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Vulnerability of Farming Households to Environmental Degradation in Developing Countries: Evidence from North Central Nigeria

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Abstract

This study examined the vulnerability level of individual farming households in North central Nigeria. A survey of 356 households in North Central Nigeria was used to generate household level data. Principal Component Analysis (PCA) was used to develop vulnerability index for individual household so as to classify households depending on their level of vulnerability to environmental degradation impacts and then ordered logistic regression model was employed to identify the key determinants of vulnerability to environmental degradation impacts. The households were categorized into three levels as: highly vulnerable (vulnerability index, Vi of 1.24), vulnerable (Vi=3.35) less vulnerable and (Vi=6.18). The result of households vulnerability to environmental degradation showed that mean household vulnerability index in the study area was 2.86, and only the farming households from Kogi State (3.189) had above this average. Households in Benue State had an average vulnerability index of 2.585 while those from Plateau State had an index of 2.811. Access to credit, land fragmentation and land tenure security positively favoured less vulnerability while intensity of environmental hazards was found to increase the likelihood of households being highly vulnerable to environmental degradation. It was recommended that government should encourage farming households in the study area to obtain loan from banks and micro-credit institutions by regulating interest rate on loans for farmers as well as removing the stringent conditions attached to loans. This will increase farmers' adaptive capacity to changes in the environment.

Key words: Vulnerability, vulnerability index, farm household, environmental degradation

1. Introduction

Countries all over the world, particularly the developing ones, face severe environmental degradation that appears to be threatening their long-term development prospects. This is so because they rely upon the use of natural resources in their growth and development process. These natural resources are being used up in a manner that appears wasteful and, thereby, forecloses options for development in the future.

The World Bank estimated that more than a million people in Sub-Saharan Africa still live in acute poverty and suffer grossly inadequate access to resources required to give them opportunity for economic development. The immediate struggle for basic survival by the poor in various countries undermines the legitimate concerns of environmental protection and leads to consequent pressure on the environment, with attendant pervasive degradations (Hisham, 1993). When the environment becomes less valuable or damaged, environmental degradation is said to occur. When habitats are destroyed, biodiversity is lost, or natural resources are depleted, the environment is hurt (Etuonovbe, 2009).

The widening degradation of agricultural land, coupled with the low adoption/use of environmentally friendly and socio-economically robust technologies among resource-poor rural households have created a serious gap in meeting the objective of food production to feed the ever increasing population (FGN, 2004). Currently, Nigeria is facing a serious challenge in agricultural production to feed the growing population in the context of shrinking agricultural land and impact of climatic variability. This situation is forcing rural farmers to depend more on the natural resources for their livelihood and therefore become more vulnerable to environmental degradation.

The impact of environmental degradation is however spatially heterogeneous across a diverse range of geopolitical scales. For instance at the international level, the risk is generally believed to be more acute in developing countries because they rely heavily on climate-sensitive sectors, such as agriculture and fisheries, and have a low GDP, high levels of poverty, low levels of education and limited human, institutional, economic, technical and financial capacity (Preston *et al*., 2006; IPCC, 2007). At the national level, various ecosystems, sectors, and sub- populations and households within a country have been identified as being more or less at-risk of environmental degradation in a changing climate depending on length of coastline, level of emergency preparedness and economic and livelihood sensitivity to climate related elements and population growth (NEST, 2004; IPCC, 2007).

The implication is that vulnerability of countries and households to the effects of environmental degradation depends not only on the magnitude of climatic stress, but also on the sensitivity and capacity of affected households to adapt to or cope with such stress (NEST 2004). In the context of the global warming problem, assessing vulnerability is an important component of any attempt to define the magnitude of the threat. Moreover, analysis of vulnerability provides a starting point for the determination of effective means of promoting remedial action to limit impacts by supporting coping strategies and facilitating adaptation. This study thus, analysed the vulnerability of farming households to environmental degradation based on the integrated vulnerability assessment approach and determined the factors influencing households' vulnerability to environmental degradation in North Central Nigeria.

2. Conceptual Framework

The Intergovernmental Panel on Climate Change (IPCC) defines vulnerability as the extent to which a natural or social system is susceptible to sustaining damage from climate change. Wilbanks, Lankao, Bao, Berkhout and Cairncross (2007), noted that the two factors that contribute to vulnerability are largely determined by the development context which has such a strong influence on households' income, education and access to information, on people's exposure to environmental hazards in their homes and workplaces and on the quality and extent of provision for infrastructure and services.

Vulnerability perspective considers how communities are exposed to dangers, the ways in which they are readily harmed, and the protection that they lack (Brauch, 2002).Vulnerability is not simply a function of exposure, but also of people's capacity to adapt to change. If the people's capacity to adapt to change remains unchanged, increased exposure will lead to increased vulnerability. Furthermore, vulnerability is influenced by both physical and socioeconomic characteristics, which are themselves not static implying that vulnerability is context specific, and specific to place, time and the perspective of those assessing it (Adger, 1996; Aandahi, & O'Brien, 2001).

Three perspectives of vulnerability from climate change and hazards research are identified, which address the dynamic and integrated nature of social and environmental vulnerability (Dolan & Walker, 2004). The first perspective characterizes vulnerability in terms of exposure to hazardous events and how this affects people and structures. The second perspective views vulnerability as basically a human relationship and not a physical one, i.e. social vulnerability, while the third integrates both the physical event and the underlying causal characteristics of populations that lead to risk exposure and limited capacity of communities to respond. This study followed that of Madu (2012) and Gutu, Emana, and Ketema (2012), to adapt the integrated approach using the integrated vulnerability framework as described by Dolan and Walker (2004).

The integrated assessment approach combines both socioeconomic and biophysical approaches to determine vulnerability. The Intergovernmental Panel on Climate Change (IPCC) (2001) definition—which conceptualizes vulnerability as a function of adaptive capacity, sensitivity, and exposure—accommodates the integrated approach to vulnerability analysis (Füssel & Klein, 2006; Füssel, 2007). According to Füssel and Klein (2006), the risk-hazard framework (biophysical approach) corresponds most closely to sensitivity in the IPCC terminology while the adaptive capacity (broader social development) is largely consistent with the socioeconomic approach. Furthermore, in the IPCC framework, exposure has an external dimension, whereas both sensitivity and adaptive capacity have an internal dimension, which is implicitly assumed in the integrated vulnerability assessment framework (Füssel, 2007).

Although the integrated assessment approach corrects the weaknesses of the other approaches, it also has its limitations. The main limitation is that there is no standard method for combining the biophysical and socioeconomic indicators. This approach uses different datasets, ranging from socioeconomic datasets to biophysical factors. These datasets certainly have different yet unknown weights (Cutter, Mitchell, & Scott, 2000). The other weakness of this approach is that it does not account for the dynamism in vulnerability. Despite its weaknesses, the approach has much to offer in terms of policy decisions (Deressa, Hassan, & Ringler, 2008).

3. Materials and Methods

3.1 The Study Area

The study was carried out in North-central Nigeria. The zone has a land area of 296, 898 km^2 representing nearly 32 percent of the country's total land area (NBS, 2008). There are six states in the zone and the Federal Capital Territory, Abuja. The States include Benue, Kogi, Kwara, Nasarawa, Niger and Plateau. It is located in the central part of Nigeria and in the sub-humid region of the country, and bounded to Bauchi, Kaduna, Zamfara and Kebbi States to the north; Cross-River, Ebonyi, Enugu, Edo, Ondo, Ekiti, Osun and Oyo States to the south; Taraba State and Republic of Cameroon to the east and the Republic of Benin to the west. Situated between latitudes 6^o 30" - 11^o 20"N and longitude 7^o – 10^oE, the zone has 20.36 million people with the rural population constituting 77 percent (NPC, 2006).

3.2 Sampling Techniques

Multi-stage random sampling technique was used to select a sample size of 360 respondents. In the first stage, a random selection of three States from North-central Nigeria was made. Hence, Benue State, Kogi State and Plateau State were selected. Secondly, two agricultural zones were randomly sampled from each State selected for the study making six agricultural zones. Thirdly, two local government areas were randomly selected from each agricultural zone, giving a total of twelve local government areas. In the fourth stage, three farming communities were randomly selected from each local government area making a total of thirty-six farming communities. Lastly, ten arable crop farmers were randomly selected from each farming community, giving a sample size of 360 arable crop farmers (i.e. 120 respondents from each state). Apart from Plateau State which returned all the 120 copies of the questionnaire, 117 and 119 were returned from Benue and Plateau States respectively giving a total of 356 respondents analysed for the study.

3.3Analytical Techniques

3.3.1 Household vulnerability analysis

In order to achieve objective vii, vulnerability index was employed. Following Madu, (2012) and Gutu (2013), the data were analysed in stages. The first stage of analysis was the descriptive analysis of the land use and environmental characteristics that described the adaptive capacity, sensitivity, and exposure of the households to environmental degradation. Second, the vulnerability indices were obtained by applying Principal Component Analysis (PCA) on the adaptive, sensitivity, and exposure variables.

Vulnerability = (adaptive capacity)–(sensitivity/exposure).
The vulnerability index of each household was obtained as follows:

$$V_i = \begin{pmatrix} W_1 \\ W_2 \\ \cdot \\ \cdot \\ \cdot \\ W_{n+n} \end{pmatrix} \times \begin{pmatrix} (X_{11}+ \ldots + X_{1n}) - (K_{11}+ \ldots + K_{1n}) \\ \vdots \\ \vdots \\ (X_{m1}+ \ldots + X_{mn}) - (K_{m1}+ \cdots + K_{mn}) \end{pmatrix} \ldots\ldots\ldots\ldots (1)$$

The values of X and K were obtained by normalization using a 3-point likert-scale rating technique from the respondents. In equation 1, the *Ws*, are the first component score of each variable computed using Principal Component Analysis in SPSS.
Finally, cluster analysis was performed on the vulnerability indices to group the households according to their degree of similarity in vulnerability. The households were clustered into highly vulnerable, vulnerable and less vulnerable.

Vulnerability indicators that were used for adaptive capacity (Xs) include; literacy level, Non-farm employment, Ownership of radio, Ownership of livestock, agrochemical supply, fertilizer supply, improved seeds supply, irrigation potential, planting trees, crop diversification, access to large farm size, access to farm credit, access to electricity, use of stove, access to health services, access to food market, access to mobile phone and secured land tenure. The indicators for sensitivity/exposure (Ks) included; household size, bare farmland, sloppy farmland, use of fire wood, rainfall variability (low rainfall), temperature variability (high temperatures), biodiversity loss, soil erosion, desertification, hailstorm, frequent flooding deforestation, drought and run-off.

3.3.2 Ordered logit regression

In order to estimate the determinants of households' vulnerability to environmental degradation, ordered logit regression model was employed. In statistics, the ordered logit model (also ordered logistic regression or proportional odds model), is a regression model for ordinal dependent variables. It can be thought of as an extension of the logistic regression model that applies to dichotomous dependent variables, allowing for more than two (ordered) response categories. The model only applies to data that meet the proportional odds assumption, that the relationship between any two pairs of outcome groups is statistically the same. This means that the coefficients that describe the relationship between, say, the lowest versus all higher categories of the response variable are the same as those that describe the relationship between the next lowest category and all higher categories, etc. Because the relationship between all pairs of groups is the same, there is only one set of coefficients. Here, the dependent variable was categorised, therefore the model was specified thus:

$$\Pr(Y \leq j) = \ln\left(\frac{\sum pr(Y \leq j|X)}{1-\sum pr(Y \leq j|X)}\right) = \alpha_j + \beta_1 X_1 + \cdots + \beta_{15} X_{15} \quad \dots\dots\dots\dots \qquad (2)$$

j = 1, 2, 3

where

Y = vulnerability to environmental degradation (which is categorized into 3: highly vulnerable = 1, vulnerable = 2 and less vulnerable = 3)

α = threshold, β_1-β_{15} = estimated parameters

X_i are farm and farmer-specific characteristics, land tenure and use practices which determined level of household vulnerability to environmental degradation. They include:

X_1 = sex of a household head (male =1, female = 0), X_2 = number of household size,
X_3 = years of educational attainment, X_5 = non-farm income (₦), X_6 = farm income (₦),
X_7 = access to credit (access = 1, 0 otherwise), X_8 = crop diversity (number of crops grown),
X_9 = land fragmentation (number of plots), X_{10} = land tenure security (inheritance/purchase land = 1, otherwise 0), X_{11} = irrigation (use = 1, otherwise 0), X_{12} = land conflict (experience conflict on land = 1, otherwise 0), X_{13} = mining activity (carried out mining on the land = 1, otherwise 0), X_{14} = soil and water conservation, X_{15} = cropping intensity index and X_{16} = intensity of environmental hazards.

4. Results and Discussion

4.1 Social and economic vulnerability

The result of some of the social and economic variables related to adaptive capacity of vulnerability to environmental degradation in the study area is presented in table 1. The result showed a low adaptive capacity (i.e. mean score MS < 1.95) by the following variables, literacy level, non-farm employment, irrigation potential, tree plantation, access to large farm size, access to farm credit, access to electricity, use of stove, and secured land tenure. According to Gutu (2013), social vulnerability is the predisposition of people, organizations, and societies to suffer from natural and manmade disasters. While the economic vulnerability assessment approach mainly focuses on the economic status of individuals or social groups.

Table 1: Social and Economic Variables showing Adaptive Capacity of Household to Environmental Degradation (n = 356)

Variable	Mean score	Standard deviation
Literacy level	1.9	0.816
Non-farm employment	1.6	0.852
Ownership of radio	2.4	0.686
Ownership of livestock	2.0	0.744
Agrochemical supply	2.6	0.610
Fertilizer supply	2.8	0.495
Improved seeds supply	2.5	0.624
Irrigation potential	1.2	0.563
Planting trees	1.4	0.550
Crop diversification	2.2	0.697
Access to large farm size	1.6	0.682
Access to farm credit	1.1	0.316
Access to electricity	1.6	0.575
Use of stove	1.9	0.605
Access to health services	2.5	0.547
Access to food market	2.8	0.457
Access to mobile phone	2.5	0.663
Secured land tenure	1.7	0.783
Household size	2.6	0.526

Mean score <1.95 = low
Mean score 1.95-2.05 = moderate
Mean score >2.05 = high
Source: Computed from field survey data, 2013

4.2 Environmental and physical vulnerability

The result presented in table 2 showed some of the environmental/biophysical factors in the study area. The following factors contributed to high (i.e. MS > 2.05) sensitivity and exposure of households to environmental degradation in North-central Nigeria, bare farmland, sloppy farm land, firewood harvesting, biodiversity loss, and deforestation. As noted by Nhemachena *et al*. (2006), Deressa *et al*. (2008), Fussel (2009) and Gutu *et al*. (2013), indicators for environmental vulnerability included slope of the land, soil fertility, rainfall, temperature, frequency of hazards (drought, flooding, forest fire, disease outbreaks), and vegetation cover. In the overall vulnerability analysis model, these were variables for the measurement of sensitivity and exposure.

Table 2: Environmental and Bio-physical Factors showing Exposure/sensitivity of Household to Environmental Degradation

Variable	Mean Score	Standard deviation
Bare land	2.4	0.664
Sloppy land	2.1	0.704
Use firewood	2.9	0.332
Rainfall variability (low rainfall)	1.8	0.749
Temperature variability (high temperatures)	1.5	0.729
Biodiversity loss	2.3	0.624
Soil erosion	1.7	0.622
Desertification	1.3	0.650
Hailstorm	1.9	0.710
Frequent flooding	1.4	0.685
Deforestation	2.2	0.670
Soil moisture decrease	1.4	0.638
Run off (stream/pond water pollution)	1.8	0.642

Mean score <1.95 = low
Mean score 1.95-2.05 = moderate
Mean score >2.05 = high
Source: Computed from field survey data, 2013

4.3 Household level vulnerability to environmental degradation

In order to analyze the vulnerability level of each and every household in the study area, household level variables were used to measure the differences between the adaptive capacity and the exposure/sensitivity as in Madu (2012) and Gutu (2013). The primary variables used in this analysis were listed in tables 1 and 2. The factors in table 1 measured the adaptive capacity of the household, while the variables in table 2 measured the sensitivity and exposure to environmental degradation impacts. The matrix of data for the whole sample household was imported into SPSS version 20 to produce the principal component for each variable.

The result of the Principal Component Analysis showed ten components with Eigen value of 1 or greater accounting for 61.28% of the total variance. The first component had an Eigen value of 3.404 and accounted for 10.98%. The analysis also produced the component scores and as earlier stated only the component scores of the first component were used in weighting the variables for the construction of the vulnerability indices. The component scores were shown in table 3.

From the result in table 3, it was observed that the result of the principal component analysis for factor score was positively associated with majority of the indicators identified under adaptive capacity and negatively associated with majority of the indicators categorised under exposure and sensitivity. Therefore, in order to construct vulnerability indices, indicators of adaptive capacity, which were positively associated with the first principal component analysis, and indicators of sensitivity and exposure, which were negatively associated with the principal component analysis were taken. In total, 22 indicators were considered.

Table 3: Factor Loading of the First Principal Component for Vulnerability variables

Vulnerability variables	**Factor component**
Literacy level	-0.018
Non-farm employment	0.068
Ownership of radio	0.109
Ownership of livestock	0.052
Agrochemical supply	0.128
Fertilizer supply	-0.032
Improved seeds supply	0.234
Irrigation potential	0.133
Planting trees	0.783
Crop diversification	0.636
Access to large farm size	0.250
Access to farm credit	0.033
Access to electricity	-0.077
Use of stove	0.022
Access to health services	0.024
Access to food market	0.086
Access to mobile phone	-0.628
Secured land tenure	0.701
High household size	0.254
sloppy farm land	0.037
Use firewood	0.077
Rainfall variability	-0.004
Temperature variability	-0.012
Biodiversity loss	-0.247
Soil erosion	-0.296
Desertification	0.031
Hailstorm	-0.009
Frequent flooding	0.050
Deforestation	0.020
Soil moisture decrease	-0.074
Run off	-0.116

Source: Computed from field survey data, 2013

The difference between adaptive capacity (using social and economic variables) and exposure/sensitivity (using biophysical variables) was computed for individual household after multiplying each factor score by the variable for each household as shown by equation 1. Table 4 showed the result of vulnerability index of households in North Central Nigeria. The result showed that mean households' vulnerability index in North-central Nigeria (full sample) was 2.86.

Furthermore, a hierarchical cluster analysis was done in order to group households together at various levels of similarity on the basis of vulnerability. The vulnerability index was clustered at three major centres (Table 5). Cluster one with an average vulnerability index of 1.24. had 30.9% of households clustered around it. The households in this cluster although had positive indices were characterised by low values, hence, were considered to be highly vulnerable to environmental degradation. The second cluster with an average vulnerability index of 3.35 was the vulnerable group comprising majority of the households in the study area. The third cluster was made up of only 5.9 percent of respondents, with average index of 6.18. The households in this cluster by their high positive indices were the least vulnerable to environmental degradation in the study area. They were experiencing low vulnerability to environmental degradation probably because the rural households had high literacy rate, high household income and had more access to infrastructure and technology. Such households were also characterised by high degree of non-farm employment. According to Madu (2010) the diversification of economic activities and access to infrastructure and technology made households less reliant on agriculture which was more sensitive to climate and agents of degradation.

Individuals in a community often vary in terms of wealth, health status, access to credit, access to information and technology. These variations are responsible for the variations in vulnerability levels. The greater the level of dependence of a household on natural resources, such as farming, fishing, or forestry, the greater would be their vulnerability to environmental degradation because these resources depend on rainfall (and other climatic factors) which are projected to change under climate change. The level of dependence on natural resources varied from household to household depending on the contribution of natural resources to income. In this study area, most households directly depended on farming activities which were vulnerable to changes in the environment.

Table 4: Mean Vulnerability Index for Households

Index	Fullsample (n=356)
Adaptive capacity	5.8515
Sensitivity/exposure	-2.9886
Vulnerability index	2.8630

Source: computed from field survey data, 2013

Table 5: Percentage Distribution of Vulnerability Indices in the Study Area

Vulnerability	Percentage			
	Full sample (n=356)	Kogi State (n = 119)	Benue State (n = 117)	Plateau State (n=120)
Cluster 1 (1.24) =Highly Vulnerable	30.9	25.2	35.9	31.7
Cluster 2 (3.35)= Vulnerable	63.2	66.4	59.8	63.3
Cluster 3 (6.18) =Less Vulnerable	5.9	8.4	4.3	5.0
Total	100.0	100.0	100.0	100.0

Source: Computed from field survey data, 2013

4.4 Factors determining households' level of vulnerability to environmental degradation

The estimation of the determinants of household level of vulnerability to environmental degradation in the study area was analysed using STATA 9.0 software. The response variable which was level of vulnerability to environmental degradation for this study was defined by three ordered categories; highly vulnerable, vulnerable and less vulnerable, coded as 1, 2, and 3 respectively. The result of the parameter estimates (estimated coefficients along with z values and odds ratios) were presented in table 7.
From the ordered logistic regression done (Table 7), determinants of vulnerability levels were identified. Consequently, social, economic and natural resources capacities which include sex of a household head, number of household size, years of educational attainment, non-farm income, farm income, access to credit, crop diversity, land fragmentation, land tenure security and irrigation. Moreover, factors of sensitivity and exposure like land conflict, mining activity, soil and water conservation, cropping intensity and intensity of environmental hazards were used in the model.

This study used the parameter estimates and the odd ratios to interpret the behaviour of determinants of the level of households' vulnerability to environmental degradation. Evidence from the models as contained in table 7 showed that the set of significant explanatory variables varied across the categories in terms of the levels of significance and signs. The positive signs suggested that an increase in the variable is associated with higher category (in this case, less vulnerable (3)), while a negative and significant parameter meant that the independent variable was associated with lower category (in this case, highly vulnerable (1)).

Access to credit by households was found to have positive and statistically significant relationship with the level of vulnerability to environmental degradation at 1% level with the odds ratio of 6.51. This implied that farming households having more access to credit were 6.51 times more likely to be less vulnerable to environmental degradation in the study area. Credit availability during period of natural shocks leads farmers to access early maturing varieties, drought tolerant varieties and fertilizer. This result was in agreement with the findings of Gutu (2013) who found a positive relationship between access to credit and level of households' vulnerability to climate change in Ethiopia.

Land tenure security had a direct and significant relationship with households' level of vulnerability to environmental degradation in the study area suggesting that this variable favoured the higher category of the level of vulnerability to environmental degradation (i.e. less vulnerable category). This implied that farming households having more secured farm lands were 7.61 times more likely to be less vulnerable to environmental degradation in North-central Nigeria than those with less secured farm land. If households had secured land tenure for cultivation, they would probably had more access to credit schemes, and more practices of conservation measures (tree planting, construction of physical structures, fallow period) which would reduce the impact of environmental degradation.

Land fragmentation (0.298) had a positive and significant relationship with households' level of vulnerability to environmental degradation in North-central Nigeria at 1% level. The variable had an odds ratio of 1.35 suggesting that farm households with many number of plots were 1.35 times more likely to be less vulnerable to environmental degradation than those with fewer plots. The number of plots a farmer operates at different locations play vital role in reducing vulnerability. Heavy rainfall, diseases, high temperature and other environmental degradation induced hazards do not equally harm everywhere in a region, hence the households with different farm plots get better potential to be resilient and survive. In particular, when households are oriented toward diversification of agricultural activities, the availability of plots in different places with different types of soils that experience different weather conditions is important. Accordingly, the result showed that those households with more number of farm plots were less vulnerable as compared to those with single or fewer plots. Gutu (2013) also found a positive relationship between number of plots and vulnerability to climate change in Ethiopia.

Intensity of environmental hazard was found to have an inverse (-1.33) and statistically significant relationship with households' level of vulnerability to environmental degradation in Northcentral Nigeria at 1% level. The odds ratio for this variable was found to be 0.26 implying that households with higher intensity of environmental hazards were 0.26 time more likely to be highly vulnerable to environmental degradation in the study area than those experiencing less intensity of environmental hazards. Leichenko and O'Brien (2008) noted that hazards and extreme events themselves could alter the context for economic and social development, which could in turn reduce the capacity to respond to future extremes. Cumulative effects of events of environmental hazards not only damage or destroy material assets and human lives, but might also influence the capacity and resilience of individuals to recover their sense of well-being.

Table 7: Parameter Estimates of the Ordered Logit Regression for Factors influencing Households' Vulnerability to Environmental Degradation

Independent variables	Coefficients	Odds Ratio
Sex	0.45 (1.22)	1.56
Household size	0.04 (0.97)	1.04
Education	0.01 (0.23)	1.01
Off-farm employment	-4.4e-7 (-1.17)	1.00
Farm income	1.3e-7 (1.04)	1.00
Access to credit	1.87 (3.68)*	6.51
Crop diversification	0.16 (1.41)	1.17
Land Fragmentation	0.30 (3.39)*	1.35
Land tenure security	2.03 (6.37)*	7.61
Irrigation use	0.62 (1.40)	1.86
Land conflict	-0.19 (-0.54)	0.82
Mining activity	-0.16 (-0.46)	0.85
Soil/water conservation	-0.18 (-0.52)	0.84
Cropping intensity index	-0.08 (-0.10)	0.92
Intensity of environmental hazards	-1.33 (-3.13)*	0.26
Cut1	-0.91	
Cut2	4.24	
Number of observations	356	
wald chi^2 (15)	128.07	
Prob> chi^2	0.00	
Pseudo R^2	0.27	
Loglikelihood	-212.12	

Note: *, ** denotes z-test significant at 1% and 5% levels respectively
Values in parenthesis represent z-statistic
Source: Computed from field survey data, 2013

5. Conclusion and Recommendations

Households in the study area were within the vulnerable level of vulnerability to environmental degradation. Households living in the same geographic location and facing the same type of environmental change and anthropogenic induced risks can differ in their level of vulnerability. Households with access to credit, households with diversified farmland and households with secured land tenure have lower levels of vulnerability as compared to others.

Thus, the following recommendations were made:

1. Government should encourage farming households in North Central Nigeria to obtain loan from banks and micro-credit institutions by regulating interest rate on loans for farmers as well as removing the stringent conditions attached to loans. This will increase farmers' adaptive capacity to changes in the environment;
2. Also, Government should formulate and implement economically viable land reform policy to ensure that the farmers feel emotional attachment to the land they cultivate. Such policies should focus on establishing a more effective and efficient land title registration system that would remove the bottlenecks in the land market and enhance individual tenure security; and
3. Farmers, should diversify farm land to different locations as the environmental degradation induced hazards do not equally harm everywhere in a region.

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