Households' vulnerability to Climate Change: Insights from a farming community in Aguie district of Niger

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Abstract

There is evidence that the effects of climate change constitute a serious problem for the development of sub-Sahara African. Developing countries are more vulnerable to extreme climate change due to their low adaptive capacity. The objective of this research is to analyze household vulnerability to climate change in Aguie district of Niger. Principal components analysis was used to construct the different index. Results of farmers' perception of factors determining vulnerability outlined food expenditure (2.58), ceremonies (2.13), farming (1.34), and livestock (1.00) as the key factors. The vulnerability level of the study area is 0.075, However, farmers (0.093) are found to be the most vulnerable and pastoralists (-0.328) the least vulnerable. The study also shows that education rate, association membership, strategies index, soil fertility, food coverage, income and agriculture experience family size, income, association membership, strategies index, and farm tree coverage (a proxy of soil fertility) have a significant effect on vulnerability. As far as policy implication, specific attention should be given to small-scale farmers to reducing their sensitivity to climate change through soil fertility management.

Keywords: Adaptation, Drought, Exposure, Sensitivity, Resilience

1. Introduction

Vulnerability concept is widely used in different research traditions, but there is no consensus on its meaning (Adger 2006; Gallopín 2006; Smit and Wandel 2006). It has been variously defined by the literature regarding the specific research area. Whereas some authors described vulnerability as: "the capacity to be wounded" Dow (1992); others related vulnerability to a lack of entitlements to things like food security, sustainable livelihoods, social structures, due to natural hazards and events, such as floods, droughts, famines or others nuisance (Janssen and Ostrom 2006; Sen 1981). In the context of climate change, IPCC (2001) defined vulnerability as "the degree, to which a system is likely or unable to cope with the adverse effects of climate change, including climate change and extreme weather conditions"(Bruce et al. 1996; McCarthy 2001). However, from most of the definitions, the common theme is the inability of the system to meet a need for better living conditions. To better characterize the concept of vulnerability, the social-ecologic dimension was integrated This is in concordance with Lin and Chang (2013) who argued that developing country 's vulnerability from natural hazards research needs to be considered more urgently and in combination with social vulnerability.

Previous assessments revealed that the African continent is particularly vulnerable to climate change because of the widespread poverty, frequent droughts, mismanagement of land, and higher dependence on rainfed agriculture (Hulme 1996; Watson et al. 1998). In sub-Sahara Africa, the effects of extreme climate change constitute a main drawback for the development of the country. Smith (2001) reported that there is high confidence that developing countries will be more vulnerable to climate change impacts than developed countries and there is medium confidence that climate change impacts would intensify income inequalities between and within countries (Smith et al. 2001).

In Niger, climate change is at the root of several disruptions to biophysical processes and the most vulnerable sectors selected under National Action Program for Adaptation (Karfakis et al.) are agriculture, livestock, forestry, water resources, Wildlife, fisheries, health, and wetlands (Project and FEM 2005). The impacts of these disturbances on these sectors lead to permanent food insecurity, jeopardizing the lives of many vulnerable households. According to WFP (2017), more than 1.5 million of people are already affected by food insecurity and about 1.5 other million are expected to be chronically food insecure (WFP 2017). The fragility of Niger's ecosystems makes it very vulnerable to climate change and the difficult socio-economic context weakens adaptability to build the strong resilience of rural households. Furthermore, government financial and logistic capacity is very limited to confront such constraints. For that reason, cooperation between private, public institutions and farmers is viewed as a solution to reduce rural households' vulnerability through adaptation activities. Under this cooperation, many innovative adapting strategies have been explored by farmers to enhance adaptive capacity and to reduce vulnerability to climate change. However, the outcomes of adaptation strategies strongly depend on how farmers perceive factors affecting their vulnerability (Adger W N et al. 2009; Grothmann and Patt 2005a). Therefore, knowing farmers perception of factors affect their vulnerability and the extent of community vulnerability are very important to addressing the cause of vulnerability, although to understanding the local exposure to climate change and risks, the farmers' capacity to cope with climate change impacts as well as for policymakers and others similar actors that target the exposed households to make decisions concerning vulnerability reduction (Brooks et al. 2005; O'Brien et al. 2004). Therefore, this study is designed to assess household vulnerability to climate change and determining factors. Specifically, the research attempts to:

a. Analyze farmers' perception of vulnerability determinants;

b. Assess households' level of vulnerability;

c. Determine the most influential factors affecting households' vulnerability.

2. Methodology

2.1 Study area description

The study was undertaken in two purposely selected villages located in part of the dry land of Niger, namely: Guidan Dan May Gari and Guidan Kodaou located at 13°51′21″N 08°18′12″E respectively in Aguie's district of Maradi region, southeastern of Niger (Fig. 1). The department of Aguie covers an area of about 1794 km² and hosts a population of 245, 996 people (INS 2014). The ethnic distribution of the population of this region is predominantly Hausa (83%), while Fulani and Buzaye represent 10 % and 6%, respectively. Maradi is one of the regions severely impacted and much broadcasted for a local food crisis of 2005 and 2006 (Haglund et al. 2011). The population density of Aguie's district is about 137 inhabitants per km²(Aissétou 2009; INS 2014). The main economic activities of the local community are mainly herded size grazing and given limited pasture especially in during dry spells where there is often strong competition for pasture and water resources (Andres and Lebailly 2013).

The climate is Sahelian, characterized by a dry and rainy season. The rainy season usually started around the period from May-to-June and ended around August-September. According to Niger meteorological data, Aguie district recorded rainfall level on average is 522 mm/year, the average minimum temperature is 21.6°C and the average of maximum temperature is 35.8°C (INS 2014). However, there is a wide spatial and temporal variation in the received annual rainfall amounts. Many studies for future trends simulation on climate change in Niger projected that by 2025 average monthly precipitation will increase slightly and average monthly temperature will increase very slightly compared to the normal period 1961-1990 (UNDP 2006).

The region of Maradi to which Aguie district belonged has been facing acute food shortage partly because of the hardest lifestyle, and the adverse climatic conditions making agriculture more difficult. In addition to the adverse conditions, there are also issues of land tenure and conflicts, and consequently environmental degradation of common use resources(Aissétou 2009). All these factors increase the vulnerability of the people in this community (Kanta 2007). This situation motivated several institutions to intervene in this area through awareness creation, training, and farmers' capacity strengthening: these include PPILDA project, Save the Children, CAIDAV, and Lahia Project.

2.2 Sampling technique and data collection

A triangulated combination of both qualitative and quantitative research methods which has been recognized as a revolution in the history of methodology (Johnson et al. 2007) was used in this study. The approach ensures an adequate comprehension, understanding, and interpretation of the phenomenon under investigation, which in this case is farmers' socio-environmental vulnerability and strategies for vulnerability mitigation. This method is based on statistical analysis of detailed records on households' characteristics through the use of interviews, questionnaires, observations, and field mapping.

To select the participants, a multistage sampling approach was employed where the number of households to be surveyed was identified from records at the department archives of Aguie district in Niger. At the second stage, two villages were purposely selected based on data obtained from the district. The identified villages were; Guidan Dan May Gari and Guidan Kodaou. Guidan Dan May Gari village had 226 households and Guidan Kodaou village had 220 households. Thus, on average in all villages, there were 446 households. Farm household is the unit of analysis. The respondent households in each of the selected villages were randomly selected based on the household lists provided by the department of local government. From each household, the household head was interviewed depending their availability and willingness. A reconnaissance visit was made to verify the correctness of the random selection criteria. During the visit, interviews were held to obtain relative information about a vulnerability in the context of the study area, particularly the farmers' perception of vulnerability and its causes, the measurement of vulnerability, and the different strategies employed by households to reduce their socio-environmental vulnerability. The collected information served as a basis for the construction of the semi-structured questionnaire. In the fifth and last step, 80 household heads were randomly selected from each village.

A total of 160 household heads (35.87% of the population) were interviewed from March to June 2016 spread over the two villages (80 farmers per village) respectively at Guidan Kodaou and Guidan Dan May Gari. The data tools used included; semi-structured questionnaires and semi-structured interviews, resource mapping complemented by the collection of relevant background information from local administrations, development projects, and NGOs.

The questionnaires items contained questions and statements regarding the respondents background, including their socio-demographics and economic characteristics such as: age of household head, schooling level of household head, number of household member as well as their education levels and gender, farming year experience, farmers association membership (yes or no), profession of household head, beneficiary of aid from institution (yes or no), ethnic group, annual income from the different sources (agricultural, livestock, forestry exploitation, trader, wage labor, aid, credit and other to specify), farmers' perception of climate change and climate risks over the past 10 years (rainfall amount, rainy season duration, temperature variation, parasite attack, crop yield change, wind speed, drought, flood and sunshine of dry season), and farm characteristics (farm size, number of each categories of animals, soil fertility appreciation, crop production for each type of crop). In addition, farmers were also asked to provide a view of the household nutrition status (daily meal over time, dietary), household current food stock, household strategies to overcome food insecurity. The households' heads of were also asked to indicate the type and frequency of disturbance (flood, drought, pest attacks, diseases, livestock raiding, fire, involuntary resettlement, and displacement, conflicts) experienced by households in the past 10 years, and mention the current strategies employed to overcome or mitigate each disturbance. Farmers were invited to indicate the extent to which their responses were adequate to address the disturbances. Background about the household status of the market (access and information), insurance, saving and ICTs (Information and Communication Technologies) use were also collected. And finally, household heads were asked to review the households' main sources of income and the main expenditure, as well as financial and other support, received from institutions and society. A pretest or a pilot study was done on 10 farmers in a common local language (Hausa) in the area. This created room for the questionnaire to be adjusted to meet the objectives of the study.

2.3 Data analyses

The study uses an indicator approach to assess household vulnerability to climate change and change Indicator approach is commonly used to assess vulnerability to climate change and change at household, community, or regional level. According to Deressa (2009), the indicator approach includes the selection of several variables determining vulnerability to compute an index. Based on the IPCC fourth assessment report, the system vulnerability is determined by its level of exposure, sensitivity, and adaptive capacity. Therefore, the vulnerability can be written as follows:

Vulnerability = Exposure +Sensitivity – Adaptive capacity

The vulnerability index is built by combining adaptive capacity indices with sensitivity and exposure indices. Biophysical and socio-economic factors that influence household production are used to construct adaptive capacity indices. Based on the identified biophysical and socio-economic proxies listed in Table 1, the adaptive capacity indices were constructed using the principal component method.

We initially used dryness and soil degradation indices to construct climate sensitivity indices using the principal component method. To measure dryness indices, we used annual rainfall data set from 1951 to 2013. Secondly, we measure exposure indices by using the principal component method to summarize natural disasters' proxies into one index. Likewise, the impact index was constructed using the principal component method with sensitivity and exposure indices as proxies. The table shows the different indicators and proxies used to measure the different component and sub-components. The factor method uses Sullivan (2006) approach to weight the indices and makes sure that each sub-component contributes equally to the overall index. As well, based on UNDP (2007) approach, all the identified variables for vulnerability index construction are standardized to a range of 0 to 100. The formula used for variables standardization is given as follow:

$$\text{Index value} = \frac{(Actual\ value - minimum\ value)}{(Maximum\ value - minimum\ value)} * 100$$

Table 1: Vulnerability key indicators

Components	Sub-components	Indicator	Proxy
Adaptive capacity	Biophysical	Perception of soil fertility	Scale
		Farm size	Number of hectares
	Socioeconomics	Households' education rate	Percent
		Farm income	USD$
		Livestock size	UTL
		Access to credit	Ordinal
		Infrastructure availability village	Percent
		Association membership	Ordinal
		Income diversification	Percent
		Coping strategy	Percent
		Perception of Adaptive capacity	Scale
Climate sensitivity index	Dryness index	Annual rainfall	Millimeters
	Soil degradation index	Degradation indices and percent of vegetation coverage	Percent
Exposure	Natural disasters	Average number of the flood, and drought in the past 10 years	Count
		Average number of the pest in the past 10 years	Count
		Average number of diseases in the past 10 years	Count

3. Results and Discussions

3.1 Households' perception of the factor affecting of their vulnerability

There is evidence that how farmers perceive the risks they are exposed influence the coping strategy implementation as well as the outcome of the adaptation. Therefore, this study attempts to assess farmers' perception of factors affecting their vulnerability. Table 2 reports the results of the descriptive statistics of factors affecting households' vulnerability.

Table 2: Descriptive statistics of explanatory variables

Variables	Mean (χ)	Rank
Food buying	2.58	1
Ceremonies	2.13	2
Farming	1.34	3
Livestock	1.00	4
Healthcare	0.55	5
Education	0.43	6
Family dress	0.22	7
Transport	0.14	8
Taxes	0.06	9
Telecommunication	0.00	10

The higher mean indicates the more determinant

Food expenditure (χ = 2.58) is found to be the most important factors affecting households' vulnerability. Our descriptive results reveal that about 43% of households cover only 6 months of consumption and only 17% of households manage to cover consumption until the beginning of the next rainy season. The average food coverage by crop production is 7 months with a standard deviation of 2.5. This is why the majority of the respondents translates vulnerability into food stress.

Fulani Mari from Guidan Kodaou reports that *"The vulnerability results in a lack of entitlement or possessing nothing that can protect you in case of crop failure, epidemics or animal disease". A view from a pastoralist man stated that "Vulnerability is caused by poor harvests, lack of livestock forage, and lack of grazing areas: that means you can have animals but not have a place to feed them".*

This is certainly due to the decrease in crops yield associated with environmental degradation, demographic pressure and an increase in the price of food. World Bank (2016) reports that in Africa, a decrease in agricultural yields could lead to a 12% rise in food prices, given that households in this region spend up to 60% of their income on food (Hallegatte et al. 2016).

Ceremonies (weddings, baptisms, religious and customary festivals) are also expected to affect household livelihood. The descriptive results rank ceremonies second (χ = 2.13) of the most important factor aggravating households' vulnerability. Ceremony organization or the gifts offered compels certain households to sell out a part of their crops production and/or a productive asset such as lands or animals.

Maman (Trader) from Guidan Kodaou reported that in 2016 he was compelled to sell one of his farms to finance the ceremony of his son's marriage. A similar situation was also reported by Gonao from Guidan Dan Mai Gari who sold part of his production to finance the baptism of his son.

Most of the households who mentioned ceremonies as the causal agent of a vulnerability reported that without the ceremonies, they could not be affected by food stress. Ndumba (2003) identified ceremonies as the second important factor determining households' vulnerability (Ndumba 2003). It is therefore important to identify the adequate and durable solution to reduce the negative effect of ceremonies on households' livelihood.

Productive inputs expenditures specifically regarding farming (χ = 1.34) and livestock (χ = 1.00) are also identified key factors affecting households' vulnerability respectively. Empirical studies revealed that expenditure related to agriculture inputs and livestock management (feeding and care) have a positive impact on households vulnerability (Demeke et al. 2009; Hendrickson et al. 1998). In most cases, household production begins to dry up from March, while the on-site rain starts around June thus creating a gap of at least 3 months. Likewise, forage for animal record always deficient and agro-pastoralists and pastoralists always struggle to feed their animals especially during lean-season.

A pastoralist man reports that *"Insufficient forage for animals requires us to migrate for transhumance to the north to find pasture during the May-January period."*

Human healthcare (χ = 0.55), **children education** (χ = 0.43), **family dressing** (χ = 0.22), **transport** (χ = 0.14), and **taxes** (χ = 0.06) are also perceived as factor affecting households' vulnerability at differing level. Surprisingly, no one household spell out household size as a factor affecting vulnerability. The implication of this result is that farmers in the area perceive human capital (household size) as an important factor for household development. In fact, in Hausa culture which is the majority (91.20%), the higher the number of household members, the less likely the household to be heavily affected by a specific shock? The household size increases the household labor power and social safety net and the individual contributions to the main household are highly significant for adaptation and development. This is why some household head is encouraged to extend their household by having more children and or marring many wives. Consistent with Coltrane (2000) and Ndumba (2003) although men's household work has increased relatively, women and children are doing much more than men.

3.2 Vulnerability Components Analysis

To measure vulnerability we considered three indicators that influence households' vulnerability to climate change. The components include sensitivity, exposure, and adaptive capacity. Table 3 summarizes the characteristics of principal components analysis.

Table 3: Modal characteristics

Variable	Components	Initial Eigenvalues	% of Variance	KMO
Sensitivity	1	1.084	54.203	0.500
	2	0.916	45.797	
Exposure	1	1.228	40.930	0.553
	2	0.896	29.851	
	3	0.877	29.219	
Adaptive capacity	1	1.330	44.320	0.440
	2	1.069	35.632	
	3	0.601	20.047	

The results reveal that only adaptive capacity produced more than one component score with values above 1. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy shows that the variables used for principal component analysis are satisfactory.

The variances results of the components with Eigenvalues above 1 are also relevant. The results of indicators scores are reported in Figure 1.

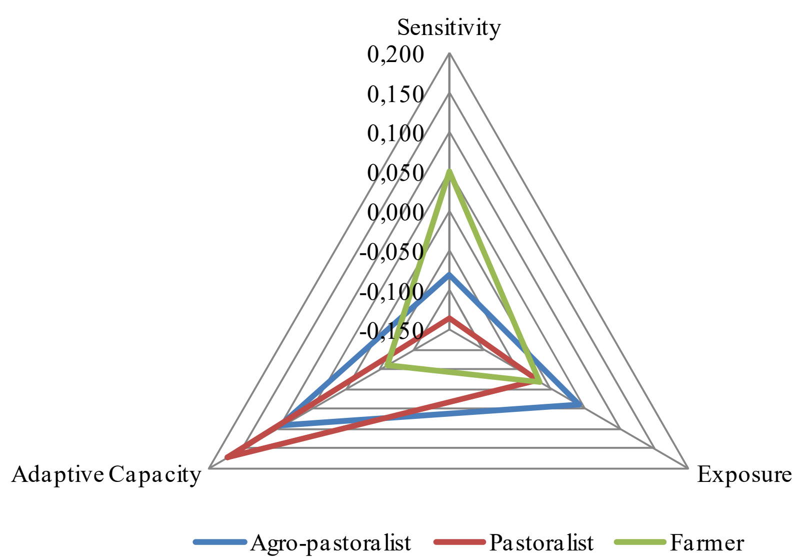

Figure 1: Path diagram of vulnerability components

Based on a principal component analysis results, Figure 1 reveals that the study area is very sensitive to climate change (0.040) with higher exposure (0.029) and low adaptive capacity (-0.006). The results demonstrate that agro-pastoralists have the highest degree of climate exposure while pastoralists depict the lowest level of climate exposure. Similarly, farmers indicate the highest level of sensitivity to climate change counter to pastoralists.

Figure 1 reveals that pastoralists group holds the highest adaptive capacity, whereas farmers show the lowest level of adaptive capacity.

3-3 Vulnerability Analysis by Livelihood Strategies

The principal component analysis was used to construct a vulnerability index. To better understand the livelihood strategies of vulnerability, the results were classified using compare mean. Results are reported in Figure 2.

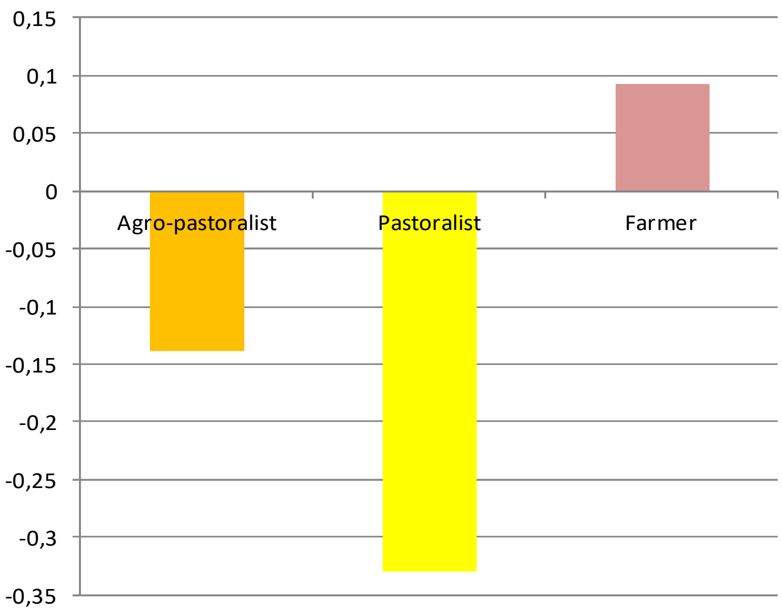

Figure 2: Livelihood strategies vulnerability to climate change

Vulnerability to climate change is determined by the difference between impact (sensitivity + exposure) and adaptive capacity. The household is assumed to be vulnerable if the impact index is greater than the adaptive capacity index. The positive sign indicates the higher vulnerability and the negative otherwise. The study reveals that the average degree of vulnerability in the district is 0.075 and 54% of the household is vulnerable albeit at a different level. Neil Adger (1999) estimated the vulnerability of Xuan Thuy at 0.06 levels. Bara G et al. (2010) reported that 63% of the population in Niger is vulnerable.

Households' vulnerability to climate change depends on livelihood strategies. Figure 2 depicts vulnerability level by livelihood strategies. The higher level of vulnerability is found in a farmers' group followed by agro-pastoralists while pastoralists group indicates low level. The implication of these results is that specific attention might be given to farmers to enhance their adaptive capacity or to reduce their impacts. However, it is imperative to know that the group with the highest (or the lowest) impact exposure is not necessarily the most vulnerable. Agro-pastoralists group have the highest level of exposure, yet they are less vulnerable than farmers as result of high adaptive capacity. Likewise, the household may have the highest level of sensitivity but the most resilient as result of higher adaptive capacity. Although, it may happen that the group with the highest (or the lowest) adaptive capacity is the most vulnerable as result of high (or low) sensitivity or exposure). O'Brien et al. (2004) found that in India most of the districts have a medium level of sensitivity to climate change, yet are still highly vulnerable to climate change as the result of low adaptive capacity. In contrast, some districts have a very high sensitivity to climate change, yet are found to be moderately vulnerable as the result of high adaptive capacity. This implies that the combination of sensitivity, exposure, and adaptive capacity are very important in understanding and determining vulnerability to climate change.

3-4 Factors Affecting Households' Vulnerability to Climate Change

A linear regression model using enter method was developed to determine the influence of household socio-economic characteristics and land characteristics on climate vulnerability. Table 4 presents the descriptive statistic of variables used in the model;

Table 4: Descriptive statistics of the variables

Variables	Mean	S.D
Family size	8.48	4.441
Association Member (binary variable 1=Member and 0 otherwise)	.29	.472
Net Income	1447	1360
Farm tree coverage (1=0-20%, 2=20-40%, 3=40-60%, 4=60-80% and 5=80-100%)	2.62	.944
Farming experience	31.09	13.097
Education rate	.3122	.21730
Soil quality (0-4, 0 for Low fertility)	3.04	.764
Months covered by the production	7.08	2.488

The results of the modal test reveal that R and R^2 value were respectively 0.704 and 0.496 with a corresponding F-value (6.998), highly significant at 1%. These values indicate a good model fit. Therefore, we can conclude that all of the selected variables are a good fit and can significantly predict the factors affecting the household vulnerability to climate change. Five out of nine variables used in the regression indicate a significant influence on vulnerability. These include family size, income, association membership, strategies index, and farm tree coverage. The results are presented in Table 5.

Table 5: Influence of selected variables on household's vulnerability

Variables	**β**	**t**	**Sig.**
(Constant)		-2.565	.013
Family size	.481	4.418	.000
Association Member	-.257	-2.577	.012
Strategies Index	-.240	-2.244	.028
Net Income	-.374	-3.650	.001
Farm tree coverage	.410	4.331	.000
Soil Fertility	-.170	-1.595	.116
Farming experience	-.148	-1.274	.207
Education rate	-.115	-1.160	.250
Months covered by the production	-.068	-.710	.480

R = 0.704, R^2 =0.496, F= 6.998

The results interpretation is based on the regression coefficient (β). A positive coefficient implies an increase in the likelihood of vulnerability for every unit increase in the predictor variable, whereas a negative coefficient depicts the opposite relationship.

Family size: The regression results reveal a higher significant and positive influence of family size on households' vulnerability. The larger the household size the greater the chance of the household to be affected by the vulnerability. A unit increase of household size increases the vulnerability likelihood by 48.1%. This is mainly due to the households' low capacity (because of the limited assets) to transform the human resource as an opportunity to improve productivity. The higher family pressure on the household head may also explain the positive sign of family size on vulnerability because in most of the cases all the family members' charges rely on the household head. Thus the larger the family sizes the higher the pressure and the lower the household head capacity responses. Abdou, a respondent from Guidan Dan May Gari categorized vulnerable households as follows: *"The type of family with many mouths to feed but hold limited farm and few animals"*.

Farmers' association membership: Is negatively associated with vulnerability to climate change. A household with a member belonged to farmers' association is less likely to be vulnerable to climate change. This might be due to the frequent contact of association members' with extension service and regular training received from institutions. The training improves farmers' skill of climate risk management (implementation of adaptation strategies), hence, improve their adaptive capacity.

Strategies index: There is evidence that farmers who are diversifying strategies are less likely to be vulnerable to climate change. Table 5 reveals that the fewer the strategies implemented, the higher the chance the household to be vulnerable to climate change. This implies that household who are employing few strategies are more likely to be vulnerable to climate change. A unit increase of strategy decreases the probability of being vulnerable by 24%.

Income: income as a proxy of food production (VIP and collinearity test reveal a strong relationship between these two variables) is an important factor in determining household adaptive capacity; the household with high income (or high food production) is expected to have the high adaptive capacity, thus less vulnerable. Our results reveal that household per capita income is high and significantly influence vulnerability. A unit increase of per capita income decreases the probability of being vulnerable by 37.4%. This implies the higher the income the lower the level of vulnerability. During group interview a farmer from Guidan Kodaou economically relate vulnerability as: *"Economically, someone is vulnerable when he doesn't have income-generating activities or when he is short of animals or money"*.

Farm tree coverage: The tree density in the farm is assumed to reduce crops' sensibility to climate change negative impact and facilitate adaptation process. The study results reveal that the higher the tree density the lesser the likelihood of being vulnerable to climate change. Raynaut (1997) supports our finding by stating that trees are a fundamental element of the production systems that go beyond simple pure wood production (Raynaut 1997). The tree is a central component to improve food production and react efficiently to climatic risks, thus it is a significant climate change impact redactor. This is why Larwan and Saadou (2011) place tree role as a central for through such functions as increasing soil fertility, providing fodder, habitat for beneficial organisms (e.g. predators of crop pests) and reducing temperatures and wind speeds (Larwanou and Saadou 2011)

Soil fertility: In this study, it is hypothesized that farm soil fertility will reduce crops' sensitivity to climate change. Soil fertility depicts negative influence on households' vulnerability to climate change. The higher the soil fertility the lower the probability of the household to be vulnerable to climate change negative impact. The soil fertility plays an important role in maintaining soil moisture, and plant nutrition; hence, reduce crops' sensitivity to rainfall variability and parasites attacks. Fosu-Mensah et al. (2012) and Nyuor et al. (2016) support our findings by reporting that soil fertility is among the most important factors that influence farmers' climate change adaptation.

Food production: The results reveal also that the fewer the months covered by food production, the higher the probability the household to be vulnerable. Farmers' perception of factors determining vulnerability matches well the regression results. This is also in line with Bohle et al. (1994) findings who stated that vulnerable with marginal resources encompass the rural producers, the landless and urban poor who have low food production.

Education: It is an important factor determining households' skill of activity management. It's assumed that the households with a high number of educated members are less likely to be vulnerable. The study reveals that a unite increase of educated member decreases the probability of a household to be vulnerable by 11.5%. This is because such kind of households' livelihood depends less on agriculture (Gbetibouo and Ringler 2009).

Farming experience: Experience in agriculture sector is assumed to influence negatively in households' vulnerability to climate change. The results reveal that the higher the agriculture experience, the lower the likelihood of the household to be vulnerable.

However, empirical studies reveal that depending on the context factors including farming experience and education have relative impact (positive or negative) on farmers vulnerability to climate change (Deressa et al. 2008; Hassan and Nhemachena 2008)

4. Conclusion

The research seeks to analysis household vulnerability to climate change. The research identified ten factors determining households' vulnerability respectively food expenditure (2.58), ceremonies (2.13), farming (1.34), livestock (1.00), healthcare (0.55), education (0.43), family dressing (0.22), transport (0.14), and tax (0.06). The results reveal that the sample population is vulnerable to 0.075 levels. However, the level of vulnerable differs from the livelihood strategies. Farmers (0.093) are found to be the most vulnerable and pastoralists (-0.328) the least vulnerable. The study reveals also family size, income, association membership, strategies index, and farm tree coverage are most significant factors determining households' vulnerability to climate change.

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