical Role in Africas Development". By S.fan *et al.*,2009. Policy Brief 12.

IPCC (2001) Climate Change 2001: Impacts, Adaptation and Vulnerability, Contribution of WG II to the Third Assessment Report of the Intergovernmental Panel on Climate Change (Cambridge Unv. Press, Cambridge, UK). Pp 75-108

Kim, C.G; Park H.T., Lee S.M , Joo H.J., Kwon O.S. and Mendelsohn R. (2008): Impact of Climate change on Agricultural Sector in Korea, Research Report R565. Korea rural Economic Institute.

Mabe, F.N. Sarpong, D.B and Osei-Asare, Y (2012) Adaptive Capacities of Farmers to Climate Change Adaptation Strategies and their Effects on Rice Production in the Northern Region of Ghana, Russian Journal of Agricultural and Socio-economic Sciences. 11 (11): 9-17.

Maccarthy, D.S and Vlek, P.L.G. (2012) Impact of Climate Change on Sorghum under Different Nutrient and Crop Residue Management in Semi-Arid Region of Ghana: a Modelling Perspective, Africa Crop Science Journal, 20 (2): 243-259

Maddison (2006) Adapting to Climate Change: Challenges and Opportunities for the Development Community, Institute of Development Studies.

Muna Elhang, M. (2012) Assessment of Climate Change Impact on Sorghum Productivity in Sudan, Third RUFORUM Biennial Meeting 24 – 28 September, 2012, Entebbe, Uganda, pp 813 – 819

Mwadalu, R. And Mwangi, M. (2013) Potential Role of Sorghum in Enhancing Food Security in semi-Arid Eastern Kenya: a Review, Journal of Applied Biosience, 71:5786-5799

Niger State Agricultural and Mechanization Development Authority (NAMDA) National Population Commission (N P C), (Census, 2006)

Opeke, L.K (2006): Essential of Crop Farming. Spectrum Books Limited, Sectrum HOUSE, Ring Road, PMB 5612, Ibadan, Nigeria.

World Bank (2010): " World Development Report: Development and Climate change, Washington DC: world Bank