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STRATEGIES FOR ADAPTING TO CLIMATE CHANGE BY LIVESTOCK FARMERS IN SOUTHWESTERN NIGERIA

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ABSTRACT

Livestock production sector is one of the area in agriculture which is sensitive to climate change effect. In quest to unveil the coping mechanism adopted by farmers to mitigate the effect climate change imposes on livestock production, this study however examined farmers' strategies for adapting to climate change by livestock farmers in South-western Nigeria. Specifically, it identifies the various adaptation techniques adopted to mitigate the perceived effect of climate change, as well as the effect of climate change on livestock production and adaptation strategies. Data were collected using well-structured questionnaire and interview schedule administered on 120 farmers through the use of multistage sampling procedure in the study area. Descriptive statistics and multinomial Logit were used to analyze data collected. The multinomial Logit model used to analyze the determinants of farm-level adaptation measures revealed that age, sex, farm size and experience are statistically significant at various levels. The adaptation measure used are moving focus from livestock to crop, adopting drought tolerant animal, investing in multiple livestock species and engaging in nonfarm activities. Priority should be set on adjusting to ongoing and potential effects of climate change, deforestation and bush burning should be discourage and lastly adoption of new technologies to improve production will help reduce the effect of climate change.

Contribution/ Originality: This is one of the few studies that provide empirical fact on the adaptation strategies adopted by livestock farmers in mitigating the effect of climate change in Nigeria.

1. INTRODUCTION

A main driver of agriculture is Climate because it influences product quality, input cost, product prices, and the management systems, choice of production system, yield potential and variability, geographical distribution of livestock, the management systems and technologies used. Climate change influences directly the daily life of every plant and animal on the earth's surface and therefore form a crucial entity of the environment (Adebayo, 2008). It signifies one of the greatest environmental, social and economic threats facing the planets today. In developing countries, climate change has a significant impact on the livestock productivity and agriculture in general. Intergovernmental panel on climate change (Intergovernmental Panel on Climate Change (IPCC), 2007a) states that climate change is a change in the state of climate that can be identified by changes in the mean and or the variability of its properties that persists for an extended period typically decades or longer. The effect of climate

change is expected to elevate the vulnerability of livestock system and reinforce existing factors that are affecting livestock production system such as rapid population and economic growth, rising demands and products. Variability in climate change is rapidly emerging as one of the most serious global problems affecting many sectors in the world and is considered to be one of the most serious threats to sustainable development with adverse effects on environment, food security, economic activities and natural resources (Huq, Reid, & Murray, 2006; IPCC, 2007b).

In Nigeria, livestock is crucial for increased agricultural productivity. Livestock farming plays a very relevant role as a source of income and also serves as an additional occupation to supplement the income of farmer's families with climate change affecting the productivity and health of livestock including the livestock product. The negative impact of climate change is more severely felt by people in developing countries who depend mostly on the natural resource base for their livelihoods. Agriculture and livestock keeping area are amongst the most climate sensitive economy sector more exposed to effects of climate change (IFAD, 2007).

Response strategies to climatic change will be affected by several factors including the magnitude, rate and regional patterns of climate change as well as the degree of vulnerability to climate change. Although climatic change is ultimately a global issue, the impacts of climate change will vary from one country to another and even within given regional zones. Responses to climate change include mitigation to reduce the magnitude of climate change impact on the long run. These strategies are aimed at controlling or preventing climate change. Another way of response to climate change is by adaptation or accommodating the impacts of climate change. Adaptation includes all activities that help farmers and ecosystem reduces/minimize the cost of natural disasters (IFAD, 2007). Livestock farmers have traditionally adapted to various environmental and climatic changes by building on their in depth knowledge of the environment in which they live. However, increased human population, urbanization and environmental degradation and increased consumption of animal protein have made some of these coping strategies ineffective (Sidahmed, 2008).

To approach the issue on strategies of adapting to climate change 'properly', the understanding of the livestock farmer in the study area on climate change must be taken into consideration since some of the livestock farmers perceive climate as having strong spiritual, emotional and physical dimension. It is therefore assumed that livestock farmers in the study area have an inherent adaptive knowledge from which to draw and survive in high stress environmental and socio – economic condition. Thus, the farmers' response is very important to understanding and identifying the effects of climate change on livestock production and the ease adaptation.

However, communities in Nigeria have always managed their resources and livelihoods in the face of challenging environmental and socio- economic conditions (Mertz, Mbow, Reenberg, & Diouf, 2009; Mortimore & Adams, 2001). They have to an extent develop strategic ways to enable them cope and adapt to the uneven and irregularities of climate change, severe disease infection, feeding pattern and so on (IPCC, 2007c; Molua, 2008). There is great necessity to adequate information and learn about the strategic ways by which livestock farmers know about climate change. Hence, this study examine various adaptation techniques adopted by the livestock farmers to buffer against variation in the climate as well as identify the determinants of farmer's strategies of adapting to climate change in the study.

2. RESEARCH METHODOLOGY

This study was conducted in southwestern Nigeria, which consists of Lagos, Ogun, Oyo, Osun, Ondo and Ekiti states. The area lies between longitude 20 311 and 60 001 East and Latitude 60 211 and 80 371N (Faleyimu, Akinyemi, & Agbeja, 2010) with a total land area of 77,818 km2 and a population of 27,581,992 (NPC, 2006). The study area is bounded in the east by Edo and Delta states, in the north by Kwara and Kogi states, in the west by the Republic of Benin and in the south by the Gulf of Guinea. The climate of south-western Nigeria is tropical in nature and it is characterized by wet and dry seasons. The temperature ranges between 21°C and 34°C, while the

annual rainfall ranges between 1500mm and 3000mm. The wet season is associated with the south-western monsoon wind from the Atlantic Ocean while the dry season is associated with the northeast trade wind from the Sahara desert.

The vegetation is South-western Nigeria is made up of fresh water swamp and mangrove forest at the belt, the lowland in forest stretches inland to Ogun and part of Ondo state, while secondary forest is towards the northern boundary where derived and southern Savannah exist (Faleyimu et al., 2010). Southwestern Nigeria is dominated by the Yoruba ethnic group. Economic activities undertaken include trading, handcraft, public service employment, and agriculture. The predominant crops in the region are cassava, maize, and vegetables such as okra, cucumber, tomatoes, pepper, and tree crops like mango, cashew, cocoa, kola nut, among others.

In the administration of a well-structured questionnaire, a multistage random sampling techniques was adopted to collect primary data. Two states were randomly selected from the six states in the region. These are Oyo and Ekiti states. The second stage involved a random selection of a local government area (LGA) in each of the state. These are Lagelu and Irepodun/Ifelodun LGAs. Six villages were randomly selected from each of the LGAs, this represented the third stage. The last stage was the random selection of ten farmers from each village to make a total population of 120 farmers.

Data was analyzed using descriptive statistics and multinomial Logit model (MNL). The descriptive statistics used includes frequency distribution and percentages. Multinomial Logit model (MNL) was used to determine the factors influencing the adaptation strategies used. The advantage of using MNL is its computational simplicity in calculating the choice probabilities that are expressible between adaptation measures chosen by any livestock farmer with a number of climate attribute and some socio economic characteristics. The analyses presented in this study identify the important determinants of adoption of various adaptation measures to provide policy information on which factors to target and how, so as to encourage farmers to increase their use of different adaptation measures.

Let A_i be a random variable representing the adaptation measure chosen by any farming household. We assume that each farmer faces a set of discrete, mutually exclusive choices of adaptation measures. These measures are assumed to depend on a number of climate attributes, socioeconomic characteristics and other factors X. The MNL model for adaptation choice specifies the following relationship between the probability of choosing option A_i and the set of explanatory variables X as Greene (2003):

$$\text{Prob}(A_i = j)\ \frac{e^{\beta_j^i x_i}}{\sum i_{k=0} e^{\beta_j^i x_i}}, j = 1,1\ldots\ldots\ldots\ldots J \quad (1)$$

Where β_j is a vector of coefficients on each of the independent variables X. Equation 1 can be normalized to remove indeterminacy in the model by assuming that $\beta_0 = 0$ and the probabilities can be estimated as:

$$\text{Prob}\ (A_i = j/x_i)\frac{e^{\beta_j^i x_i}}{1+\sum i_{k=0} e^{\beta_j^i x_i}}, j = 0,1\ldots\ldots\ldots\ldots J, \beta_0 = 0 \quad (2)$$

Estimating Equation 2 yields the J log-odds ratios:

$$\text{In}\left[\frac{P_{ij}}{P_{ik}}\right] = x_j^i\left(\beta_j - \beta_k\right) = x_j^i \beta_j\ , \text{if k=0} \quad (3)$$

The dependent variable is therefore the log of one alternative relative to the base alternative. The MNL coefficients are difficult to interpret, and associating the j with the j^{th} outcome is tempting and misleading. To interpret the effects of explanatory variables on the probabilities, marginal effects are usually derived as Greene (2003):

$$\delta_j = \frac{\partial P_j}{\partial x_i} = P_j\left[\beta_j - \sum_{k=0}^{j} P_k \beta_k\right] = P_j(\beta_j - \beta) \quad (4)$$

The marginal effects measure the expected change in probability of a particular choice being made with respect to a unit change in an explanatory variable (Greene, 2000; Long, 1997). The signs of the marginal effects and respective coefficients may be different, as the former depend on the sign and magnitude of all other coefficients.

3. RESULTS AND DISCUSSION

A. General Characteristics of Climate Change Experienced by Respondents

The general features of climate change experienced by the respondents are presented in Table 1. The result revealed that 54.2% of the respondents experienced higher temperatures while the least (23.3%) of them experienced earlier onset of rainfall. The response to the incidence of higher temperature led the respondents to find adaptation measures to lower the temperature in order to favor the livestock. Also, the issue of delayed onset of rainfall resulted in the respondents search for alternative source of water.

Table-1. General characteristics of Climate Change.

General features of Climate change	Frequency	Percentage (%)
Types of Climate Change		
More frequent drought	38	31.7
Earlier –on-set of rainfall	28	23.3
Hailstorm	6	5.0
Less rain	39	32.5
Varying temperature	1	0.8
Delayed on-set of rainfall	56	46.7
Erratic rainfall pattern	51	42.5
Too much rain	52	43.3
Higher temperature	65	54.2
Effect of Climate Change		
Decline in livestock productivity	86	71.7
Death of livestock	65	54.2
Food price increase	49	40.8
Problem of access to water	37	30.8
Fluctuation in livestock market prices	21	17.5
No effect	6	5.0
Increases in livestock productivity	11	9.2
Food shortage/insecurity	24	20.0
Decline in forage resource	15	12.5
Animal disease	37	30.8
Restricted livestock mobility	22	18.3
Action taken by respondents		
Did nothing	11	9.2
Diversified into crop production	33	27.5
Migration to another rural area	14	11.7
Sell animal to buy crop	28	23.3
Invest in multiple livestock species	33	27.5
Adapted drought tolerant animal	17	14.2
Started non-farm activates	12	10.6
Assistance from family/close relations	27	22.5
Migrated to urban area	7	5.8
Livestock mostly affected		
Cattle	40	33.3
Goat	16	13.3
Sheep	68	56.7
Poultry	79	65.8
Pig	3	2.5

Source: Field survey, 2017.
Note: *Response >100% due to multiple choice response.

It was observed that the climate change noticed by the respondents brought about some changes in livestock productivity. Some of the effects of the climate change were decline in livestock productivity (71.7%), death of livestock (54.2%), food price increase (40.8%), problem of access to water (30.8%), and increase in diseased animal (30.8%) and fluctuation in livestock market prices (17.5%). While, 5.0% of the respondents indicated that there was no significant effect, 9.2% however indicated that there was increase in productivity. The high percentage noticed in the decline in livestock productivity is an indicator that climate change is no longer favorable for livestock production.

In response to climate change the table further revealed 27.5% of the respondents moved focus from livestock to crop production as well as invest in multiple livestock species while 23.3% of them sell their animals to buy crop. However, only 5.8% of the respondents migrated to urban area. Lastly, the perceived effect of climate change is observed to be greatly noticed on poultry relative to other livestock (65.8%) while the least revealed that is 13.3% indicated that goat is mostly affected by climate change.

B. Strategies Adopted by Respondents

The intensity of strategies adopted by the respondents as presented in Table 2 revealed that 55.8% of the respondents now source help from extension and veterinary services as a strategic means for adapting to climate change compared to only 18.3% of them that use the strategy initially. About 46% of the respondents claimed they introduced mixed livestock farming system against 29.2% who practiced this system earlier. This implies that the farmers have various livestock that they rear due to sensitivity of some livestock to climate change (poultry) relative to others e.g. goat. This helps to decrease risk in cases of extreme weather condition. The percentage of respondents that adopted provision of shade which helps to reduce the higher temperature and provision of water to reduce heat stress doubled those of them that initially use the system from 21.7% to 42.5%. This is an indication that the strategy was appreciated by them. There is generally low percentage of respondents who adopted removal or introduction of subsidies by government (4.2%) and insurance system (6%) both at the initial and later stage that in the study area, this may be as a result that government does not give subsidies and farmers do not insure their animals as well.

Table-2. Distribution on types of strategies adopted by the respondents types of strategies.

Types of strategies	Old	Freq(%)	New	Freq(%)
Diversification intensification and or integration of pasture management	33	27.5	46	38.3
Modifying stock routings and distances	44	36.7	33	27.5
Introducing mixed livestock farming systems	35	29.2	55	45.8
Obtaining the local breeds that have adapted to local climate stress and feed sources	29	24.2	39	32.5
Removal or introduction of subsidies	15	12.5	5	4.2
Insurance systems	14	16.7	6	5.0
Income diversification practices	27	21.7	36	30.0
Forecasting and crisis-preparedness system	26	22.5	29	24.2
Provision of shade and water to reduce heat stress	26	21.7	51	42.5
Help of extension services and veterinary services	22	18.3	67	55.8

Note: *Response >100% due to multiple choice response

C. Reasons Why the Practices Changed

The respondents gave various reasons why they changed from their previous practices to an improved practices and this is as shown in Table 3. An average of the respondents claimed they changed to new method to reduce heat stress (55%). While 43 percent claimed to increase productivity, 44 percent gave reason such as reduction in morbidity and mortality of livestock and about 26percent claimed to increase the quantity and quality of livestock produce and forage plant. However, the least reason given was to increase water holding capacity (6.7%).

Table-3. Reasons why the practices changed.

Reason for change	Frequency	Percentage (%)
To increase productivity	52	43.3
To reduce heat stress	66	55.0
To decrease morbidity and mortality	53	44.2
To increase the quantity and quality of livestock produce and forage plants	31	25.8
To increase the profit margin	12	10.0
To increase water holding capacity	8	6.7
For effective management of water resources	17	14.2

Source: Field survey, 2017.
Note: *Response >100% due to multiple choice response.

D. Suggestions Raised By Respondents on How to Address Climate Change

Respondents were allowed to comment freely on what they perceived can be done to reduce the effect from climate change and this is presented in Table 4. The table revealed that 9.2% of the respondents perceive that preparing ahead of the occurrences will be effective in combating climate change. While some of them feels that awareness and enlighten the farmers (6.7%) will help to combat the effect, discouragement of bush burning (3.3%), government encouraging afforestation (1.7%) among others.

Table-4. Suggestions by Respondents to combat effect of climate change.

Suggestions	Frequency	Percentage (%)
Awareness and enlighten farmers	8	6.7
Preparing ahead towards the occurrence	11	9.2
Government should encourage afforestation and enlighten the farmers on the effect of tree planting,	3	2.5
Deforestation and de-vegetation	2	1.7
Bush burning should be discouraged	4	3.3
Improved breeds of livestock should be available	2	1.7
Establishment of weather forecasting station local government	3	2.5
Provision of subsidy on agricultural goods	2	1.7
Availability of disease free and properly quarantined	1	0.7
Provision of loan with little or no collateral	2	1.7
Provision of irrigation facilities to boost food	3	2.5
Improved social and infrastructural facilities	2	1.7

Source: Field survey, 2017.
Note: Response <120 due to multiple choice response.

E. Result of the Multinomial Logit Model

The analytical approaches that are commonly used in an adoption decision study involving multiple choices are the Multinomial Logit Model and Multinomial Probit Model. They are important for analyzing farmer adaptation decision as these are usually made jointly. This study used Multinomial Logit Model to analyse the determinants of farmer's decision. Table 5 presents the parameter estimates of the multinomial Logit model and Table 6 presents the estimated marginal effects and significant levels from the multinomial Logit model. The likelihood ratio statistics as indicated by x^2 statistics are highly significant ($P<0.0283$), suggesting the model has a strong explanatory power. As shown in Table 5 the parameter estimates of the multinomial logit model provide only the direction of the effect of the independent variables on the dependent (response) variable, estimates do not represent actual magnitude of change or probabilities. Therefore the marginal effects measure the expected change in probability of a particular choice being made with and discussed. In all cases, the estimated coefficient was compared with base category of no adaptation.

Age of the household head has positive and negative impacts on adaptation measure. It is shown that old age is associated with moving focus from livestock to crop. The older farmers are more likely to move focus from livestock to crop and less likely to adopt nonfarm activities whereas the young farmers tends to adapt to nothing (no

adaptation). Also, the result of data analysed did not suggest a clear cut effect for the gender factor other than that male-headed household are more likely to adopt investing in multiple livestock species and less likely to adopt non-farm activities. Twenty eight percent of male-headed household are more likely to adopt investing in multiple livestock species while 19.8% are less likely to adopt non-farm activities.

Educational level has a strong positive influence on the probability of adopting adaptation measures to climate change. This is because, it significantly increase adopting drought tolerant animals and moving focus from livestock to crop. The coefficient on the adaptation options has negative signs but significant in adoption of investing in multiple livestock species. A unit increase in number of years of schooling would result in a 7.3% and 7.9% increase in the probability of adopting drought tolerant animal and moving focus from livestock to crop respectively. Household size has mixed impacts on farmer's adaptation to climate change. For most of the adaptation methods, increasing household size did not significantly increase the probability of adaptation though the coefficient of the adaptation option of investing in multiple livestock species is positive. This implies that large families are able to adopt investing a multiple livestock species whereas smaller ones tend to move focus from livestock to crop and non-farm activities.

Farming experience is a significant determinant of adoption decision as further revealed in Table 6. The household head with more experience are more likely to invest in multiple livestock species and less likely to adopt drought tolerant animals than the less experience household head. A unit increase in the years of experience would result in 4% and 15% increase in the probability of investing in multiple livestock species and therefore decrease in adopting drought tolerant animals. Lastly, farm size significantly increase the likelihood of adopting all the adaptation measure while investing in multiple livestock is an exception because of the negative sign of its coefficient. This is an implication that farmers with large farms would adopt drought tolerant animals, move focus from livestock to crop and do non-farm activities while farmer with small farm size will invest in multiple livestock species.

Table-5. Parameter Estimate of the Multinomial Logit model.

Explanatory Variables	Moved focus from livestock to crop	Invest in multiple livestock species	Adopted drought tolerant animals	Nonfarm activities
Constant	-1.126(-0.695)	0.560(0.307)	0.994(0.392)	3.900(2.141)*
Age	0.074(2.82)***	0.035(1.148)	-0.026(-0.623)	-0.004(-0.119)
Sex	-0.747(-0.107)	0.849(1.03)	-1.045(-1.981)**	-0.052(-0.548)
Education	0.035(0.512)	-0.049(-0.648)	0.084(0.689)	-0.056(-0.606)
Household size	-0.293(-2.377)**	-0.252(-1.916)*	-0.250(-1.207)	-0.425(-3.439)***
Experience	0.001(0.832)	0.002(0.944)	0.685(2.666)***	-0.000(-0.168)
Farm size	-0.429(-1.674)*	-0.710(-0.790)	0.479(0.533)	-0.429(-0.477)
Diagnostics				
Base category	No adaptation			
Number of observation	120			
Chi-square	38.848			
Log likelihood	-162.517, Prob < 0.0283			

Source: Data analysis, 2017.
Note: ***, **, * Significant at 1%, 5% and 10% probability level respectively.

4. SUMMARY AND CONCLUSION

It is established from this study that farmers were aware of climate change and its impacts on livestock production. They are able to develop their livelihood and adaptation strategies in a way that enables them to constantly cope with an erratic impact of climate change on livestock production. Adaptation is understood to include efforts to adjust to ongoing and potential effects of climate change. The different combinations of measures

and practices are grouped into four major adaptation options: moved focus from livestock to crop, invest in multiple livestock species, adapted drought tolerant animal and nonfarm activities.

Table-6. Marginal effect from multinomial logit model.

Explanatory Variable	No Adaptation	Move focus from livestock to crop	Invest in multiple livestock species	Adapted drought tolerant animal	Non farm activities
Constant	-0.116(-1.133)	0.190(-0.976)	-0.112(-0.456)	0.002(0.599)	0.302(1.146)
Age	-0.059(2.531)***	0.040(1.830)*	-0.03(-0.640)	-0.039(-0.176)	-0.037(-1.659)*
Sex	-0.103(-0.127)	0.073(-0.0938)	0.281(2.515)***	-0.098(-0.0160)	-0.198(-2.962)***
Education	-0.068(0.211)	0.079(2.127)**	-0.065(-1.674)*	0.073(2.558)***	-0.001(-0.190)
Household size	0.045(0.132)	-0.211(-2.562)***	0.016(1.656)*	-0.001(0.114)	-0.014(-1.689)*
Experience	-0.04(-0.132)	-0.011(-0.089)	0.15(1.801)*	-0.004(-2.762)***	-0.141(-1.290)
Farm size	0.108(1.080)	0.237(1.692)*	-0.450(-1.984)**	0.066(1.778)*	0.021(1.876)*

Source: Data analysis, 2017.
Note: ***, **, * Significant at 1%, 5% and 10% probability level respectively.

This study also revealed that majority of the respondents agreed that lack of improved breeds of animals, relative difficulty in obtaining new stock, animal disease, lack of money to acquire modern techniques and inadequate information on weather incidence are hindrances to adaptation techniques. Mitigation and adaptation can be used as means of coping with the effect of climate change. Therefore, it was recommended that improved and properly quarantined livestock which can withstand the rigors of climate change should be made available to livestock farmers and awareness should be created as well as educating the farmers on the effects of bush burning, afforestation, deforestation and the latest technologies to improve production will help reduce the effect of climate change.

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