Original Research Article

DYNAMIC RELATIONSHIP BETWEEN VULNERABILITY TO CLIMATE CHANGE, LIVELIHOOD DIVERSIFICATION, PERCEPTION ON CLIMATE CHANGE AND INCOME OF THE FARMERS IN NORTH CENTRAL

ABSTRACT

Aims: Although a number of researchers have outlined the strategies farmers adopt to ensure stability of family income but literature provides less understanding on the dynamic relationship between vulnerability to climate change, livelihood diversification, perception on climate change and income of the farmers. It is therefore the aim of this study to establish the relationship between these concepts.
Study design: Original research.
Place and Duration of Study: The study was conducted in North Central Nigeria in 2019.
Methodology: Multi-stage sampling technique was employed in the collection of primary data for this study. In the first stage, the two (2) States were randomly selected from North Central Nigeria. In the second stage, five (5) Local Government Areas (LGAs) were randomly selected from the selected States, giving a total of ten (10) LGAs. In the third stage, sampling of farm households in each community were determined proportionately using Krejcie and Morgan (1970) formula. Data were collected from 483 farm households via questionnaire administered by trained enumerators. The data were analyzed using adaptive capacity index, vulnerability index and seemingly unrelated regression.
Results: Result of the seemingly unrelated regression revealed that increase in the number of livelihood activities and income of the farmer reduces vulnerability to climate change. More so, increase in the income of the farmer increases the number of livelihood activities the farmer engaged in and also increases the perception of the farmer on climate change.
Conclusion: farmers should diversify their sources of livelihood so as to reduce their vulnerability and improve resilience to climate change. The level of literacy among farm households and availability of social amenities should be looked into when formulating policy and developmental issues as they reduces vulnerability to climate change. Financial institutions should help facilitate access to credit by farmers so as to stimulate the adoption of climate smart practices.

Keywords: Climate change; vulnerability index; adaptive capacity index; seemingly unrelated regression; North Central Nigeria.

1. INTRODUCTION

Farmers' decisions on the choice of livelihood depend on numerous factors such as perception and vulnerability on climate change as well as income of the farmers. Farm households combine their proficiencies, abilities and knowledge with the diverse resources at their disposal to form activities that qualify them to achieve the best conceivable livelihood outcomes such as income [1]. The perception that farmers have about climate change not

only informs their planting decisions, but also determines the adoption of adaptation measures [2]; [3]. Climate change perception is a complex process that encompasses a range of psychological constructs such as knowledge, beliefs, attitudes and concerns about if and how the climate is changing [4]. Perception is influenced and shaped, among other things, by the individuals' characteristics, their experience, the information that they receive, and the cultural and geographic context in which they live. The perception of those that directly depend on the weather for at least part of their income, such as farmers, tend to be more accurate than others [5].

Livelihood activities are rooted in natural resources in which people depend on either directly or indirectly. Consequently, there is close connection between livelihood choice, climate change variability and productivity of the natural resource base. Lending credence to this view, [6] pointed out that livelihoods activities depend on the environment in which the household functions. Livelihood in this research is in line with [7] composed of a range of activities, both the access to assets and the use to which they can be put are mediated by social factors (social relations, institutions, and organizations) and by exogenous trends (for example economic trends) and shocks (drought, disease, floods, pests). Climate change is evident in North Central Nigeria as [8] reported that farmers were mostly aware of increased/high temperature, soil erosion, soil infertility, high rainfall and disappearance of wildlife. As such, farm households form livelihoods amidst climate-induced changes.

Climate change has become a focus point by researchers in livelihoods formation due its impacts on people and ecosystem functioning. Developing countries like Nigeria depend on climate-sensitive activities as a result experiences climate change impacts. Different motivators and barriers influence how people respond to climatic change impacts such as their vulnerability, livelihood diversification, assets as well as income. [9] pointed out that households that rely on rain fed farming particularly in Africa face instabilities in annual income and exhibits how components of income change in response to variations in rainfall. Households therefore try to reduce the consequence of an income shock by diversifying in or out of agriculture or both. The assumption is that based on the views of [10] households with more spread livelihood sources are less susceptible to the impacts of climate change.

Vulnerability to climate change is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive [11]. There are two core considerations when thinking about the vulnerability context, and these are: the extent to which different groups are exposed to particular stresses and shocks; and the sensitivity of their livelihoods to these factors [12]. Over dependence on the climate sensitive sector, unsound land use practice and management, and lack of required capital in adaptation option practices worsen the livelihood vulnerability of rural farm households to climate change [13]. Climate change has altered livelihoods, leading to an increasing vulnerability, reducing the possibilities of securing livelihoods and poverty annihilation [14]. As such there is need diverse every necessary means to reduce the impact of climate change.

Livelihood diversification has been recognized by researchers [15]; [16] to plays a crucial role in promoting economic growth, reducing rural poverty and environmental change in developing countries. This has to do with combining both agricultural and non-agricultural activities to survive and improve the standard of living of the rural populace [17]. Farm households are trying to diversify their sources of livelihood so as to reduce risks and cope with economic and environmental shocks [18]. In the same view, [19] opined that farm households engage in livelihood diversification due to uncertainty related to climate-sensitive occupations like farming as a major coping strategy for various economic and environmental

challenges. Lending credence to this, [20] affirmed that increase in income from diversified livelihood sources allows farmers to enhance their adaptive capacity to cope with climate risk. In the light of the foregoing, this study seeks to provide answer to this pertinent research question; what is the dynamic relationship between vulnerability to climate change, livelihood diversification, perception on climate change and income of the farmers in North Central Nigeria. It is on the view that livelihood diversification would serve as coping strategy to the effects of climate change and as a result, the income generated could be used by the farmers to adapt to different adaptation strategies which would invariably reduce their vulnerability to climate change as well as increase their perception on climate change. The objective of this research is to determine the dynamic relationship between vulnerability to climate change, livelihood diversification, perception on climate change and income of the farmers in North Central Nigeria.

2. METHODOLOGY

The study was conducted in North Central Nigeria. The States that make up the north central zone are Benue, Kogi, Kwara, Nasarawa Niger, Plateau and Federal Capital Abuja. Central Nigeria covers a total land area of 242, 425.00 sq kilometres and lies between latitude 4^0 and 14^0 North of the equator and longitudes 3^0 and 14^0 East of the Greenwich meridian. The area has an estimated population of 20, 266, 257 people [21].Going by the population growth rate of 2.5% [22], the population is projected to 29, 351, 574 people. Multi-stage sampling technique was employed in the collection of primary data for this study. In the first stage, the two (2) States were randomly selected from North Central Nigeria. In the second stage, five (5) Local Government Areas (LGAs) were randomly selected from the selected States, giving a total of ten (10) LGAs. In the third stage, sampling of farm households in each community were determined proportionately using [23] formula.

$$S = \frac{X^2 NP(1-P)}{d^2(N-1)+X^2P(1-P)} \quad (1)$$

Where: S = The required sample size; X^2 = Table value of chi-square for 1 degree of freedom at the desired confidence level (1.96); N = Population size; P = Population proportion (assumed to be 0.80); d^2 = Degree of accuracy expressed as a proportion (0.05). Data for this study were collected using structured questionnaire. The primary data were obtained through administration of structured questionnaire and interview schedule to elicit information from 483 farmers, on all the information needed to achieve the stated objective. The questionnaires were administered by trained enumerators supervised by the team of researchers.

The data were analyzed using Seemingly Unrelated regression model. The empirical Seemingly Unrelated regression model is specified in equation (2)-(5):

$$Y_1 = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + \beta_{12}X_{12} + \beta_{13}X_{13} + \beta_{14}Y_2 + \beta_{15}Y_3 + \beta_{16}Y_4 + e_1 \quad (2)$$

$$Y_2 = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + \beta_{12}X_{12} + \beta_{13}X_{13} + \beta_{14}Y_1 + \beta_{15}Y_3 + \beta_{16}Y_4 + e_2 \quad (3)$$

$$Y_3 = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + \beta_{12}X_{12} + \beta_{13}X_{13} + \beta_{14}Y_1 + \beta_{15}Y_2 + \beta_{16}Y_4 + e_3 \quad (4)$$

$$Y_4 = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + \beta_{12}X_{12} + \beta_{13}X_{13} + \beta_{14}Y_1 + \beta_{15}Y_2 + \beta_{16}Y_3 + e_4 \quad (5)$$

Where in equation (2)-(5): Y_1 = vulnerability to climate change (index); Y_2 = livelihood diversification (Number of different livelihood activities); Y_3 = perception on climate change (weighted mean); Y_4= Income of the farmer (NGN); X_1 = Age of the farmer (years); X_2 = Household size (Number); X_3 = Educational status of the farmer (Number of years spent in school); X_4 = Livestock diversification (Tropical Livestock Unit); X_6 = Crop diversification (Number of different crop grown); X_7 = Credit use (NGN); X_8 = Farm size (hectares); X_9 = Availability of social amenities (Number); X_{10} = Membership of association (Number); X_{11} =

Extension contact (Number); X_{12} = Poverty status (poor =1, non-poor = 0); X_{13} = Adaptive capacity (index); β_{0i}= constant term to be estimated; β_1 - β_{16} = Parameters to be estimated; e_1 - e_4 = error terms. The vulnerability index was calculated using three indicators of exposure, sensitivity and adaptive capacity with sub indicators following [24]. Perception on climate change was calculated using five point Likert type scale to generate the weighted mean. Adaptive capacity index was calculated using eight indicators of knowledge, use, availability, accessibility, consultation, affordability, benefit and sources of information on each adaptation strategies adopted by the farmers on a Likert type scale following [25].

3. RESULTS AND DISCUSSION

Result of the Seemingly Unrelated regression model on the dynamic relationship between vulnerability, livelihood diversification, perception on climate change and income of the farmers is presented in Table 1. The R Square (R^2) revealed that 67% of the variations in vulnerability, 40% in livelihood diversification, 32% in perception on climate change and 61% in income of the farmers are explained by the variables included in the models. The likelihood ratio statistics as indicated by Chi^2 (χ^2) statistics of 1012.72, 415.70, 313.63 and 961.84 for vulnerability, livelihood diversification, perception on climate change and income were statistically significant at 1% probability levels, (Prob. > Chi = 0.0000) suggesting that the models have strong explanatory power. In the vulnerability model, crop diversification (0.012) and poverty status (0.061) significantly increases vulnerability to climate change at 10% and 1% probability levels respectively. The possible reason for this might be that farmers' engagement in crop production which could be under rain-fed and being poor increases the sensitivity of the farmers to climate change and as result increases their vulnerability. While a year increase in the level of education (-0.007), an increase in the tropical livestock ownership unit (-0.004), an increase in access to functional social amenities available in the area (-0.019), an increase in the membership of association the farmers belong (-0.034), an increase in the adaptive capacity of the farmers (-0.459), an increase in livelihood diversification (-0.042) and a naira increase in the income of the farmers (-0.019) significantly reduces vulnerability to climate change at different probability levels. The implication of a negative relationship between livelihood diversification and vulnerability to climate change is that engagement in different livelihood activities reduces farmers' vulnerability to climate change which could serve as coping strategy. The possible reason for a negative relationship between income of the farmers and vulnerability to climate is that as the farmers income increases the possibility of adoption climate smart agricultural practices increases. This result is line with the views of [26]; [27] who pointed out that the inadequate economic resources, low educational level, and limited technology and infrastructure worsen farm households level of vulnerability to climate change. This result is also in accordance with the findings of [28] affirmed that climate vulnerability level of the farmers are significantly influenced by education, credit, membership of farmer based organization, unemployed household members, non-farm income, environmental warning and droughts.

In the livelihood diversification model, a number increase in the household size (0.019), would push the farmer to engage in other activities so as to offset household expenses. A year increase in educational level of the household head (0.016), would provide an opportunity to be employed in different livelihood activities due to the knowledge and skill acquired. A unit increase in the livestock ownership (0.006), which is a form asset can serves as coping strategy that could be reinvested in other businesses. A naira increase in credit accessed by the farmers (0.015), gives the farmers the opportunity to invest in off-farm business. A unit increase in the extension contact accessed by the farmers (0.025), might bring about increase in yield as well as farm income which could be used to establish other businesses. An increase in the adaptive capacity of the farmers to climate change (1.089),

increases their adaptation to climate change and so also their income. A naira increase in the income of the farmers (0.328) significantly increases the number of livelihood diversification the farmers engaged. The positive effect of income of the farmers on the livelihood diversification might be that there would be more money to invest in different businesses. While household vulnerability index (-0.697) significantly decreases the number of livelihood diversification of the farmers at 1% probability level. The possible reason for this, is that the vulnerable households might lack the resources to diversify into different activities. This result is consistence with the findings of [29] who opined that there are several factors such as educational level, number of livestock ownership, farming experience, etc., that affect diversified diversification.

In the perception on climate change model, a unit increase in livestock ownership (0.014), an hectare increase in farm size (0.031), a unit increase in extension contact (0.015), could give the farmers the ability to keep track of climate variability as well as their perception on climate change. Whereas, being poor (-0.145), significantly reduces farmers' perception on climate change, probably the farmers might not to be well informed about climate change which could be from different medium. A unit increase in the adaptive capacity (0.506) and a naira increase in the income of the farmers (0.278) significantly increases the farmers' perception on climate change. The possible reason for a positive relationship between the farmers' income and perception on climate change could be that higher income might give room for large social network and access to climate change information. This is in accordance with the findings of [30] who ascertained that residents' education level and household size are the main factors that affect the perception of climate change.

In the income model, a year increase in the level of education (0.025), a naira increase in credit accessed by the farmers (0.016), a unit increase in access to functional social amenities in the area (0.311), a unit increase in the membership of association the farmers belongs to (0.248), a unit increase in extension contact accessed by the farmers (0.026), a unit increase in adaptive capacity of the farmers to climate change (0.436), increase in livelihood diversification of the farmers (0.412) and perception on climate change (0.566) significantly increases income of the farmers at different probability levels. While poverty status (-0.916) and household vulnerability index (-0.386) significantly reduces income of the farmers at 1% and 10% probability levels. The possible reason for the negative relationship between household vulnerability and income of the farmers is that vulnerability is also associated with poverty. The positive relationship between livelihood diversification and income of the farmers is that engaging in different activities gives room for better wealth accumulation. Farmers with high perception on climate change carefully adapt to different strategies so as to reduce the impact of climate change on their income. This result is in line with the findings of [31] who confirmed the important role of education, different employment activities, fixed assets in improving household income.

Table 1: Estimates of dynamics between vulnerability, Livelihood diversification, perception and income of the farmers in North Central Nigeria

Variables	Vulnerability Coefficients	Livelihood diversification Coefficients	Perception on climate change Coefficients	Income Coefficients
Age	-0.001	-0.004	0.004	0.004
	(-1.64)	(-1.31)	(1.57)	(1.45)
Household size	0.002	0.019***	-0.006	0.008
	(1.40)	(2.66)	(-1.12)	(1.07)
Education	-0.007***	0.016**	0.001	0.025***
	(-4.94)	(2.54)	(0.16)	(3.66)

Tropical Livestock Units	-0.004*** (-6.04)	0.006** (2.25)	0.014*** (6.77)	0.001 (0.22)
Crop diversification	0.012* (1.71)	-0.006 (-0.21)	-0.006 (-0.27)	0.049 (1.53)
Credit	-0.002 (-1.42)	0.015*** (3.03)	-0.005 (-1.36)	0.016*** (2.89)
Farm size	-0.005 (-1.19)	-0.027 (-1.54)	0.031** (2.26)	0.009 (0.50)
Social amenities	-0.019** (-2.54)	-0.043 (-1.43)	-0.025 (-1.08)	0.311*** (10.80)
Membership of association	-0.034*** (-2.86)	0.061 (1.26)	-0.046 (-1.20)	0.248*** (4.68)
Extension contact	-0.003 (-1.42)	0.025*** (3.30)	0.015** (2.52)	0.026*** (3.17)
Poverty status	0.061*** (3.37)	-0.092 (-1.24)	-0.145** (-2.50)	-0.916*** (-13.23)
Adaptive capacity	-0.459*** (-12.16)	1.089*** (6.49)	0.506*** (3.76)	0.436** (2.24)
Household vulnerability index	-	-0.697*** (-3.76)	0.079 (0.54)	-0.386* (-1.85)
Livelihood diversification	-0.042*** (-3.76)	-	-0.009 (-0.24)	0.412*** (8.31)
Perception on climate change	0.008 (0.54)	-0.014 (-0.24)	-	0.566*** (9.04)
Income	-0.019* (-1.85)	0.328*** (8.31)	0.278*** (9.04)	-
Constant	0.871*** (6.34)	4.296*** (7.56)	0.798* (1.80)	9.844*** (23.38)
R^2	0.6766	0.4071	0.3251	0.6156
RMSE	0.1235	0.5085	0.3998	0.5794
Chi^2	1012.72	415.70	313.63	961.84
$Prob>Chi^2$	0.000	0.000	0.000	0.000

Values in parentheses are the t-values. *** P<0.01, **P<0.05 and *P<0.10.
Source: Field survey, 2019.

4. CONCLUSION

Increase in livelihood diversification and income of the farmer reduces vulnerability to climate change. More so, increase in the income of the farmer increases livelihood activities the farmer engaged in and also increases the perception of the farmer on climate change. Based on the findings, the study therefore recommended that farmers should diversify their sources of livelihood so as to reduce their vulnerability and improve resilience to climate change. The level of literacy among farm households and availability of social amenities should be looked into when formulating policy and developmental issues as they reduces vulnerability to climate change. Financial institutions should help facilitate access to credit by farmers so as to stimulate the adoption of climate smart practices and also break the vicious cycle of poverty among farmers.

CONSENT

This is not applicable to this study.

ETHICAL APPROVAL

This is not applicable to this study.

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