ASSESSMENT OF FARM HOUSEHOLDS' VULNERABILITY TO CLIMATE CHANGE IN THE NIGER DELTA REGION OF NIGERIA

Oyekale, A.S.

Department of Agricultural Economics,
University of Ibadan, Nigeria.
asoyekale@yahoo.com

ABSTRACT

Climate change is currently an emerging problem in Nigeria. The Niger Delta region presents some vulnerability due to activities of some oil companies. This study provides an assessment of farm households' perception of climate change and vulnerability in the Niger Delta region of Nigeria. The data were obtained form 381 households that were randomly selected from 3 States in the Niger Delta region of Nigeria. The descriptive and Probit regression analytical methods were used. Results showed that only 20.21 percent of the farmers claimed to be adversely affected by climate change in the form of increased temperature, increased rainfall, delayed rainfall and deforestation. Farming households considered themselves vulnerable to climate change due to the nature of their primary occupation and lack of the required capital and skill for income diversification. In order to cope, majority of the respondents have resorted into weather monitoring, crop rotation and mixed farming. Also, results show that vulnerability tends to increase among those farmers that have land kept under fallowing, more livestock land, land problem, land conflict and recently sold land. It was recommended that efforts to sensitize the farmers on climate change and training on appropriate means of weather monitoring are required to reduce the negative effects of climate change, among others.

Keywords: Climate-change - vulnerability - perception, Niger Delta

INTRODUCTION

Emerging problem of climate variability, with its associated impact on farming activities now poses some serious concerns to food policy makers. In the Niger Delta region of Nigeria, activities of oil companies have subjected the region to higher vulnerability to climate change. The linkage between climatic factors and household welfare can be best understood by noting that such fluctuations ultimately translate into some form of income shocks. These risks and uncertainties cannot be overlooked when they result in consumption fluctuations (Dercon 1996). This is most likely to be the case in rural areas, where there are no functioning credit and insurance institutions to safeguard and protect vulnerable households.

Moreover, while rainfall variability is not the only exogenous factor affecting farm output and income, it is the factor that contributes to income variability that is most likely to influence household

welfare, especially in a predominantly agrarian setting. Changes in climate will interact with other forms of stress associated with agricultural production and affect crop yields and productivity in different ways, depending on the types of agricultural practices and systems in place (Watson *et al.* 1997). The main direct effects will be through changes in temperature, precipitation, length of growing season, and timing of extreme or critical threshold events relative to crop development.

Blaikie (1994) described vulnerability as the characteristics of a person or a group to anticipate, cope, resist and recover from the impact of a natural hazard. Chambers (1989) also noted that vulnerability represents the ability or not to modify the impacts of disaster and the means to cushion risks. Vulnerability manifests itself in poorer countries due to a lack of resources and capacity to respond. At the community level class, caste, gender, ethnicity, age, level of education and access to resources all determine vulnerability (Blaikie 1994; Warrick and Rahman 1992; Adger and Kelly 2001).

In some other context, risk and vulnerability to environmental change have generally considered resources such as land or economic assets as the object of analysis, while some climatic factors act as subject of risk (Downing and Patwadhan 2000). Also, some disciplines have attempted to examine the various aspects of social vulnerability, often in the context of vulnerability to famine (Chambers 1989; Swift 1989). In the neo-classical economics, risk aversion absolutely deviates behaviour of economic agents away from profit or welfare maximization. Both potential threat of extreme climatic events and coping strategies have been postulated to result in risk minimization strategies, which have some negative and significant welfare implications.

In some previous studies, Blaikie *et al.* (1994) highlighted some social factors that are involved in collective vulnerability as gender and ethnic factor. Also, Adger and Kelly (1998) highlighted the role of credit in recovery from stress and disruption of livelihoods. Adger (1996) justified the focus on absolute poverty as variable for climate change vulnerability because it exacerbates vulnerability through the mechanisms of lack of resources for handling external shocks, correlation of poverty to disempowerment, lack of access to resources when shocks occur, and the reliance of the poor on communal and other resources which may be more physically vulnerable to external shocks. In addition, Bailey and Pomeroy (1996) emphasized the need for diversified means of livelihoods in order to cope with adverse climatic shocks.

Selvaraju *et al.* (2006) analyzed the livelihood adaptation to climate change in a drought-prone area of Bangladesh. The findings reveal that the forms of climate change observed were change in the seasonal cycle and rainfall pattern, frequent droughts, increased incidence of pest and disease and the average temperature has increased in the summer, with shortened winter. Also, Nhemachena (2007) used a multivariate discrete choice model to identify the determinants of farm-level adaptation strategies against climate change in Southern Africa. Results confirm that access to credit and extension and awareness of climate change are some of the important determinants of farm-level adaptation.

The objective of this study is to assess the level of perception of rural households about climatic change and determine the factors that predispose the households to be negatively affected. The study is justified by Wisner (1978), who asserted that the systematic comparison of individuals and societal response to disaster in social formations dominated by different modes of production is a potentially rich scientific undertaking, which has been largely neglected. Within the framework of social vulnerability analysis, policy makers will be able to identify the group of people that are likely to be most affected by adverse climatic factors, and devise ways to assist them. Also, a better understanding of farmer's perceptions of the long-term climatic changes, current adaptation measures and their determinants will be important to inform policy for future successful adaptation of the agricultural sector (Nhemachena 2007). In the remaining parts of the paper, we have presented the materials and methods of data analysis, results and findings and conclusions in the specified order.

MATERIALS AND METHODS

The data for this study were derived from household survey that was conducted in three States in the Niger Delta region of Nigeria. The multi-stage random sampling procedure was used. At the first stage, three States (Abia, Akwa Ibom and Rivers) were randomly selected out of the States that form the Niger Delta region of Nigeria. The second stage involved random selection of 3 Local Government Areas (LGAs) each from the selected States. At the 3rd stage, 50 questionnaires were administered to randomly selected farmers in each of the local government areas, making 150 for each State and 450 for all the States. Due to insufficient information and non-return, the study only used 381 respondents (100 from Abia, 146 from Akwa Ibom and 135 from Rivers). The data collected touched issues of land ownership, land use, land management, farm input and output and climate change perception and vulnerability.

Data analysis

We used descriptive analytical methods like frequencies, average, standard deviation and coefficient of variation ([standard deviation/mean]*100) to describe the data. The determinants of vulnerability were analyzed by estimating a Probit regression model, which can be stated as:

$$P_{ij} = \text{Prob}(Y_{ij} = 1) = \Phi(-\alpha' Z) = \int_{-\infty}^{\alpha' Z} \frac{1}{(2\prod)^{1/2}} e^{\left(\frac{-t^2}{2}\right)} dt$$

In this case, t is a standardized normal variable with mean of 0 and variance of 1. The first stage of the analysis was to remove collinear variables by examining the variance inflating factors of the variables when run with Ordinary Least Square regression. Therefore, the comprehensive list of the variables, that are contained in table 1 was reduced to that which finally entered the model as contained in table 3. Y_{ij} is the binary dependent variables with value 1 if affected by climate change and 0 otherwise. The independent variables that were included in the final analysis are married marital status (yes =1, 0 otherwise), household size, fallowing land (hectares), involved in fishing (yes =1, 0 otherwise), livestock land (hectare), problem with getting land (yes =1, 0 otherwise), land conflict (yes =1, 0 otherwise), sold land (yes =1, 0

otherwise), bush burning (yes =1, 0 otherwise), mulching (yes =1, 0 otherwise), crop rotation (yes =1, 0 otherwise), organic manure (yes =1, 0 otherwise), fertilizer application (yes =1, 0 otherwise), cover cropping (yes =1, 0 otherwise), oil spillage (yes =1, 0 otherwise), nearest market distance (km), amount of loan obtained (₦)

Because Limdep 7.0 Software was used, the marginal contributions of the independent variables could be estimated. This, according to Arulampalam (1998), can be stated as:

$$\frac{\partial[\Pr ob(Y_{ij}=1/Z_i)]}{\partial Z_i} = \Phi(Z_i'\alpha)\alpha_{ij}$$

Results and discussion

Socio-economic profile of the farmers

Table 1 presents the socio-economic characteristics of the farmers. The proportion of house heads that were male is 61 percent. House heads that were married constitute 89 percent, with the remaining either being single (9 percent) or divorcee (2 percent). These values are comparable to the results of Oyekale *et al.* (2006) using the 2004 national data. Average age of the house heads is approximately 50 years, with standard deviation of 15.03 years. This gives variability index of 30.11 percent and comparable to 48 years computed for the nation in 2004. Average farming experience is approximately 19 years, with 72.81 percent variability. Average household size is 6 members, with variability of 45.56 percent. This also comparable to average of 6 members computed for the nation using the 2004 national data.

An average of 1.48 persons was contributing to financing the rural households. This may be a reflection of a rural setting where incomes are largely derived from the farming activities of the husbands and wives. About 77 percent of the house heads could read and write. The average distance of the nearest market is 6.69 km, with high variability index of 169.41 percent. About 77 percent of these markets were operated on a daily basis. Also, only 22 percent of the house heads belong to cooperative societies. Average amount of loans obtained from different sources is about ₦15,000, with very high variability index of 792.57 percent.

The second segment of table 1 contains information about land ownership and management practices. It shows that average number of hectares being kept in fallow by the farmers is 1.10 hectare, while 1.29 hectare is on cash crops, 3.09 hectares on food crops, and 0.36 hectare on livestock rearing. About 28 percent of the farmers indicated to have one form of problem or another with getting land, while 20 percent already experienced land conflicts. Only 10 percent recently sold part of the land owned, and 84 percent indicated that fertile lands are available for sale in their communities.

The cultural practices being used by the farmers reveal that 87 percent get involved in bush burning. This may be as a result of the study area being humid region, where rainfall is high and intensity of weed growth is high. Bush burning is able to suppress the intensity of weed growth by destroying some seeds of the weeds. Only 12 percent use tractors for land preparation, while 14 percent were using crop residues and plants to mulch their farms. Crop rotation was used by 16

percent and 46 percent used organic manure of plant or animal source. Only 67 percent applied fertilizer to their crops, while 16 percent were planting cover crops to prevent erosion to enhance soil productivity. Only 5 percent indicated to have oil spilled on their farms.

Climate change and adaptation strategies

Table 2 presents the results of analysis of households' perception of climate change in the Niger Delta region of Nigeria. It shows that 7.35 percent of the households noticed hot weather as a form of changes observed in climate. Also, 4.46 percent indicated increased rain that often results into flooding and increased erosion. Delay in rainfall was observed by 5.51 percent, while deforestation was indicated by 3.67 percent.

The perceived causes of changes in climate as reported by the households are prolonged dry season (5.51 percent), depletion of ozone layer (3.94 percent), increased temperature (3.15 percent), fall in temperature (1.31 percent) and deforestation (2.10 percent). Also, the main factors that could make the farm households vulnerable to climate change were reported. These include involvement in farming as a major occupation (9.71 percent), lack of financial power for income diversification (17.06 percent), lack of skill in other ventures that may not be affected by climate change (7.61 percent) and other reasons (inability to clearly predict climate, lack of institutional supports to address the growing problems) (5.51 percent). Part of the main strategies to cope include planting of cover crops to safeguard crops from inadequate rainfall (0.79 percent), adoption of mixed cropping to ensure that failure of one crop is not failure of the whole farm (4.20 percent), monitoring of changes in some weather variables (9.45 percent), irrigation (1.05 percent), crop rotation (1.84 percent) and planting of sole crop (mono-cropping) (1.57 percent).

Determinants of vulnerability to climate change

Table 3 shows the results of the Probit regression. The dependent variable is a self-reported binary variable indicating whether an household is affected by some form of changes in climate or not. Precisely, 20.21 percent of the respondents indicated to be affected by climate change. Table 3 shows that the Chi Square value of the estimated equation is statistically significant ($p<0.01$). This implies that the model produced a good fit for the data. Out of the included variables, number hectares fallowing, livestock land area, problem with getting fertile land to purchase, land conflict, sold land, bush burning, use of organic manure, planting of cover crops and spillage of oil on farm are statistically significant ($p<0.10$). Being affected by climate change significantly increased with the number of land being kept under fallowing ($p<0.01$). Precisely, under the traditional shifting cultivation that is still the dominant land use system in the area, lands are subjected to fallowing when their level of fertility has declined. Therefore, as the number of degraded plots of land that a farmer owns increases, probability of being affected by climate change significantly increases. This goes in line with the findings of some case studies reported by Leary and Kulkarni (2007), which showed that scarce and degraded natural resources contribute to vulnerability and detract farm households from the capacity to adapt to climate change. Also, this variable has a marginal

coefficient of 0.3025, implying that increasing fallowing land by 10 percent will increase the probability of being affected by climate change by 3.025 percent.

Also, the parameter of livestock land area variable is statistically significant ($p<0.01$), and positively signed. This implies that increasing the land areas devoted to livestock farming increases the probability of being affected by climate change. Dabi *et al* (2007) submitted that in the event of climate change, the lands from which farmer derive their livelihoods may be highly erodable and degraded. Livestock farmers are always hard hit due to scarcity of good pasture. Also, some forms of changes in climate can have adverse effects on livestock production due to increased incidence of pests and diseases. The marginal coefficient shows that increasing the livestock land areas by 10 percent will increase the probability of being affected by climate change by 0.443 percent.

Those farmers that indicated that they have some problems in obtaining fertile land from their immediate communities have significantly higher probability ($p<0.01$) of being affected by climate change. This may result from inability get enough land for farming and diversify production activities. Leary and Kulkarni (2007) submitted that in some instances, treatment of a resource as an open access commons has contributed to its degradation and created disincentives for adaptations to protect the resource. The marginal coefficient of the variable reveals that if the number of people without access to fertile land increases by 10 percent, the probability of being affected by climate change will increase by 1.497 percent.

Also, those farmers that indicated to have recently sold farmland have significantly higher probability of being affected by climate change ($p<0.10$). Hick (1993) observed that households may result into distressed sales of available land and livestock in the event of climate problem.

Those farmers that indicated to be using bush burning method of land preparation have significantly lower probability ($p<0.05$) of being affected by climate change. Some form of climate change that has to do with cultural practice is instability of rainfall. In some instances, abrupt stoppage of rain after brief commencement subject farmers to double labour cost. However, bush burning reduces the intensity of weed growth, thereby reducing labour cost in case of inconsistent rainfall. This finding emphasizes how the coping mechanism of farmers against climate problem can be further hazardous to environmental safety. This is because Watson *et al.* (1997) submitted that human activities (primarily the burning of fossil fuels and changes in land use and land cover) are increasing the atmospheric concentrations of greenhouse gases, which alter radiative balances and tend to warm the atmosphere. The marginal coefficient reveals that increasing the proportion of the people that use bush burning by 10 percent will reduce the probability of being affected by climate change by 1.282 percent.

The farmers that were using organic manure have significantly higher probability of being affected by climate change. This is the case because availability of organic manures may be influenced by fluctuations in climatic factors that negatively affect livestock and crop production. The marginal coefficient

shows that if the proportion of the people using cover crops increases by 10 percent, the probability of being affected by climate change will increase by 1.136 percent.

Also, those farmers that were planting cover crops have significantly higher probability of being affected by climate change ($p<0.01$). This may be due to possession of less resistance to environmental stress by many cover crops. The most popular cover crop in the Niger Delta are melon, pumpkin, cowpea etc. The marginal coefficients for this variable reveals that increasing the proportion of people that were planting cover crops by 10 percent will increase the probability of being affected by climate change by 1.8 percent.

Finally, the farmers that indicated to be affected with oil spillage have significantly lower probability of being affected by climate change ($p<0.10$). This is expected because a farmer whose cropland is affected by climate change may not be so involved in agricultural production. Similarly, increasing the proportion of people that are affected by climate change by 10 percent will reduce the probability of being affected by climate change by 1.863 percent.

RECOMMENDATIONS

Climate change as an emerging problem in many developing countries requires quick attention in order to averse the possibility of displacing human race from the earth. The short term implications of climate change are to be greatly felt by farmers, majority of which depend on one form of weather variable or the other for productivity. In Nigeria, available studies on climate change impact on households' welfare are very few, while the issue of vulnerability factors is largely neglected. This study therefore attempted to fill a major research gap by providing an assessment of the factors subjecting households to vulnerability to climate change. The following findings will be useful for policy interventions:

The majority of the farmers reported increased temperature, increased rainfall, delayed rainfall and deforestation as the observed form of climatic problem in the Niger Delta. These issues require attention and detailed research on the impact of gas flaring and other environmental hazards that some oil companies that are located in the region constitute is required. The gravity of climatic impact that gas flaring can have can be best understood if we realize that bush burning activities alone have been traced to ozone layer depletion (Watson *et al*. 1997). Also, regulatory measures to control depletion of some common forest in the region should be put in place. This is due to the hazardous effect that deforestation can have on the climate.

The study showed that farming households consider themselves vulnerable to climate change due to the nature of their primary occupation and lack of required capital and skill for income diversification. It is therefore recommended that in the event of adverse climatic situation, farmers should be appropriately protected by some insurance institutions. Also, activities of the some rural development and poverty reduction agencies in Nigeria should target skill development for involvement in secondary occupations by these farmers.

It was noted that only 20.21 percent of the farmers claimed to be currently adversely affected by climate change problem. The

need to increase awareness and sensitize rural communities cannot be over-emphasized. This becomes important due to the some technicalities required for adequately monitoring climatic problems. Also, majority of the respondents have resorted into weather monitoring as means of reducing the negative consequences of climate change. The farmers should be trained and empowered in order to be able to effectively monitor the weather and report noticeable changes to appropriate institutions.

Also, for appropriate coping, irrigation farming should be promoted. Only 1.05 percent of the farmers are using irrigation as a coping mechanism. This underscores the need for government's support to facilitate irrigation farming in Nigeria. Extension of the on-going Fadama program to more rural communities will assist in reducing the impact of irregular or insufficient rainfall. Issues that are related to land use in the Niger Delta must be addressed. This is because the results show that vulnerability tends to increase among those farmers that have land kept under fallowing, more livestock land, land problem, land conflict and recently sold land. These findings underscore the fact that climate change effect will be largely felt among households with some land problems. Skill development to ensure less dependent on degraded land and development of appropriate soil management practices are required.

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REFERENCES

Adger, W. and Kelly, P., 2001. *Living with environmental change: social vulnerability, adaptation and resilience in Vietnam,* Routledge, London.

Adger, W.N. and Kelly, P.M., 1998. *Social Vulnerability to Climate Change and the Architecture of Entitlements*. Paper presented at IPCC Workshop on Adaptation to Climatic Variability and Change, San José, Costa Rica, 29 March - 1 April 1998.

Adger, W.N., 1996. *An assessment of vulnerability to climate change in Xuan Thuy,Vietnam*. unpublished paper, CSERGE, University of East Anglia and University College London.

Arulampalam, W., 1998. A note on estimated coefficients in Random Effect Probit Models JEL classification C13, C23. Unpublished Paper.

Bailey, C. and Pomeroy, C., 1996., Resource dependency and development options in coastal South East Asia. *Society and Natural Resources* 9, 191-199.

Blaikie, P., 1994. *At risk: natural hazards, people's vulnerability, and disasters* Routledge, London.

Blaikie, P., Cannon, T., Davies, I. and Wisner, B., 1994. *At Risk – Natural Hazards, People's Vulnerability, and Disasters*, London: Routledge.

Chambers, R., 1989. Vulnerability, coping and policy. *IDS Bulletin* 20 (2), 1-7.

Dabi, D.D., Adepetu, A.O., Ihemegbulem, A.A.V., and Agaye, J., 2007. 'Determinants of adaptive strategies and opportunities of rural households in northern Nigeria.' In N. Leary, J. Adejuwon, V. Barros, I. Burton and R. Lasco (eds), *Adaptation to Climate Change*. Earthscan, London, UK (forthcoming).

Dercon, S., 1996. "Risk, crop choice, and savings: Evidence from Tanzania". *Economic Development and Cultural Change*, 44(3): 485–513.

Downing, T.E. and Patwadhan, A., 2000. Assessing Vulnerability for Climate Adaptation.

Hicks, D., 1993. An evaluation of the Zimbabwe drought relief programme 1992/93: the roles of household level response and decentralized decision-making, Harare: World Food Programme.

IPCC (Intergovernmental Panel on Climate Change) 2001. Working Group II, *Climate Change 2001: Impacts, Adaptation and Vulnerability, contribution of Working Group II to the third assessment report of the IPCC*, Cambridge University Press, New York.

Leary, N. and Kulkarni, J., 2007. Climate Change Vulnerability and Adaptation in Developing Country Regions Draft Final Report of the AIACC Project A Global Environment Facility Enabling Activity in the Climate Change Focal Area Project No. GFL-2328-2724-4330 April 2007.

Nhemachena, C., 2007. Micro-Level Analysis of Farmers' Adaptation to Climate Change in Southern Africa. IFPRI Discussion Paper 00714.

Oyekale, A.S., Adetola, I.A., Tolulope, O.O., 2006. Measurement and Sources of Income Inequality among Rural and Urban Households in Nigeria. PMMA Working paper 2006-20.

Swift, J., 1989. Why are rural people vulnerable to famine? *IDS Bulletin* 20 (2), 8-15. Selvaraju, R., Subbiah, A.R. Baas, S and Juergens. I. 2006. Livelihood adaptation to climate variability and change in drought-prone areas of Bangladesh, Food and Agriculture Organization (FAO).

Warrick, R. and Rahman, R., 1992. "Future Sea Level Rise: Environmental and Socio-Political Consideration" in Mintzer & Stockholm Environment Institute, *Confronting climate change: risks, implications and responses*, Cambridge University Press, Cambridge.

Watson, R.T., Zinyowera, M.C., Moss, R.H. and. Dokken, D.J., 1997. The regional impacts of climate change: an assessment of vulnerability. A special Report of IPCC Working Group II Published for the Intergovernmental Panel on Climate Change.

Wisner, B., 1978. An appeal for a significantly comparative method in disaster research. *Disasters* 2, 80-82.

Table 1: Socio-economic characteristics of the respondents

Socio-economic characteristics	Mean	Standard Deviation	Coefficient of variation
House head age (years)	49.92	15.03	30.11
Sex (male =1, 0 otherwise)	0.61	-	-
Farming experience (years)	19.02	13.85	72.81
Married marital status (yes =1, 0 otherwise)	0.89	-	-
Household size	6.07	2.77	45.56
Number financing home	1.48	1.35	91.29
Head can read or write (yes =1, 0 otherwise)	0.77	-	-
Nearest market distance (km)	6.69	11.33	169.41
Daily market operation (yes =1, 0 otherwise)	0.58	-	-
Membership of cooperative (yes =1, 0 otherwise)	0.22	-	-
Amount of loan obtained (₦)	15001.31	118895.21	792.57
Land ownership and management practices			
Fallowing land (hectares)	1.10	1.92	175.20
Cash crop (hectares)	1.29	3.86	299.37
Food crop (hectares)	3.09	4.55	147.54
Livestock land (hectare)	0.36	1.27	356.07
Vegetable land (hectares)	0.67	1.43	214.08
Problem with getting land (yes =1, 0 otherwise)	0.28	-	-
Land conflict (yes =1, 0 otherwise)	0.20	-	-
Sold land (yes =1, 0 otherwise)	0.10	-	-
Fertile land available to buy (yes =1, 0 otherwise)	0.84	-	-
Bush burning (yes =1, 0 otherwise)	0.87	-	-
Tractor use (yes =1, 0 otherwise)	0.12	-	-
Mulching (yes =1, 0 otherwise)	0.14	-	-
Crop rotation (yes =1, 0 otherwise)	0.16	-	-
Organic manure (yes =1, 0 otherwise)	0.46	-	-
Fertilizer application (yes =1, 0 otherwise)	0.67	-	-
Cover cropping (yes =1, 0 otherwise)	0.16	-	-
Oil spillage (yes =1, 0 otherwise)	0.05	-	-

Table 2: Perceived forms of climate change, causes, vulnerability and coping strategies

Description of variables	Frequency	Percentage
Form of climate change		
Hot weather	28	7.35
Increased rain	17	4.46
Delayed rain	21	5.51
Deforestation	14	3.67
Ozone depletion	2	0.52
Perceived causes		
Prolonged dry season	21	5.51
Ozone depletion	15	3.94
Increased temperature	12	3.15
Fall in temperature	5	1.31
Deforestation	8	2.10
Vulnerability factors		
Farming as major occupation	37	9.71
No money for diversification	65	17.06
Lack of skill for other enterprises	29	7.61
Other reasons	21	5.51
Coping strategies		
Cover crop	3	0.79
Mixed cropping	16	4.20
Weather monitoring	36	9.45
Crop rotation	7	1.84
Mono-cropping	6	1.57
Irrigation	4	1.05

Table 3: Probit regression results of the determinants of vulnerability to climate change

Variables	Estimated Coefficient	t-statistics	Marginal coefficient	t-statistics
Constant	-1.8237***	-4.6240	-0.4187***	-4.8490
Marital status	0.2657	0.8470	0.0610	0.8450
Household size	0.0298	0.9170	0.0068	0.9230
Fallowing land	0.1417***	2.5950	0.3025***	2.5790
Fishing	-0.0429	-0.4170	-0.0099	-0.4170
Livestock land	0.1928**	2.2190	0.0443**	2.1650
Land problem	0.6518***	3.3120	0.1497***	3.3050
Land conflict	0.4171**	1.9950	0.0958**	2.0020
Sold land	0.4985*	1.8610	0.1144*	1.8410
Bush burning	-0.5585**	-2.2930	-0.1282**	-2.2870
Organic manure	0.4948***	2.6230	0.1136***	2.6680
Mulching	-0.0825	-0.3320	-0.0189	-0.3310
Fertilizer use	-0.1564	-0.7920	-0.0359	-0.7930
Cover crops	0.7841***	3.5200	0.1800***	3.4830
Oil spillage	-0.8113*	-1.7950	-0.1863*	-1.7770
Market distance	0.0098	1.2860	0.0022	1.2820
Loan	.325E-05	1.5060	.756E-06	1.4480
Log likelihood function	-133.4379			
Restricted log likelihood	-191.7571			
Chi-squared	116.6384***			

Note: *** - statistical significance at 1 percent, ** - statistical significance at 5 percent, * - statistical significance at 10 percent.