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Effective choice of livelihood adaptation strategies to climate variability: Empirical evidence from rural farm households in Akwa Ibom State, Nigeria

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Abstract

Livelihood choice decisions among farm households towards climate variability are perceived as basic strategies in reducing poverty, food insecurity and vulnerable situations. This study applies a multinomial logistic model to explain the number of livelihood activities that are adopted by farm households in Akwa Ibom State, Nigeria. The analysis was based on secondary (rainfall and temperature) and household data from 220 randomly selected households across the six agricultural zones of the State. The results showed that whilst household size, marital status and land size was negative and statistically significantly related to the likelihood of the household choosing livestock production. The choice of forestry activities over crop production was positive and statistically significantly related to land size and precipitation, but negatively related to age. The household's level of education was positively and significantly related to the odd of their choosing livestock production or other non-agricultural activities. Furthermore, asset value was positively and statistically significantly related to their choice of livestock production and fishing activity, but negative and statistically significantly related to their choice of other non- agricultural activities. Also, precipitation was positive and statistically significantly related to their choice of forestry and other non-agricultural activities, instead of crop production, perhaps because, as the effects of climate change becomes severe; they begin to restrict their agricultural activities and move to non-agricultural livelihood options. Measures to mitigate the effect of climate change among farm households are recommended.

Keywords: Farm Households; Livelihood Strategies; Choice Decisions; Climate Change; Multinomial Logit; Nigeria

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1. Introduction

Climate change has been increasingly recognized as a global phenomenon affecting every country, people in different location, social classes, and gender, both young and old. According to Intergovernmental Panel on Climate Change (IPCC), climate change is defined as a change in the state of the climate that can be identified by using statistical tests, by change in the mean and the variability of climatic properties that persist for an extended period typically decades or longer (IPCC, 2007). Climate change is a serious crisis, challenging the sustainable, social justice, equity and respect for human right; especially the rights of future generations (United Nation, 2009). Adverse effects of climate change includes increase in temperature, changes in rainfall patterns, sea level rise, salt-water intrusion and high probability of extreme weather events such as flooding and draughts (Bates et al., 2008). These negative effects are likely to be felt more strongly in developing countries, because a large proportion of the population lives in exposed areas, depending mostly on natural resources for their livelihood and have limited institutional capacities to take proactive measures (Adger, 1999).

The threat of climate change is expected to affect both crop and livestock production, input supplies, and other sources of livelihood. For instance, crop and livestock yields are directly affected by changes in climatic factors such as temperature and precipitation and the severity of extreme events like floods, windstorms and droughts. By 2020, rising temperatures and variable precipitation are likely to reduce the production of staple foods by up to 50 percent in some African countries, leading to declining yields and ability of farmers to feed themselves (NIMET, 2013a). In addition, threat of climate change on "various weather sensitive sectors such as the health sector, can be quite devastating, as can be seen from Nigeria's 2012 flood disaster, which displaced over 2.1 million people, injured 5,871 and claimed about 363 lives, destroying about 5,900 homes" (NIMET, 2013b).

Studies by Deschenes and Greenstone (2007) and Barrios et al. (2010) suggested that climate change could impact economic growth. Also, climate change compounds Nigeria's human development challenges; this could be why Nigeria is not improving in her human development index. For instance, Nigeria was ranked 152nd out 188 countries (UNDP, 2015). It is predicted that by 2050, the Gross Domestic Products (GDP) of Nigeria could drop by 4.5 percent (Cervigni et al., 2013). Since agricultural activities in Nigeria are mainly dependent on the vagaries of weather. These climate changes are aggravating environmental issues such as deforestation and degradation, freshwater shortage, food security and air and water pollution. Further, Bosello, Campagnola and Eboli, (2013) noted that in Nigeria, climate change will also cause a decrease in crop production, GDP losses (projected to start in 2025), an increase in crop prices, and a higher food dependency on foreign imports. In addition, it is predicted that there will be a decline of between 4.8 percent and 7.4 percent in crop production, the prices of crops will increase between 17 percent and 32 percent, and agricultural imports will increase between 13 percent and 23 percent by 2050 (Bosello et al., 2013). It is obvious the earth is getting warmer and human beings are mainly to be blamed. These projected increases in extreme climate events as well as more changes in the weather patterns may further threaten the means of livelihood in the face of inaction.

The climate change crisis poses challenges to which everybody should respond. Climate change is already affecting almost all sectors of the economy with serious biophysical and socio-economic impacts in Akwa Ibom State. Many farm households and communities in the state are in the climate frontline struggling daily to adapt to the changing climate. Already, the sea level rise and excessive flooding has led to loss of valuable assets and other means of livelihood by farm households in some coastal communities in Akwa Ibom State, hence, causing their relocation. This has resulted in creating resource shortages, unemployment, sickness and hunger, and ultimately poor economic growth.

As a response most, households and individuals are already implementing alternative livelihood strategies (diversification of activities). Farm households diversify their livelihood activities to better cope with negative events and adverse factors that affect agriculture (Ellis, 2000; Ellis and Freeman, 2004). The strategies households adopt when choosing among livelihood options are determined by a range of socio-economic factors as well as their asset endowment (Eneyew, 2012). These strategies are discussed using sustainable livelihood approaches. Scoones, (2009), articulate that sustainable livelihood approaches (SLA's) emanated due to increased focus on poverty reduction, people oriented approaches to development and environmental sustainability. The SLA's focus on both people and their livelihood; prioritizing the way their assets (both the tangible and intangible) are utilized to achieve set goals. By definition, livelihoods comprises capabilities, assets (both materials and social resources) and activities required for a means of living (Chambers and Conway, 1992). A sustainable livelihood is that which can cope with and recover from stress and shock, and also maintain or enhance its capabilities and assets and provide sustainable livelihood opportunities for future generations. Given that livelihood assets could be threatened in the process of climate change, as evidenced in the constraints that climate change presents including; lack of employment opportunities, loss of farm land as well as other productive assets. These factors directly constrained households' asset status, resulting in households dwelling on diverse activities for survival. The poor's assets (natural capital, social capital, human capital, financial capital and physical capital) constitute a stock of capital which can be stored, accumulated, exchanged or depleted and put to work to generate a flow of income or other benefits (Narayan and Pritchette, 1999). Further, livelihood outcomes are not only dependent on access to capital assets or are being constrained by vulnerability context, they are also transformed by the environment of structures and process which may facilitate or deny entitlements (Serrato, 2008). Institutions create and determine vulnerability context, assets and outcome. The SLA's considers the causes of vulnerability of the poor, their assets and the policies, processes and institutions that affect their use of assets. These combine to produce a wide range of ways in which farm households construct their livelihood. It is within this framework that this study examined the different livelihood options adopted by households in Akwa Ibom State as a response to climate variability. Wisner et al., (2004) reports that the nature and magnitude of environmental stress like climate change per se do not determine vulnerability of agriculture, but that agricultural vulnerability is determined by the combination of the societal capacity and/ or strategies to cope with and recover from environmental change. While the coping capacity and degree of exposure is related to environmental changes, they are both also related to assets or natural resource endowment as well as the livelihood choice decisions of the households. Although, some empirical literature in Nigeria have examined the potential impacts of climate change on agriculture, economic growth, existing

studies so far has not established how climate change affect livelihood options/ choice decisions among farm households in Nigeria. This paper aimed to bridge this information gap by estimating the socio- economic factors influencing the choice of livelihood options among farm households in Akwa Ibom State, Nigeria.

2. Materials and methods

2.1. Study area

The study was conducted in Akwa Ibom State in Nigeria, with a population of about 3,920,208 million (NPC, 2006). The State is located in the South-South geo-political zone of Nigeria and is a major oil-producing area in the country. Akwa Ibom State lies between latitudes 4°32' and 5°33' N and longitude 7°25' and 8°25' E. It shares its southern boundary with the Atlantic Ocean. The State has a very rich potential for agriculture, and is suitable for food and tree crops, fish and livestock farming. Crops widely grown in the area are leafy vegetables such as waterleaf, fluted pumpkin and garden egg. Others include cassava, maize, yam, pepper, plantain and cucumber. The state comprises six agricultural zones, namely: Oron, Eket, Abak, Ikot-Ekpene, Etinan and Uyo, with agriculture being the main local employer.

2.2. Data collection

Data for the study were obtained from both primary and secondary sources. Secondary data (average annual rainfall for ten years, 2001 to 2011, and temperature) was obtained from Nigerian Bureau of statistics, while the primary data were obtained using a structured questionnaire administered to farm households. Multistage sampling technique was employed in this study. In stage one, one Local Government Area was randomly selected from each of the six agricultural zones, they include; Abak, Eket, Etinan, Ikot- Ekpene, Oron and Uyo. In stage two, five communities were randomly selected from each of the selected Local Government Area's, giving a total of 30 communities. In stage three, 10 households were randomly selected from each of the communities, giving a total of 300 farm households (50 from each zone). However, not all questionnaires were completed, hence, some copies were rejected. The analysis was therefore based on information from a total of 240 households (50 from Uyo, Eket and Ikot-Ekpene, and 35 from Abak and Etinan, and 20 from Oron zones). Data were collected in 2015.

2.3. Estimation procedure

The likelihood of a household choosing a livelihood strategy in response to climate variability is more or less influenced by the said households' socio-economic and demographic characteristics. Hence, the usual modeling approach involving multiple choices in decision process is Multinomial logit model (MNL). The Multinomial logit model analyzes a choice between three or more alternative response. It allows for analysis of decisions and facilitates the determination of choice probabilities for different livelihood categories (Nkamleu and Kielland, 2006).

Let Y be for households taking on the values = { 1, 2, 3, 4……..N}with each individual household having set of livelihood options or portfolios (j = 0, 1,2,3,4……J) each representing different livelihood strategies and/or options. Where vector Xi is of the form K x I; socio-economic characteristics of each household. However, under perfect state of conditions Xi affects the response probabilities (Prob. (Y = j| Xi); j = 0,1,2,3……..J. The MNL model for choice decisions of livelihood strategies is specified as relationship between the probabilities of choosing option j and set of explanatory variables Xi (Green, 2003). The model is specified thus:

$$\text{Prob } (Y = j|\ X) = 1 \frac{\ell^{\beta i \chi_i}}{1 + \sum_{k=0}^{j} \ell^{\beta i \chi i}} \qquad j = 0, 1, 2, 3, \ldots\ldots\ldots\ldots\ldots J \qquad (1)$$

However, to identify the model it is more appropriate to normalize equation (1) by setting β0 = 0 to remove problem of indeterminacy. This is because probabilities sum up to one. It is J parameter vectors required to compute probabilities of J + 1 choices. Hence, the probabilities can be estimated as follows.

$$\text{Prob } (Y = j|\ X) = 1 \frac{\ell^{\beta i \chi_i}}{1 + \sum_{k=1}^{j} \ell^{\beta i \chi i}} \qquad j = 0, 1, 2, 3, \ldots\ldots J \qquad \beta_{(0)} = 0 \qquad (2)$$

Moreover, from the equation (2), if J = 1 then the implication is that J log-odd ratios of the model can be computed as follows (Green, 2003).

$$\text{In} \left[\frac{p_{ij}}{p_{ik}}\right] = X_i (\beta_j - \beta_k) = X_i \beta_j ; \qquad \text{if} \quad k = 0 \qquad (3)$$

The reduced linear form of equation

$$Y = \beta_0 + \sum_{j=1}^{j} \beta\ jXi + \varepsilon \qquad (4)$$

Where β(0), β(j) and β(k) in the MNL model are vectors of parameters to be estimated, is the error term and Xi are the socio-economic characteristics influencing the choice of livelihood strategies. However, the parameter estimates of the MNL model do not represent actual magnitude of change or probabilities (since it provide only the direction of the effect of the independent variables on the dependent (response) variable). Here, the marginal effects from the MNL, which measure the expected change in probability of a particular choice being made with respect to a unit change in an independent variable, are also reported and discussed. The livelihood strategies adopted by households were grouped into five categories as thus: category 1, if the household chose crop production; category 2, if forestry activities, category 3, if livestock production, 4 if fishing and category 5 if any other non-agricultural activity. In all cases the estimated coefficients was

compared with the base category (Crop production as a livelihood strategy). In other words the factors influencing the choice of livelihood can be a function of some climactic factors and/or socio- economic characteristics of the farm households as explanatory variables for the Multinomial logit model. These variables are: X1 = Gender of the household head (if male 1; 0 if female), X2 = Age of households head (in years), X3 = Marital status (Couple 1, otherwise 0), X4 = Household size (number of individual in the family.), X5 = Education of household head (years), X6 = Asset Value (Value of productive asset in Naira), X7 = Land size (in hectares), X8 = Access to credit (Access = 1, 0 otherwise), X10= Membership of farmers cooperative (if any 1, otherwise 0), X11 = Precipitation (Annual mean rainfall level in mm), X 12= Temperature (Average of the area in degree celcius).

Table 1. List, codes and description of variables used in the regression

Variable	Codes	Description
Education (X_1)	Years	Continuous
Age of the head of household (X_2)	Years	Continuous
Gender (X_3)	Male=1,Female=0	Dummy
Household size (X_4)	Number of people in the household	Continuous
Marital Status (X_5)	Couple= 1, single = 0	Dummy
Asset value (X_6) (value of productive asset)	Amount (Naira/year)	Continuous
Land size (X_7)	Hectares	Continuous
Precipitation (mean annual rainfall) (X_8)	Millimeters	Continuous
Temperature (average temperature of the area) (X_9)	Degree celcius	Continuous

Source: Field survey, 2015

3. Results and Discussion

3.1. Summary statistics of variables

Table 2 shows that the summary statistics of continuous variables. The Table indicates that the mean educational level of the respondents was about 11 years, suggesting that on the average, the respondents had at least secondary education, an indication that they could read and write. The mean age was about 53 years suggesting that they were in their active and productive age. The mean household size and land size were about six persons and 1.5 hectares, respectively.

Table 2. Summary Statistics of the continuous variables

Variables	Mean	Std. Dev.	Min	Max
Educational level	10.89091	3.124057	6	16
Age	53.25	10.80277	30	70

Household size	5.98182	2.199997	2	12
Asset value	301912.6	134501.6	100050	790950
Land size	1.490455	1.33132	0.3	6
Precipitation	651.8964	23.7374	567.23	785
Temperature	23.2222	1.68487	21	32

Source: Field survey, 2015

3.2. Choice of livelihood strategies among the respondents

Household chose their sources of livelihood based on resource endowments (assets possession), institutional factors in the environment, and/ or climactic factors. Table 3 shows the frequency distribution of respondents according to their livelihood strategies. The Table shows that about 43 % of the respondents chose crop production as their major source of livelihood. About 36 % chose livestock production, while forestry, fishing and other non agricultural livelihood sources were chosen by about 7.3 %, 6.8 and 14.09 % of the respondents, respectively.

Table 3. Frequency distribution of respondents according major livelihood strategies

Choice of livelihood strategies	Number of respondents	Percentage
Crop production	95	43.18*
Forestry activities	16	7.27*
Livestock production	81	36.82*
Fishing activities	15	6.82*
Other non-agricultural livelihood sources	31	14.09*

**Multiple responses were recorded; hence, it exceeded 100%*
Source: field survey, 2015

3.3. Factors influencing Choices of livelihood strategies among the respondents

Table 4 summarizes the multinomial logistic regression analysis of the socio-economic factors that influence livelihood choices adopted by the respondents in the study area. The base category in the model was crop production. The model was estimated with maximum likelihood procedure. The Chi square results was highly significant ($P< 0.0001$), suggesting that the model has a strong explanatory power. The pseudo R2 was 31.33 %, thus confirming households' livelihood choice decision making process could be attributed to fitted covariates. In considering consistency with a priori expectations on the relationship between the dependent and the explanatory variables, the model appeared to behave well.

In comparison with crop production, the coefficient of educational level was positive and statistically significantly ($p< 0.01$) related to the probability of the household choosing livestock production and other

non-agricultural activity strategy as major livelihood sources. The marginal effects suggest the probability of a household choosing livestock production and other non-agricultural sources of livelihood increased by about 7% and 0.03%, respectively. This could mean that highly educated households will chose livestock production and other non-agricultural livelihood option. This is true because in a traditional African society, crop productions are mostly done by people with low level of education.

In comparison with crop production, the parameter of age was statistically significant ($P < 0.10$), but negatively related to the probability of the household choosing forestry activity as a livelihood option. The marginal effect showed that a unit increase in age will decrease the probability of a household choosing forestry activity by 0.2%. A possible explanation to this result is that forest might be too far from home, hence older people may not have the strength to trek long distances to forest in order to earn a living. The parameter of gender was not statistically significant in any of the livelihood options, but was positively signed in fishing activities and livestock production livelihood strategies.

In comparison with crop production, the probability of a household choosing livestock production and fishing activities, respectively, was negative and highly statistically significantly ($P < 0.05$ and $P < 0.01$) related to household size. The marginal effects suggest that a unit increase in household size will reduce the probability of a household choosing livestock production and fishing activities by 5 % and 0.6 %, respectively. This is intuitive, because unlike livestock and fishing activities, crop production is more labour intensive, and bigger household sizes could cushion the labor cost (because some households could use family labour for crop production). This finding collaborates with that of Hassan and Nhemachena (2004), who observed that household with bigger sizes were more likely to choose crop production as an adaptation strategy in combating climate variability.

In comparison with crop production, the coefficient of marital status was statistically significant ($P < 0.05$), but negatively related to the probability of the household choosing livestock production as a livelihood strategy. The marginal effects suggest that a unit increase in marital status will decrease the probability of a household choosing livestock by about 46%. Implying that married household heads could have bigger household size which could mean more family labour for crop production activity. Perhaps because crop production is labour intensive and single household heads may not be able to cope with the labour requirements.

The probability that a household chooses livestock production ($p < 0.01$), and fishing activity ($p < 0.05$) as a opposed to crop production was positive and highly significantly related to asset value. However, asset value was negative and significantly related to the probability of a household choosing other non-agricultural livelihood options. The marginal effects suggest that a unit increase in asset will lead to 137 times and 65 time increase in the likelihood of a household choosing livestock production and fishing activities, respectively. A plausible explanation to this is that household with more assets chose livestock production and fishing activities as livelihood options, perhaps because livestock production and fishing activities are capital intensive livelihood activities.

In comparison with crop production, the probability of a household choosing forestry activity was positive and statistically significantly ($p < 0.01$) related to land size. But the probability of a household choosing

livestock production was negative and statistically significantly ($p < 0.01$) related to land size. The marginal effect showed that a unit increase in land size, will increase the probability of a household choosing forestry activities by about 2 %, while reducing the odd of choosing livestock production by about 11%. The implication of this result is that the higher the area of land available for crop production the higher the odds that a household will use a greater portion of the land to plant trees, perhaps as wind breaks and to reduce the effect of climate change on their farm lands. Further, the negative coefficient of land on the livestock production category implies that farm households with large portion of land will prefer crop production as a livelihood strategy. This result lends credence to the findings of Okon, Enete and Okorji (2016), who observed that households with larger portion of land chose crop production as a livelihood strategy.

The probability of a household choosing forestry activity and other non-agricultural livelihood options as opposed to crop production was positive and statistically significantly ($p < 0.01$) related to precipitation. The marginal effects suggest that a unit increase in precipitation will lead to a about 0.01% increase in the probability of a household choosing forestry activity and a 75 % increase in the probability of a household choosing other non- agricultural livelihood options. This is to be expected because the variability in rainfall could have a serious detrimental influence on crop production, livestock stock production and fishing activities. In this instance, a household could partly rely on forestry activities and mostly non-agricultural livelihood options as their major source of livelihood.

In comparison with crop production, the parameter of temperature was not statistically significant but was positively signed in all livelihood option except in fishing production activity where it was negatively signed.

Table 4. Outputs from multinomial regression analysis

Variables/ Coefficient	**Forestry activities (2)**	**Livestock production (3)**	**Fishing activities (4)**	**Other non-farm activities (5)**
Intercept	-39.56988	-6.633169	-1.894024	-60.03799
Education	-0.118172	0.254203	-0.134645	1.39572
	(-0.003942)	(0.062760)***	(-0.00356)	(0.00034)***
Age	-0.101285	0.035605	0.046598	0.032715
	(-0.00208)*	(0.00903)	(0.00508)	(5.09e-06)
Gender (a)	0.045232	0.003618	-0.962226	-0.134650
	(0.001078)	(0.07335)	(-0.01656)	(-0.00003)
Household size	0.090257	-0.0207542	-0.51695	0.381320
	(0.00055)	(-0.04617)***	(-0.00645)***	(0.000124)
Marital Status (a)	-1.66724	-1.65584	11.79378	0.000769
	(-0.02084)	(-0.45908)**	(0.187583)	(0.000136)
Asset value	2.07e-07	5.88e-06	6.77e-06	-0.000019
	(-4.12e-08)	(1.37e-06)***	(6.54e08)**	-5.71e-09*

Land size	0.850750	-0.478277	-0.380196	-1.352866
	(0.018791)***	(-0.11893)***	(-0.002990)	(-0.000306)
Precipitation	0.057055	0.002721	-0.006658	0.030903
	(0.000999)***	(0.000274)	(-0.000133)	(7.56e-06)***
Temperature	0.261556	0.0731113	-0.295309	0.918596
	(0.004202)	(0.0174062)	(-0.004956)	(0.000233)

*Statistics: Chi² 36; prob > chi = 0.0000; pseudo R2 =0.3250; number of observations = 220. Note: Crop production (1) is the comparison category. The figures in parenthesis are marginal effects. ***p ≤ 0.01; ** < p ≤ 0.05. (a) = dy/dx is the discreet change of dummy variable from 0 to 1. Source: field survey, 2015*

4. Conclusion

Effective choice of livelihood strategy is an important concept among households, particularly because it could reduce their vulnerability to income shock in the face of climate change. Identified in this study are some socio-economic characteristics and climactic variables that influence households' livelihood choice decisions. The analysis showed that whilst household size, marital status and land size were negative and statistically significantly related to the probability of the household choosing livestock production. The choice of forestry activities over crop production was positive and statistically significantly related to land size and precipitation, but negatively related to age. The household's level of education was positively and significantly related to the odd of their choosing livestock production or other non-agricultural activities. Further, asset value was positively and statistically significantly related to their choice of livestock production and fishing activity, but negative and statistically significantly related to their choice of other non-agricultural activities. Also, precipitation was positive and statistically significantly related to the probability of a household choosing forestry and other- non-agricultural activities – suggesting a gradual movement away from core agricultural livelihood sources due to climate variability. It is hoped that this factors could act as a guide to policy makers and pro poor advocates for the achievement of sustainable development goals 1, 2 and 12.

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