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FARMER PERCEPTION OF CLIMATE CHANGE STRESSORS: ADAPTATION STRATEGIES AND EFFECT ON FARMER STRESS-MIGRATION

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ABSTRACT

Study investigated the effect of farmer perceptions of climate change stressors on stress-migration using primary data collected by means of multi-stage sampling technique in 2012 on 120 irrigated upland rice-farming households. Data were analyzed using descriptive statistics and Heckman Two-Steps probit models. Results showed that drought and flood principally reduced rice yield, led to high crop loss, increased food insecurity and indebtedness and induced farmer stress-migration. Twenty-two percent of the farmers adapted to stress-migration between the years 2007 to 2011. Farmers frequently coped with cutting expenses, engaging in wage labor, hoarding food, seeking support from friends and relations, acquiring loans and petty trading and stress-migration. Adoption of 'change of cropping patterns', uniquely influenced farmer stress-migration as farm-size influenced decision to stress-migrate. Study recommends that to reduce farmer-stress migration towards ensuring resilience of rice system under persistent climate change stress in Niger state, the Niger State government should provide incentives to attract more men and educated farmers into rice farming and revisit land related matters to ensure that farmers have access to adequate farm size.

Keywords: Climate change, Heckman Two-Steps Model, Off-farm coping strategies, Nigeria, Rice,Stress-migration

1. INTRODUCTION

Africa is notyet self-sufficient in rice; a situation projected to worsen in the future (Balasubramanian, Sie, Hijmans and Otsuka, 2007).Climate shocks like drought and flooding affect livelihoods through their effects on agricultural productivity (Guerrero-Compean, 2013) directly hitting on agricultural activities more adversely than the manufacturing sector (IPCC, 2007)and exerting greater vulnerability on countries with larger dependency on agricultural sector (Deschenes and Greenstone, 2007). As resilience is a core objective in global food security strategies, rural development programs prioritize ways to support the ability of individuals, households, and communities to adapt to shocks and stresses.

Climate change refers to variations in climate elements over a period, which can range from decades to centuries (Umar *et al.,* 2008).Farmers beingin direct contact with elements of nature are cognizant with climate change effects on their physical environment relating to natural forces such as rain, vegetation and animals.Hence, climate change has been attributed to human activities and, a threat to animal and vegetation on which humans depend for a living. Climate change stressors such as drought, erratic temperature and flood have dramatically distorted rice system. This leads to gradual drifting of labor from rural farming towards non-agricultural activities in many rural agrarian societies around West Africa.

Rice is a water-loving crop, highly vulnerable to extreme climate conditions but remains a staple for the teeming Nigerian populace. Increases in temperature and sharp decreases in precipitation may shortenrice-growing season and decrease yield of rain-fed rice (Pepijn*et al.,* 2017). Such indicators compel farmers to adapt to coping measures towards assuring future life. As the effects of climate change are already being felt, affecting the production potential of rural areas and making communities increasingly vulnerable to climate induced hazards (Gurung and Bhandari 2008); farmers adapt to measures that would secure their livelihood .Adaptation to climate change therefore happens when farmers adjust to natural or human systems in response to actual or expected climatic stimuli or their effects, to either moderate harm or exploit beneficial opportunities (IPCC, 2007). Adaptation therefore requires that farmers must first notice that the climate has changed, then identify useful adaptation strategies and implement them (Maddison, 2006).Pepijn*et al.,* (2017), projected wet season irrigated rice yields in West Africa to reduce by 21% or increase by 7%; and for the dry season rice to reduce by 45% or 15% without or with adaptation respectively. The authors viewed that with such adaptation options rain-fed rice yields would increase slightly (+8%) but subject to water availability and recommended adaptation options of smart practices and the need for more adaptation options in West Africa.

Various authors (O'Connor *et al.,* 1999; Umar *et al.*, 2008) have shown that socioeconomic factors affect climate change perception including educational attainment, income, and knowledge of the causes; sex, farming experience, age of the household head, wealth, social capital and agro-ecological factors. Christensen *et al.*, (2007), decrying that climate change would defy all effective mitigation measures, suggest an urgent need to understand how rice farmers in Nigeria have coped with climate change to date, in order to guide the strategies for adaptation in the future and reduce the negative impact. Farmer stress-migration is one of the precarious off-farm coping strategies adopted by farmers in rural areas of West African countries.

Literature Review

Bhandari and Ghimire, (2016) defined migration as any departure from the neighborhood lasting one month or more for any reason and include moving within and outside of a given region.Migration remains a survival strategy and a socio-economic factor that is central in directly affecting farmers and the agricultural system (de Brauw 2010; Ecer and Tompkins 2010, Jokisch 2002). Stress-migration is induced by the unbearable effect of the impact of climate change on farmers' productivity and wellbeing. In Burkina Faso for example, residents of dry rural areas are likely to take long-term migration measure to rural regions with greater rainfall (Lori *et al*.,2007). Migration is alsoone of many survival strategies used by Ethiopian households in times of environmental stress (Meze-Hausken,2004).

Marchiori, *et al.,* (2011) related that aminimum of 35 million peoplehavemigrated internally between 1960 and 2000 due to variations in local climates in SSA. These authors predicted that 1.4million inhabitants (about 0.28 total populations) would annually move in SSA consequential to climate variationstowards the end of the 21st century. Climate variability has effects on internal migration (Marchiori, *et al.,* 2011; Barrios *et al.,* 2006), which in turndepend on socioeconomic, political and institutional conditions that affect vulnerability to climate change and how important climate change is in determining migration decisions (Waldinger and Fankhauler, 2015). For instance, Barrios *et al*., (2006); and Henderson *et al.*, (2014)observed that decline in precipitation increased rural to urban migration in some SSA countries.Lori *et al*., (2007) also arguedthat degradation of productive agricultural land leads to complete crop failure, which may force rural populations to migrate in search of work for remittances for store bought food in place of previously grown food from homestead plots. Climate variations may induce out-migration through its effect on the overall reduction in wages (Marchiori*et al.,* 2012). Larger climate variations lead to a lower wage. This induces migration into less climate stress vulnerable sub- and urban regions. Climate variations are especially for agriculturally dominated countries, and an important determinant for international migration over the period 1960-2000. Concentration of migrant labor in urban centers lead to agglomeration externalities that expose them to the pull forces that help out-migration (Marchiori*et al.,* 2012).

Climate-change survival strategies may be on-farm or off-farm. In Delta State, Nigeria, farmers adapted to on-farm strategies including planting trees, applying soil conservation techniques, changing planting dates, using heat-tolerant species and different crop varieties, and irrigation (Ofuoku, 2011); butonce all these options are exhausted, people often migrate to a new area (Meze-Hauskenm, 2004).

Households diversify their portfolio of economic activities in order to ensure survival or to improve their standards of living (Ellis, 1998). Such activities may be on-farm or off-farm. Off-farm strategies may include reserving and borrowing food, seeking local non-farm employment, selling livestock, or selling household and farm equipment(Meze-Hausken, 2004). Such activities favor farmer out-migration.Borja, (2014) and Massey *et al*.,(1998)suggested farmer's expectation of robust income or better living as strong incentives to migrate. Intrinsically, the motivation of people moving to urban regions derives from surplus and low productivity in the rural sector (Nguyen, 2015).

The widening gap of living conditions between rural and urban areas "pull" rural residents to urban areas which are expected to provide better jobs, and better education and public services. Farmer migration is therefore a coping strategy with dual implication in rice system development. For example, the economy of Tajikistan benefitted from the remittances from migrant workers abroad (World Bank, 2014). In Vietnam,ruralhouseholds that received remittances from their migrants were associated with reduced shares of rice income, increased land productivity and were more specialized in allocation (Nguyen and Grote, 2015).

Migration could be a coping strategy to risks (Stark and Bloom, 1985). It supports income and expenditure of the origin households, and alleviates poverty in the rural areas (Nguyen *et al.*, 2013; Amare, 2012).In Burkina Faso, labour migration has been an off-farm livelihood strategy for drought–affected farmers since the 1970s (Nelson and Reenberg, 2010). In Tanzania, consumption growth increased by 6% between 1991 and 2004 due to migration (Beegle*et al.*, 2011) and the remittances was the highest in the world accounting for 50% of GDP (World

Bank, 2014). Migration remains an attempt to gain higher wages or better living standards at one's destination (Massey *et al.*,1998). Although rural out-migration tends to reduce the pressure on agricultural labor, this could not reduce agricultural income because improvements in other factors, such as an increased access to capital due to remittances compensatefor the loss of household labor (Nguyen, 2015). Agriculture and labor migration are two primary livelihood strategies (World Bank Publication, 2008). Migration has also been a frequent response to climate variability and change in the Sahel regions of West Africa (Scheffran*et al.*, 2012). Evidently, developing countries are likely to respond to climatic change by migrating internally (Waldinger and Fankhauser 2015).

Despite these evidences in favor of migration, farmer out-migration intrinsically remainsa threat to the Nigerian rural farmers. Migration of skilled labor decreases labor productivity (Machiori*et al.*, 2011) since they complement the unskilled in the production process and attract foreign R&D activities the absence of it may reduce the beneficial flows (Docquier and Rapoport, 2008). Such losses may result to increased inequality (Waldinger and Fankhauser, 2015). Migrantsmay encounter negative economic effects if they migrate to areas where their labor forces were not employed efficiently. Moreover, uncoordinated distress migration is a sign of adaptation failure (Waldinger and Frankhauser, 2015).Migrants mainly come from relatively poor rural areas, although they may not be the poorest people in those places (Nguyen, *et al.*, 2013), and may often be the more educated ones. Their outmigration results in brain drain and falling agricultural production (Connell, 1987).The rural to urban migration in developing countries imposes complex effect on rural development (de Brauw, 2010).

Climate change affecting current/future income or living standards, may affect decisions to migrate by increasing income differentials (Waldinger and Fankhauser, 2015). IPCCin the fourth reportregretted that there is lack of robust evidence regarding the relationship between migration and climate variations (Boko*et al.*, 2007). Moreover, the estimates of climate change effect have been based on broad assessment of people exposed to increasing risks rather than analyses of whether exposure will lead to migration (World Bank, 2010). The general knowledge of the effect of climate variations on migration is surprisingly limited despite that this topic is so very much at the heart of the modern, international debate. Although most previous studies only proxy climate change variations by changes in rainfall (Barrios *et al.*, 2008); it is also well-known that a significant part of climate variations in SSA is related to increases in temperature. Essentially, Dell *et al.*, (2012), shows that annual variations in temperature drives the detrimental impact of climate variations on economic performances.

Concisely, this study intended to draw attention of stakeholders in Nigeria rice system development towards migration, an obscured consequence of climate change, in order to attract productive human resources into the system. This is achieved through the analysis of the interaction of farmers' perception of climate change and socio-economic factors that lead to migration decisions.

The remaining part of this study is arranged in sections as follows: Section 3, Methodology; Section 4, Results and Discussions; and Section 5 Conclusions and Recommendations.

3. Study Methodology

Section 3.1: Study Area

The study was conducted in Niger state, Nigeria; in 2012 in 15 villages in the local government areas of Lavun, Katcha and Wushishi. Niger state lies on latitude 3° 20'E and longitude 11°

3'Nand covers about 8.6 million hectares, representing 9.3% of the total land area of the country (NBS, 2010). This record shows that about 7 millionhectares (80%) are arable and that Niger state is endowed with abundant natural resources such as fertile soils, minerals, forests and rivers. It has good weather conditions well-suited to the growth of many crop species, livestock and fish. Niger state is predominantly rural, with 80% of its population depending on agriculture. The traditional agricultural production system is largely small scale (3–5 ha), using mixed cropping, shifting cultivation, handlebar-intensive technologies and methods. Factors retarding agricultural growth include vagaries of the weather, pests, diseases and a low capital base. Almost all soil types typical of the Savannah regions of West Africa can be found in Niger state, varying from shallow to deep. Deeper alluvial soils are amongst the best and have special potential for both rained and irrigated farming. The state experiences distinct dry and wet seasons. The length of wet season decreases from the south, which has an annual rainfall of 1600mm, to thenorth, with 1100mm. Rice is grown in virtually all parts of the state and is one of its major agricultural outputs, (NBS, 2010**).**

Section 3.2: Data Collection

Data used for the analysis were collected through a household survey conducted in 2012 in Minna, Niger state, Nigeria. A total of120 households were surveyed from 3 local government areas (LGAs) of Lavun, Katcha and Wushishi randomly drawn from the regions of Niger state where rice growing activities were intensive. Focus group discussions and informal interviews were made and a total of240 upland rice farmers were randomly selected and interviewed with the aids of well-structured questionnaires. Data were collected on farm characteristics and household income at farmer level on farmers' response to extreme variability in climate conditions. On the farmer's experience of stressors, the respondents were asked, "Did the household experience the stressors over the past 5 years?" given the options of drought, submergence, flooding and salinity and were required to rank the stressors according to severity of its impacton farm productivity(1=most severe to 5=least severe).

To identify the off-farm-strategies, farmers were made to indicate if they adopted the following options:-hired out for wage labor;go to neighbouring villages for labor work;shop-keeping, acquire loan, take support from relatives/friends, children drop-out from school, mortgage land, migrate, sell assets, spend less on store food and other necessities. In this way, the proportion of the farmers who out-migrated was ascertained. We argue that although accruable remittances may make stress-migration attractive, yet permanent loss of rice laborto "pull-push" forces is inevitable. Whether the rate of stress migration is low or high, the threat it poses on rice system resilience should not be neglected.

Theoretical Framework

Linking agricultural change and labor out-migration in a post-frontier, poor, rural agricultural setting is important for both theoretical and practical reasons (BhandariandGhimire, 2016)**.** The "push-pull" theory documented in Idahosa and Akpomera, (2012)proffered a link between rural farming and stress-migration showing the interconnectivity of vicious cycle of economic depletion effect of climate change vagaries on rural farmers, and the consequential individual farmers' migration (See Figure .Aligning to this thought, we conceptualize the push factors as those that cause rice labor to depart from rice farming activities. Hence, climate change stressors become perceivable link between low crop productivity, total crop failure and reduced welfare of farmers and the stress- migration. We therefore hypothesize that the perception of severe climate change elements is associated with increased individual stress-migration in rice system in Niger state of Nigeria.

Conceptual Framework

The push-pull theory of migration is adopted to illustrate how climate change influences farmer migration. The rural farmer's perception of climate change stress factors(such as drought and flooding) and, adaptation to diverse coping strategies in quest for improved welfare affect the farmer's decision to continue or quit rice farming activities. Low crop productivity and crop failurein the rural rice farming regions due to climate change stress lead to low farm revenue and income increased food insecurity and indebtedness. These are supposed push factors which cause farmers to consider leaving rice farming to other sectors or urban areas. Dissatisfaction with income is usually a key factor undermining the commitment of skilled farmers and may consequently facilitate their decision or intent to exit (Jauhar*et al.*, 2015). Hence, farmers in the rice farming rural areas,under climate change stress conditions, may encounter vicious cycle of hunger and poverty. Pull factors from the urban areas attract forces outside the context of the rice system and towards region of *virtuous* cycle of bounty. They may include factors like better paying job opportunities elsewhere within or outside Niger state, access to better living conditions, fully fledged facilities for children and the family and overall conducive working environment in the host region. Flight (gradient) tilts from the ruralareas towards the urban areas by means of a "push"force due tounconducive economic environment and poor living standard. On the other hand urban attraction force pulls from the urban areas due to availability of surplus and better living standard. This phenomenon creates high ricelabor mobility and flight induced syndrome.Hence,rice laborlost at the rural area is gained at the urban area

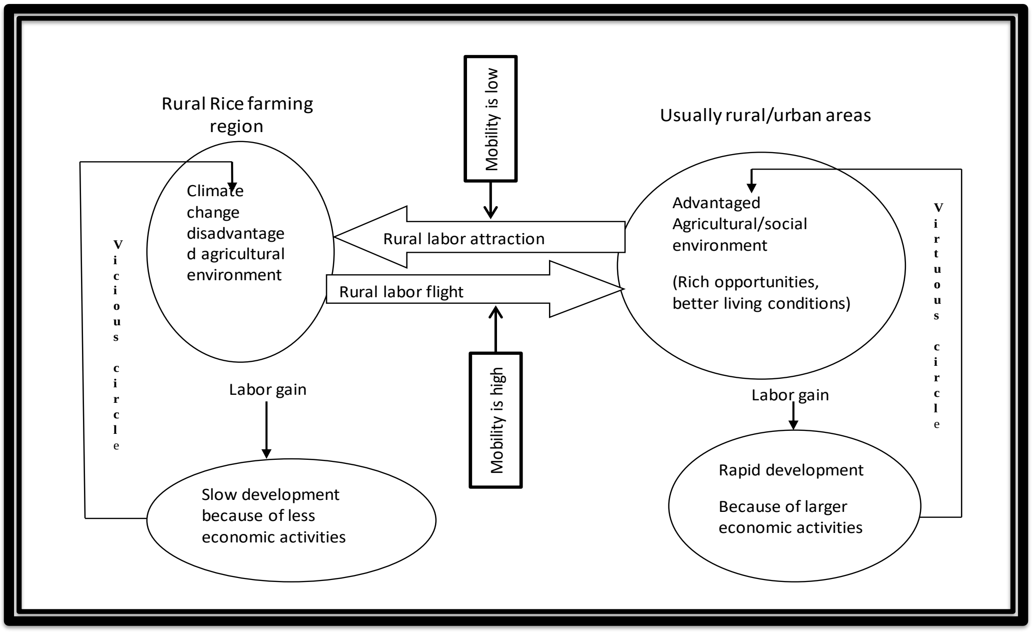

Figure 1: "Push-pull" mechanism of the climate change inducing farmer stress-outmigration factors

Specifications of Models
Using an ordinary least squares (OLS) regression model:

$y_i = x_i\beta + \varepsilon_i$ .... (1)

Where:

y_i = Migration status of the farmer with value 1 if farmer migrated or 0, otherwise.

x_i = a vector of explanatory variables (to be discussed in the next section), and

ε_i,= an error term assumed to be independently and identically normally distributed with a zero mean.

But the potential problem with the OLS estimatorin this study context is that stress-migration depends on farmers' perception of climate change. It therefore specifically seeks to know whether or not the farmer perceived increasing temperature and at the same time observed drought meaning that adaptation to stress migration is a censored random variable. Some farmers mayperceiveeither increasing temperature but no drought; others maynot have perceive any of the two conditions. These twolater categories of farmers therefore do not fall into our definition of drought induced migration.

Let the equation that determines whether a migrating farmer perceived increasing temperature be stated as:

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$z_i = w_i y_i + \mu_i$………………………………………………………………………… (2)

Where z_i is an unobservable index of eligibility for stress-migration; w_i is a vector of farmer's characteristics, and the random error(μ_i), is a new error term that is heteroskedastic and assumed to have a standard normal distribution.

If $z_i > 0$, an individual farmer, *i*, is eligible to stress-migrate. Then the condition for the sample selection is that y_i is observed only if $z_i > 0$

The expected stress-migration status given that an individual is eligible is:

$E\ [y_i | z_i > 0] + \mu_i$

$= x'_i\beta + \beta_\lambda \lambda_i (w'_i y_i) + \mu_i$……………………………………………………… (3)

Where $\lambda_i(w'_i y_i)$ is the inverse Mills ratio

Thus the expected value of y_i is equal to $x'_i\beta$ plus an additional term $\beta_\lambda \lambda_i(w'_i y_i)$. Therefore OLS estimation of equation (1), leads to bias and inconsistent estimate of β (unless β_λ=0) because it excludes the additional term and could not be used to forecast outcomes for all farmers. Heckman two-step estimator was used to correct for this sample selection bias. The model allows the use of all the observations to estimate a probitmodel of the probability that the migration of the farmers was due to the stress factors. In the second step, the inverse Mills ratio for each observation, $\lambda_i = \varphi(w_i\gamma)/\varphi(w_i\gamma)$, was then calculated. Because the inverse Mills ratio is included as an additional explanatory variable, the sample selection bias is corrected. This procedure gives consistent estimate of the parameter vector β. The estimators from this two-step procedure are consistent and asymptotically normal (see Wooldridge, 2010)

2.4 Model Variables:

Independent Variables in the selection and outcome model

The independent variables in the selection model refers to farmers'socio-economic characteristics including sex, age, and number of years of studies, number of years of residence in the village, farm size, main economic activity and annual income. These variables are believed to determine the probability that farmer perceived increasing temperature (and of course observed drought). In the outcome equation, the independent variables refer to sex, age, and number of years of studies, years in farming, income in normal year, farm size, main activity and the inverse Mills ratioλ_i. These variables are selected to determine the likelihood that a farmer would migrate.The difference between thesetwo categories of variables was analyzed by treating each category of the variable as a separate covariate. Then the first category of the respective variableswas selected as its base. Thus the coefficient reflects the deviation in the independent variable (predicted probability to adapt to migration) for the particular category relative to the reference category. To correct for multi-collinearity and make easy parameter identification, we ensured that not all the variables in the selection equation are included in the outcome equation. This also makes parameter estimation precise.

Section 4.0: Results and Discussion

***4.1.1** Descriptive Statistics of the Respondents*

The socioeconomic characteristics of the surveyed farmers (Table 1) shows mean age of 33 years, whichhas implication on climate change perception and farmer mobility. Average number of years of study of the farmers was7.4meaningan average farmer is intellectually empowered to understand principles of crop production to be able to handle climate related challenges facing the rice farming business and farmers mobility. The mean year in farming was19 showing that the farmers were experienced enough to understand principles of rice production and current changes in their production environment due to perceived climate elements. The mean income of farmers in a normal stress free year was N419, 776.67(1195.13USD). The respondents are small scale farmers keeping average farm size of 2ha.

Table 1: Descriptive statistics of respondents

	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.
Variables	**Female**			**Male**		
Age	**105**	**37**	**5.973**	**73**	**27.3**	**5.9137**
Number of years of study	**103**	**5.7**	**2.809**	**70**	**10.11**	**3.3080**
Years in farming	**105**	**18.2**	**6.796**	**73**	**19.69**	**5.1226**
Years resident in village	**102**	**28.21**	**11.841**	**70**	**26.04**	**6.378**
Income per normal year	**105**	**59,3593.4**	**190841.6**	**73**		**17,7042**
Farm size	**105**	**2.11**	**0.5492**	**73**	**2.20**	**0.4167**

4.1.2. Household-level perceptions of climate change and climate variability

The respondents clearly understand the changes in climate, and memories of the years dominated by extreme climatic conditions that have led to changes in their production systems. Households mainly experienced drought and submergence in the five years prior to the survey (2007-2011). Figure1 shows that 11 years prior to survey, 20.8%and 55.0% of the households perceived drought and submergence respectively with peak occurrences in 2009 followed by 2010.

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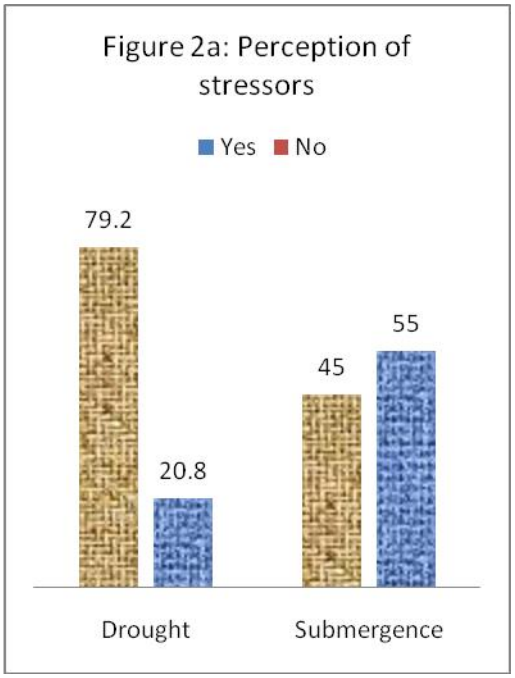

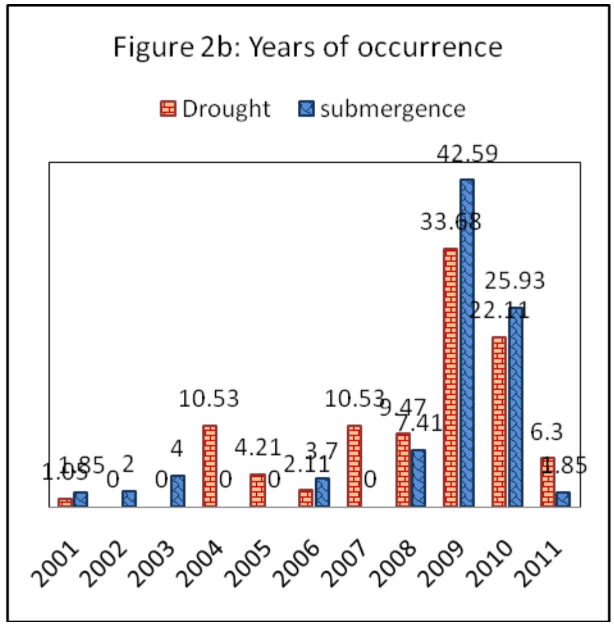

Figure 2: Distribution of Respondents according to perception of stressors and years of occurrence

Farmers' ranking of the severity of the stressors over the previous five years shows severe drought (61%) and submergence (40%) with 45% and 19% (respectively)being very severe. The fact that people have named drought and submergence as being very severe suggestsa heavy negative impact on production. The negative impacts associated with the changes in climateas identified by farmers are as presented in Table 2. While 99% of the farmers indicated that the stressors led to reduction in crop yields;68% indicated "food insecurity";84% "increased indebtedness"; and98% "crop loss". These are the underlying push elements inducing farmer stress-migration, but which did not show any significant difference when compared between men and women.

The various off-farm adaptation strategies adopted by the farmers are (in order of importance): embarked on cutting expenses and spending less, wage labor, hoarding food., sought support from friends and relations, acquired loans and engaged on petty trading before migrating by leaving their villages to seek work or other supports elsewhere.

Table 1: Frequency of Farmers according to responses on "What is the impact of climate change on production and welfare"

Variable of impact	Men % (SE)	Women % (SE)	Combined Total % (SE)	T-stat
Low yield	**98 (0.012)**	**99 (0.008)**	**99 (0.007)**	**0.568**
Food insecurity	**68 (0.043)**	**69 (0.043)**	**68 (0.03)**	**0.924**
Increased indebtedness	**83 (0.034)**	**86 (0.032)**	**84 (0.024)**	**0.613**
Crop loss	**98 (0.014)**	**98 (0.012)**	**98 (0.009)**	**0.66**

This confirms the assertion made by Meze-Hausken (2004) that in persisting extreme climate hazard, both men and women would try a range of on-farm and non-farm adaptation strategies before they resort to migration.

3.2.1 Household Level Perception

The regression result shows thatat the household level, perception of climate change is significantly and negatively associated with sex and farm size; and positively related with number of years of study, the income of the farmer in a climate change stress-free year and main economic activity of the farmer.

In the selection model, severity of drought has been captured in farmers' perceived impact son crop yield, crop loss and food insecurity. Invariably, more commercialized farms would seek to employ prompt coping measures to avert risks of crop failure and reduced productivity thereby checking perceivable climate change effects. Increases in the year of study and increase in farm income in a normal climate stress free year significantly increased the likelihood of perception of climate change. Conversely, perception of climate change decreased with the increasing number of farmers who practice agriculture as the main activity. Farmer engaging as a primary producer is a good entrepreneurial attribute, which shows to be associated with a high tendency of a farmer to exhibit prompt responses to changes in the production variables relating to climate change stresses and which invariably favors field performance.

Table 3: Result of the Heckman probit selection model

	Migration model		**Selection model**	
	Regression	Marginal effects	Regression	Marginal effects
Explanatory	Column 1		Column 3	Column 4

variables			Column 2					
	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value
Sex (Male=1)	1.101	0.112	0.368**	0.024	-2.143**	0.049	-0.290***	0.000
Age	0.036	0.464	0.014	0.464	0.402	0.838	0.043	0.213
Years of study	-0.089**	0.029	-0.036**	0.029	0.210	0.000	0.065***	0.000
Years in farming	-0.017	0.735	-0.007	0.735	0.042**	0.640	0.013	0.461
Farm size	-0.424*	0.093	-0.169*	0.090	-1.252		-0.388***	0.000
Changed crop pattern (dummy; yes=1)	-0.543*	0.078	-0.212*	0.066	0.049**	-	-	-
Years resident in village	-	-	-	-	-0.210	0.120	-0.065	0.113
Main activity					-0.765		-0.237*	0.072
Income/normal year	-	-	-	-	1.33e-06**	0.049	4.11e-07*	0.053
Constant	0.574	0.674			4.182*	0.055		
Total observation	118							
Censored	39							
Uncensored	79							
Wald Chi square (0 slope)	45.9***							
Wald Chi square	7.46**							

***, **, * = Significant at 1%, 5% and 10% probability level, respectively

3.2 Results of the Heckman-two-stepsProbit Decision Model

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The Heckman-two-step sprobitmodel estimated the likelihood of a farmer to migrate due to a perceived climate change stress factors. The values of ρ = -1 and Wald chi^2 = 101.79, (significant at 1% level), shows strong explanatory power with the model indicating the presence of sample selection problem. Result shows that3 out of the 6 suspected explanatory variables negatively and significantly affected the probability of a farmer to stress migrate (Table 4). These include years of study, farm size and adoption of the strategy of 'change of crop pattern'. The marginal effect analysis shows that sex of the respondents positively and significantly determines stress-migration (explaining 37% in decision). This is in line with the finding by Truong Thi Ngoc Chi *et al*., (2001) where the sex of the migrants in the study of lowland rice was dominantly male. This is unsurprising because men tend to have more access to technical information and education than women do. Educational status has long been shown to be positively related to access to information on improved technologies (Norris and Batie 1987,Maddison, 2006). Therefore, farmers with higher levels of education are more likely to understand better the waves of climate change. This enhances adaptation and invariably reduces stress-migration. A unit increase in year of study or farm size decreased the probability of farmer stress-migration by 4% or 17% respectively. According to Singh *et al.*, (2011) the more the per capita holding with a family the less is the chance of out-migration from that family Access to land is specifically enhanced by financial and capital empowerment which in turn disposes the household to highly probability to adapt to more favorable coping strategies that reduce tendency to stress-migrate.

Table 4: Result of the Heckman probit selection model

	Migration model				**Selection model**			
Explanatory variables	Regression Column 1		Marginal effects Column 2		Regression Column 3		Marginal effects Column 4	
	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value
Sex (Male=1)	1.1015	0.112	0.3682**	0.024	-2.1433**	0.049	-0.290***	0.000
Age	0.0362	0.464	0.0144	0.464	0.402	0.838	0.043	0.213
Years of study	-0.0897**	0.029	-0.0357**	0.029	0.210	0.000	0.065***	0.000
Years in farming	-0.0166	0.735	-0.007	0.735	0.042**	0.640	0.013	0.461

Farm size	-0.4239*	0.093	-0.169*	0.090	-1.252		-0.388***	0.000
Changed crop pattern (dummy; yes=1)	-0.5432*	0.078	-0.212*	0.066	0.049**	-	-	-
Years resident in village	-	-	-	-	-0.210	0.120	-0.065	0.113
Main activity					-0.765		-0.237*	0.072
Income/normal year	-	-	-	-	1.33e-06**	0.049	4.11e-07*	0.053
Constant	0.5748	0.674			4.182*	0.055		
Total observation	118							
Censored	39							
Uncensored	79							
Wald Chi square (0 slope)	45.9***							
Wald Chi square	7.46**							

***, **, * = Significant at 1%, 5% and 10% probability level, respectively

Adopting change of crop pattern decreased probability to stress migrate by 21%. The most important factor determining perception of increasing temperature is farm size with 40% decrease at every 1ha increase. A unit increase in the number of adopters to change of crop pattern reduces probability of stress-migration by 21%.

Section 5: Conclusion and Recommendation

Overall, socio-economic characteristics of the farmers influenced their perceptions of climate change. Drought and submergence were two principal climate-related stressors frequently experienced by the farmers causing low rice yield, crop loss, increased food insecurity, high indebtedness and stress-migration.

About 22% of the respondent farmers migrated due to climate related stressors between 2001 and 2011. The various off-farm coping strategies adopted by the farmers (in the order of importance) include: Spend less, store food and other necessities, hired out for wage, seek support from relatives and friends, acquire loans, engage in petty trade, migrate, mortgage land and hired out to the neighbourhood.

The farmers resort to stress-migration after all possible efforts to cope with climate change proved abortive. Farmers would first try cutting expenses, engaging in wage, hoarding food, seeking support from friends and relations, acquiring loans and petty trading, before resorting to stress-migration. Sex, education, farm-size and adoption of ‘change of cropping patterns ‘influenced farmer stress-migration. Sex, farm size, number of years of study, the income of farming household in a stress-free year and main economic activity primarily influenced the perception of the household son climate change. Farm size remains the most significant factor driving the farmers’ perception and decision to migrate.

Overall, this study recommends that the rice development agents in Niger State should provide incentives that would help to retain rice farmers in the rural agricultural areas. This will ensure resilience of rice farming in Niger state under the persistent stressful climate change factors. The relevant Federal, State and Local Government bodies should revisit land related matters to ensure that farmers have access to adequate farm size.

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