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Determinants of Farmers' perception and adaptation to climate change: The case of maize and sorghum farmers in Benin and Nigeria.

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Abstract

Despite the fact that the majority of Africans are employed in agriculture, providing food to meet the demand of the entire population continue to be a challenge, especially with the changing climate. This study examined the determinants of farmers' perception of climate change and the effect of their perception on adaptation. This involved 644 maize and sorghum farmers, selected from Benin and Nigeria using multi-stage sampling. The data was analysed using Heckman ordered probit model. Farmers perception of climate change was high. From the empirical model, include education, years of farming, access to extension service and country of the farmer were significant in influencing the farmers' perception of climate change. Farmer perception was found to have a positive significant effect (with a p-value= 0.001) on the farmers' adaptation which suggested that farmers who predict all three climate variables correctly adopted more climate change adaptation strategies. Adaptation was also found to be higher for higher for male farmers, less educated farmers, farmers with less household members, experienced farmers, farmers with off-farm activities and farmers who had access to credit. To enhance adaptation of the farmers therefore, factors that influence the farmers' perception of climate have to be given a prime consideration. Policy makers keen on enhancing farmers' adaptation should consider providing climate related extension and education services to farmers.

Key words: Adaptation, Climate change, Heckman ordered model, Perception

1. Introduction

In recent times, climate change has become one of the greatest developmental challenge that the whole world (Rosaine Nérice Yegbemey, Yabi, Dossa, & Bauer, 2014), especially through the United Nations Framework Convention on Climate Change (UNFCCC) is in constant effort to reducing the impacts. It is now flawless that the changes in climate is increasing with more damaging impacts such as floods and droughts than in the past three decades (Ongoro & Ogara, 2012). Given this consideration, the transition of the Millennium Development Goals (MDGs) into the Sustainable Development Goals (SDGs) lead to the birth of SDG 13 which seeks to 'take urgent action to combat climate change and its impacts' (Osborn et al., 2015). In fact, in the ranking of the SDGs by level of transformational challenge in the developed countries, the SDG 13 score the highest point of 7.1 out of a maximum score of 8 (Osborn et al., 2015). Similarly, in the ordering of the SDGs, poverty and food insecurity eradication were put at the first two which is the focal importance for the developing countries and the international development agenda (Osborn et al., 2015). The implication is that while policies are designed and efforts directed towards ending poverty and food security, it must be done in the consideration to environmental impacts.

Agriculture is the major employer in Africa employing 65 percent of the workforce. While the situation of Benin and Nigeria is no different, production is largely rainfed. Unfortunately, while food insecurity (undernutrition) continues to increase in SSA (FAO, 2015), the region is said to be most vulnerable to climate change (Serdeczny, Adams, Coumou, et al., 2016) and the agriculture sector is going to experience one of the largest impacts (Sonwa et al., 2016). Thus, Ehiakpor et al. (2016) noted climate change has become more prominent in aspects of global discussion especially due to its negative impact to sectors such as the agriculture sector. While the changes in climate may reflect slow noticeable impacts on most economic activities, farmers are already realizing lower yields with increasing erratic rains. As a result, there are gaps between potential and observables yields for most major crops (Serdeczny et al., 2016; Phiiri, Egeru, & Ekwamu, 2016). This means that, climate change may activate a decreased in agriculture production, thereby, affecting income mobilization for a large portion of the population in SSA. Generally, various researches (IPCC, 2014; Stanturf et al., 2011) concluded that the impact of climate change is much or going to be higher in SSA than other parts of the world. While the effects are becoming more superficial, projections show that the variability or change in climate will continue in the next decades. Aside the direct impact on yield reduction, households' welfare is affected by climate change through efficiency reduction, increase costs of production, health problems and catalyzing social conflicts.

The only option towards achieving higher yields is through adaptation. Adaptation refers to the process of adjustment to actual or expected changes in the climate as well as the effects that come with the changes. Thus, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities (IPCC, 2014). It is not surprising that adaptation is an increasingly policy option for reducing climate impacts (Babatolu & Akinnubi, 2016). However, the decision to adapt to climate change has been reported as a function of a number of factors. One of such factors that shapes farmer's adaptation is perception on the direction of changes and impacts of the climate change. For instance, a perception study by (Babatolu & Akinnubi, 2016; Rosaine N. Yegbemey, Yabi, Tovignan, Gantoli, & Haroll Kokoye, 2013) revealed that smallholder farmers have high knowledge on climate change and these are similar to empirical observations. Perception is an important aspect of reducing the impacts of climate change as the nature of response to risks depends on the perception, in which case, misconception may lead to no adoption or even worse this can lead to maladaptation (Grothmann and Patt, 2005 in Debela et al., 2015).

A number of adaptation strategies have been widely adopted by farmers. For instance, (IPCC, 2014) indicated that adaptation strategies such as adjustments in technologies and livelihood diversification are leading to a reduction in vulnerability. However, most of these adaptation strategies do not provide the needed result without the adoption of other strategies. This means that farmers would choose a number of strategies to increase their farm outputs. Empirical studies examining perception and/or adaptation to climate change have largely used logit/probit (Iheke & Agodike, 2016; Ndamani & Watanabe, 2016) or multinomial logit (Debela et al., 2015; Sofoluwe et al., 2011). The implication of this models is that the farmer adopts only a technology. Other studies estimating perception on adaptation in a two-step used the Heckman probit model (Olunba, 2016; Okonya et al., 2013) while in estimating the effect of perception on adaptation, the treatment effect model was used (Ehiakpor et al., 2016). In this application, also, the selection variable, perception, is given as binary. In this case, perception is defined as predicting climate change rightly or wrongly or if a farmer perceives a change for a given period or not. In these cases, perception on climate change has been centred on changes in precipitation and/or temperature. However, considering the recent impacts of wind on crop production especially maize and sorghum, this study has extended the perception frontier to include a third variable which is wind. Therefore, in this study, perception is defined as perceived changes in precipitation, temperature and wind. As such, the study is innovative in using Heckman ordered probit where we are able to identify farmers into more than two groups as those who perceived changes in all three variables in line with scientific directional changes, those who perceived

only two rightly and so on. The authors believe this would provide more insight on the perception of farmers and the effects of the perception on climate change adaptation.

2. Methodology

2.1. Study area

The study was carried out in Benin and Nigeria. Both countries are located in West Africa. Benin is surrounded by Nigeria (Eastern border), Togo (Western Border), Niger (North- Eastern border), Burkina-Faso (North- Western border), and the Atlantic sea (Southern border). Nigeria is bordered by Benin in the west, Chad and Cameroon in the east, and Niger in the north. Its coast in the south lies on the Gulf of Guinea in the Atlantic Ocean. Data were collected from the northern regions which are identified to be the most vulnerable to climate change in both countries. In each country, the study sites (i.e. municipal areas and villages) were selected after a series of exploratory field visits and consultation with agricultural extension officers. As a result, the municipal areas of Bembereke and Ouake were selected in Benin whereas Lapai and Rijau were selected in Nigeria. Figure 1a and 1 b present the study areas.
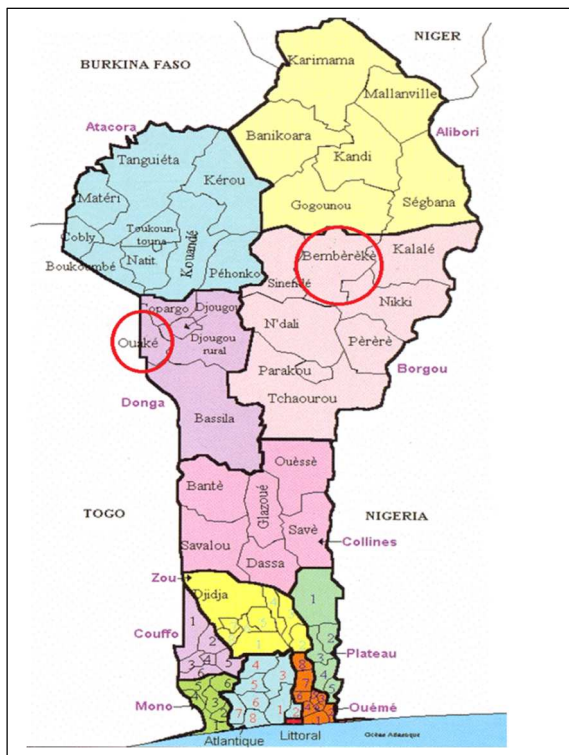

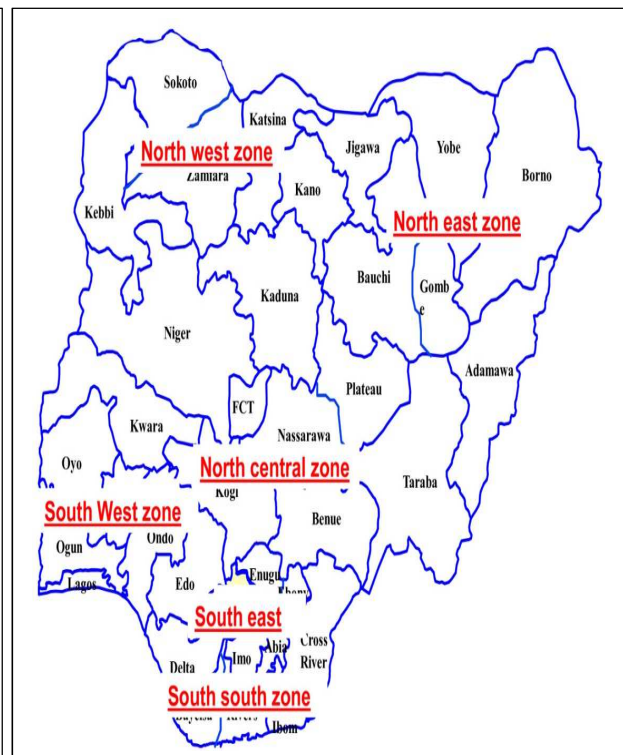**Figure 1a: Study area in Benin**   **Figure 1b: Study area in Nigeria**

2.2. Data and methods of collection

The Research units were households and the household head was the response unit. In each country, a total of 350 households were randomly sampled in the study. Note that after data cleaning the final sample size was 344 in Benin and 300 in Nigeria). The random sampling was carried out at the village level. In practice, a rapid census of the households was carried out to have a list of household in each village. A number was assigned to each household and the sample of respondents was drawn by using the table of random numbers.

Both secondary and primary data (involving both quantitative and qualitative data) were collected for the study. Secondary data sourced include variations in environmental/climate-related factors, household vulnerability and adaptation mechanisms. Regarding the research frameworks and the study objectives, primary data were collected at the household level. These data included 1) the households' socio-economic characteristics (e.g. location, structure, activities, access to credit, etc.) and 2) the observed agrarian transformations and resulting agricultural development due to climate change. Secondary data were collected from literature, documentation centres, and office of statistics and climate data in Republic of Benin and Nigeria. Primary data were collected through a household survey. A set of questionnaire was utilized to elicit the desired information from the respondents. Furthermore, investigations were conducted using non-structured and semi-structured interviews with key informants (e.g. agricultural extension officers, village leaders) and farmers. Some focus groups, observations and the triangulation were additional data collection tools. Focus group discussions were conducted by using a discussion guide.

2.3. Data analysis

An ordered response model with sample selection can be represented through the following bivariate threshold-crossing model.

$$Y_j^* = \beta_j^T X_j + U_j \qquad \text{where } j = 1, 2 \qquad (1)$$

$$Y_1 = I(Y_1^* \geq 0) \qquad (2)$$

$$Y_2 = \sum_{h=0}^{H} h I(\alpha_h \leq Y_2^* \leq \alpha_{h+1}) \qquad \text{if } Y_1 = 1 \qquad (3)$$

Where Y_1^* and Y_2^* represent continuous latent variables for the selection process and the outcome of interest, respectively; the β_j are k_j vectors of unknown parameters; the Xj are k_j vectors of exogenous variables; and the U_j are random errors. The latent variable Y_1^* is related to the

binary indicator Y_1 through the observational rule (2), where I(A) denotes the indicator function of the event A. The latent variable Y_2^* is related to the binary indicator Y_2 through the observational rule (3) where α = (α_1, …, α_H) with α < α_{h+1}, α_0= - ∞ and α_{h+1} = +∞ is a vector of H strictly increasing thresholds that partition Y_2^* into H + 1 exhaustive and mutually exclusive intervals.

Our parametric specification of the model assumes that the errors U_1 and U_2 follow a bivariate Gaussian distribution with zero means, unit variances, and correlation coefficient ρ. This is the same distributional assumption imposed in specifying a binomial family with an ordered probit link (Luca & Perotti, 2011). Under this parametric assumption on the distribution of the latent regression errors, the log-likelihood function for a random sample of n observations {(Y_{1i}, Y_{2i}, X_{1i}, X_{1i}): i= 1, …...n} is:

$$L(\theta) = \sum_{i=1}^{n} \{(1-Y_{1i}) \ln \pi_{\theta i}(\theta) + \sum_{h=0}^{H} Y_{1i} I(Y_{2i} = h) \ln \pi_{1hi}(\theta)\} \qquad (4)$$

Where θ = (ß_1, ß_2, a, ρ) is the vector of all model parameters and (π_0, π_{10}, …. π_{1H}) are the conditional probabilities associated with the H + 2 possible realizations of Y_1 and Y_2

$$\pi_0(\theta) = \Pr(Y_1 = 0) = 1 - \varphi(\beta_1^T X_1) \qquad (5)$$

With φ denoting the standardized Gaussian distribution.

Empirical model

From the above theoretical model, the present study estimated two equations, one for perception and the other for adaptation. This is given below:

$$Perception = \beta_0 + \beta_1 Sex + \beta_2 Education + \beta_3 Experience + \beta_4 FBO + \beta_5 Extension + \beta_6 country \quad (6)$$

and

$$Adaptation = \delta_0 + \delta_1 Sex + \delta_2 Education + \delta_3 Household\ size + \delta_4 Experience$$
$$+ \delta_5 Extension + \delta_6 FBO + \delta_7 Off - farm + \delta_8 Credit + \delta_9 Perception \qquad (7)$$

Where sex is a dummy variable describing males as 1 and females as 0; education is the number of years of formal education; household size is the number of people in the same household pooling and sharing same household resources; Farmer Based Organisation (FBO) is a dummy variable that is defined as 1 for farmers belonging to an FBO and 0 if a farmer belongs to no farmer group; experience is the number of years a farmer had been into the cultivation of maize or sorghum; extension is the number of times a farmer had contact with extension officers either on their farms or at home; off-farm is a dummy variable, 1 for farmers who engaged in off farm

activities and 0 for those who did not; and credit is a dummy, 1 for farmers who had access to credit for maize or sorghum crop production and 0 for those who did not. Adaptation is the total number of adaptation strategies adopted by a farmer out of the 12 strategies examined. Perception is defined as an ordered variable taking values from 0 to 4 where 0 is for farmers who predicted all three climate variables (precipitation, temperature and wind) in the wrong direction, 1 for those who predicted only one correctly and the other two wrongly, 2 for those who predicted two correctly and one wrongly and 3 for those farmers who predicted all three correct. Right predictions are: precipitation is reducing, temperature is increasing and wind is increasing.

The potential explanatory variables considered are listed in the following Table (Table 1)

Table1: Explanatory variables considered in the model

Variables	Types[a]	Modalities	Excepted Sign
Sex	**D**	**0= Female; 1=Male**	**+**
Education	**C**	**-**	**+**
Farmer based organisation (FBO)	**D**	**No=0; Yes=1**	**+**
Experience	**C**	**-**	**+**
Country	**D**	**Benin=1; Nigeria=2**	**±**
Contact with Extension service	**D**	**No=0; Yes=1**	**+**
Off-farm activities	**D**	**No=0; Yes=1**	**+**
Access to credit	**D**	**No=0; Yes=1**	**+**

[a] Types: D = discontinuons variables; C = continuous variables

Source: Authors' Specification

3. Results and discussion

3.1. Farmer's socioeconomic and demographic characteristics

The descriptive statistics of farmers' socio-economic and demographic characteristics (Table 2a and 2 b) show that respondents are about 40 ($\pm$11.39) years of age with 20.67 ($\pm$ 11.29) years of experience in agriculture (respondents in Benin (23.20 years $\pm$ 12.17) record a statistically higher experience as compared to the respondents in Nigeria (17.76 years $\pm$ 9.395) ($p <0.01$). The respondents are all head of their household. On average, a household in the study area is composed of 11 ($\pm$ 7) persons. About half of the respondents attended formal school. In the study area, about 13% of the respondents have declared to have access to formal credit. Finally, about half of farmers are in contact with extension service.

Table2a: Descriptive statistics of Qualitative variables

| | | Country | | |
		Benin	Nigeria	Total
		Gender		
	Female	16 (2.48)	26 (4.04)	42 (6.52)
	Male	328 (50.93)	274 (42.55)	602 (93.48)
	Total	344 (53.42)	300 (46.58)	644 (100)
		Fisher's exact = 0.054		
		Repartition of the respondents according to level of education attained		
Highest level of formal educational achievement	No formal education	158 (24.53)	144 (22.36)	302 (46.89)
	Primary education	102 (15.84)	55 (8.54)	157 (24.38)
	Secondary education	76 (11.80)	70 (10.87)	146 (22.67)
	University education	8 (1.24)	31 (4.81)	39 (6.06)
	Total	344 (53.42)	300 (46.58)	644 (100)
		Fisher's exact = 0.000		
		Repartition of the respondents according to contact with extension officers		
Contact with any extension agent	No	243 (37.73)	72 (11.18)	315 (48.91)
	Yes	101 (15.68)	228 (35.4)	329 (51.09)
	Total	344 (53.42)	300 (46.58)	644 (100)
		Fisher's exact = 0.022		
		Repartition of the respondents according to access to credit facility		
Access to credit facility	No	294 (45.72)	269 (41.84)	563 (87.56)
	Yes	49 (7.62)	31 (4.82)	80 (12.44)
	Total	343 (53.34)	300 (46.66)	643 (100)
		Fisher's exact = 0.151		

NB: Values in brackets are relative frequencies.

Source: Authors' computation

Table2b: Descriptive statistics of Quantitative variables

	Mean	Std. Dev.	Freq.
Descriptive statistics of the respondents' age			
Country	Mean	Std. Dev.	Freq.
Benin	40.86	11.79	344
Nigeria	39.87	10.91	300
Total	40.40	11.39	644
Analysis of Variance: F=1.21; df1=1; df2=643; Prob=0.2719			
Mean and standard deviation of the number of years of school attendance			
Benin	7.67	4.32	188
Nigeria	10.97	5.38	141
Total	9.08	5.07	329
Analysis of Variance: F=37.97; df1=1; df2=327; Prob=0.0000			
Descriptive statistics of experience in agriculture			
Benin	23.20	12.17	344
Nigeria	17.76	9.39	299
Total	20.67	11.29	643
Analysis of Variance: F=39.34; df1=1; df2=641; Prob=0.0000			
Descriptive statistics of the number of household size			

Benin	9.69	5.95	344
Nigeria	11.89	7.43	300
Total	10.71	6.76	644
Analysis of Variance: F=17.23; df1=1; df2=642; Prob=0.0000			

Source: Authors' computation

3.2. Farmers perception of climate change

Farmers perception of climate change is an important step in the fight against climate change as this influences their adaptation and economic activity choices. Farmers largely rely on their description and expectation of the climatic conditions especially rainfall in their farm decisions. This study provides the perception of climatic variables with definitions based on scientific principles. Thus, largely, while rainfalls are expected to be reducing, temperature and wind are expected to be increasing. The study observed that more farmers (91.6%) perceived rainfall correctly, thus reducing, than the case of wind (86.3%) and temperature (75.8%). In the second panel of Table 3, it was observed that some farmers (7.8%) could not predict the direction of changes in these climate variables. Generally, though, the majority (73.8%) of the farmers were able to perceive changes in all climate variables. The importance is that farmers who are able to perceive climate change rightly are likely to adopt efficient and effective strategies that would reduce the impacts of climate change on their farms and households. Although this study did not provide meteorological data using the rate of changes in these climatic variables, empirical evidence provided in the literature provided sufficient ground to justify that farmers in the study areas have good knowledge of the directional changes in climate. Limantol et al. (2016) also estimated that over 94% and almost 90% of their respondents perceived rainfall as reducing and temperature as increasing respectively. Other studies (Kabir et al., 2016; Barrucand et al., 2016) Chichongue et al., 2015; Tilahun & Bedemo, 2014; Ehiakpor et al., 2016) found that majority of their respondents perceived changes in climate change. The conclusion from these studies are generally that perception influences livelihood and adaptation. Studies such as (Nzeadibe et al., 2012) asserted that farmers have knowledge on the impacts of climate change. The synergy between these studies and the current one is that not only are farmers aware of changes on climate variables but also, are aware and perhaps, experiencing impacts from these changes.

Table 3: Perception of farmers

Variable	Frequency	Percentage
Rainfall (Decreasing)	590	91.6
Temperature (Increasing)	488	75.8
Wind (Increasing)	556	86.3
Grouping		
All three wrong	50	7.8
Only one right	29	4.5

Only two right	90	14.0
All three right	475	73.8
Total	644	100.0

Source: Authors 'calculations

3.3. Factors influencing farmers' perception

Empirical literature suggests that a number of socioeconomic and institutional variables influences the perception of farmers on climate change. In line with this, this study examined the effects of selected variables on the probability of predicting changes in three of the climatic variables as in Table 3. Aside the estimated coefficients, the log odds ratios which indicates the odds of number of right predictions. From Table 4, education, experience, extension and country significantly influenced farmers' perception. The significance of the model means that the two error terms in the perception and adaptation models are not correlated, using the two-stage approach.

Education had a positive effect on farmers' perception which means that the higher the level of education of a farmer, the higher the probability of predicting rightly the changes in the climate variables. The result also showed that the odds ratio turns to increase with the number of the number of right perceptions of the farmers but decrease with all three right predictions. Thus, an additional year of formal education would increase the odds of right predictions of one climate variable by 1.14, two climate variables by 1.182 and three climate variables by 1.137. This finding indicates the importance of knowledge in understanding climate changes. Perhaps the highly educated farmers are far able to take notice and interpret climate information more than the less educated. In their study also, Debela et al. (2015) (using multinomial logistic regression) and (Kabir et al., 2016) (using chi square), education was found to have a positive significance on the perception of climate change. Barrucand et al. (2016) asserted that for adaptation to climate change to move beyond spontaneous adaptation, it is essential that education is provided on the main aspects of climate change especially among the rural dwellers.

 It is expected that farmers with higher experience in crop production would have a higher probability of predicting rightly the changes in more climatic variables. However, the opposite is the case in this study. The odds of predicting changes in the climatic variables decreases for all combinations. Perhaps these farmers are the older farmers and did not take historical information into consideration. This study contradicted Ndambiri et al. (2013) the findings in where experience had a positive effect on farmers perception

Extension services is one the main mechanisms by which information on crop production gets to the farmers. Extension services include the introduction of farmers to new technologies and

linking farmers to input sources. It is therefore as expected that farmers with higher number of extension will have greater odds of having a right perception on the changes in climate variables. However, the odds of right perception of climate change increase higher for any two variable combinations than for the three variables. The positive significance of the extension variable warrant that in other to improve the knowledge of farmers on the current developmental challenge, climate change, extension services must be intensified. Olunba (2016) and Urgessa & Amsalu (2014) also estimated a positive effect of extension service on farmers perception. The study also find that farmers in Benin have a higher odd of having the right perception about climate change than farmers in Nigeria. However, the mechanisms for this finding is unclear and needs to be taken up for further investigation. Perhaps, climate information provision and delivery is more effective in the former country than the later. A cross tabulation also revealed that while 86.3% of farmers in Benin correctly perceived changes in the three variables, only 56.3% of the farmers in Nigeria do correctly perceived changes. Considering the importance of perception on adaptation and crop production, it is important that farmers in Nigeria are given more education on climate change.

Table 4: Factors influencing farmers' perception

Variable	Coefficient	Std. Error	P-Value	Log odds ratio		
				Only one right	Only two right	All three right
Sex	-0.369	0.501	0.462	0.229	0.139	0.295
Education	0.098***	0.024	0.00	1.140	1.182	1.137
Experience	-0.024**	0.010	0.013	0.940	0.943	0.951
FBO	0.218	0.259	0.400	0.813	0.988	0.629
Extension	0.106***	0.024	0.000	1.229	1.292	1.067
Country	2.444***	0.301	0.000	146.005	264.771	34.543
Constant	0.569	0.578	0.326			
rho	-0.757	0.071				
Log likelihood test of independence =37.78***						

***, ** and * indicates significance at 1%, 5% and 10%, respectively

Source: Authors 'estimation

3.4. Existing climate change adaptation strategies

The study identified twelve (12) climate change adaptation strategies been adopted by the farmers (Table 5). The strategy adopted by the highest percentage (84.2%) is to change the planting date. That is, most farmers do not plant at the same periods of the year they used to, instead, they plant some few weeks ahead of the previous planting season. This strategy is a way of responding the delay of the rains in recent times. Following this strategy is the related change of harvesting date by 63.4% of the respondents. The implication is that changing the

planting date would affect the harvesting period as well unless change of variety. On change of variety, 54.5% and 36% of the farmers changed their previous varieties to the use of early maturing and drought resistant varieties, respectively. It is ironically that as high as 57.8% of the farmers indicated that they used to pray to the 'icons' they worship for good production environment especially, good rains. The least adapted strategy is off-farm engagement (7%).

Table 5: Climate change adaptation strategies adopted by farmers

Adaptation strategy	Frequency	Percentage
Change planting date	542	84.2
On-farm diversification	225	34.9
Change harvesting dates	408	63.4
Drought resistant varieties	232	36.0
Early maturing varieties	351	54.5
Off-farm diversification	045	07.0
Land tenure	328	50.9
Land relocation	330	51.2
Repeated sowing	336	52.2
Food consumption pattern	206	32.0
Gender role (labour allocation)	144	22.4
Prayers (Cushioning)	372	57.8

Source: Authors 'calculations

3.5. Effect of farmer perception on climate change adaptation

One of the objective of this paper is to estimate the effect of farmers' perceptions of climate change on the number of adoption strategies adopted by a farmer. This is provided in table 3. The study provided evident that the perception of farmers in Benin and Nigeria has a significant influence on the adaptation to climate change. Thus, farmers who perceived changes in climate variables correctly adopts more of adaptation strategies. Generally, for the uncertainty of outcomes from individual adaptation strategies, farmers who have perceived changes in climate change would adopt more strategies as a risk distribution measure. Also, it was observed that there is a relationship between some of the adaptation strategies which means that the adoption of one strategy would lead to autonomous adoption of another. This study has confirmed other empirical results across the globe, where it was concluded that having knowledge on changes in climate would influence the decision to adapt or mitigate. Otherwise, adaptation would be a way of life where farmers and generally man, would adopt some of these strategies without any objective of minimising the impacts of climate change while maximising the gains from their economic ventures. Other factors that significantly influenced climate change adaptation include sex, education, household size, experience, off-farm activity and credit. Ehiakpor et al. (2016), Urgessa & Amsalu (2014) and Ndambiri et al. (2013) also found that farmers who perceive increase in temperature and a decrease in precipitation had a higher probability of

adapting to climate change. The significance of the Wald chi square suggested that the estimated model is appropriate and the variables jointly explained the variations in perception and adaptation.

The positive significance of sex suggest that male farmers adopt more adaptation strategies than female farmers. This is no irony since agriculture have traditionally been known as men's job. Also, male farmers often have much exposure in terms of awareness to the adaptation strategies and access to resources for the adaptation. This provided evidence that climate issues are not gender neutral, hence the need to specifically target women in addressing climate change. Obayelu et al. (2014) also estimated that male farmers have a higher probability of adjusting their planting periods in order to reduce impacts of climate change. This was similar to Okonya et al (2013).

Farmers with higher education were found to adopt less adaptation strategies than farmers with lower levels of education. This could mean that formal education provides the opportunity for farmers to identify few workable strategies to adopt, hence, a reduction in uncertainty about the adaptation strategies. Also, considering the fact that crop farming is engaged mostly by the less educated, it is expected that indigenous knowledge could play a significant role in farmers' adaptation other than formal education. It is important to recall that education had a positive effect on farmers' perception of climate change but a negative effect on adaptation. Therefore, the mechanisms through which formal education play a role in adaptation needs to be given a further attention. Empirically, Ndambiri et al. (2013) and Urgessa & Amsalu (2014) estimated a positive effect of education on climate change adaptation.

Contrarily, the study estimated that farmers with larger household members adopted less adaptation strategies. It was expected that considering the important role of family members in providing cheap and readily available labour to the farmers, farmers with larger household members would adopt more of the strategies. Ndambiri et al. (2013) also estimated a negative significant effect of household size on adaptation and argued that larger family members provide labour for these households to engage in off-farm activities in the bid for household income to resolve the problem of meeting the consumption needs that comes with a larger household size.

Although **experience had a negative effect on perception** (Table 6), farmers with higher experience adopted more adaptation strategies than those with less experience. This can be as a result of their ability to understand the farming systems better and respond accordingly. Farmers who have been cultivating crops over the years have known much on the production environment, when to plant and do other activities might have noticed changes in the climate

and respond accordingly. Perhaps, they might have tried various strategies over the years. Similar to this study were the findings of Olunba (2016) and Ndambiri et al. (2013) where the latter authors argued that experienced farmers are able to spread risk of climate change due to the high skills.

Off-farm had a positive significant effect on climate change adaptation which means that farmers with off-farm activities adopts more climate change adaptation strategies. Off-farm is one of the common livelihood or income source diversification among farmers in the region. Therefore, it is expected that additional income from these off-farm activities could be used to supplement on-farm income for climate change adaptation, especially, for those strategies that are capital intensive.

Farmers who had access to credit also adopted more adaptation strategies than those without credit. Considering the various adaptation strategies adopted by the farmers, it is appropriate that credit could enhance the adaptation of these strategies. This is an important finding which justify the support of farmers with credit in order to increase their farm outcomes amidst the changing climate. Other studies that found credit access to enhance climate change adaptation include Ndamani & Watanabe (2016), Urgessa & Amsalu (2014) and Okonya et al. (2013).

Table 6: Effect of farmer perception on climate change adaptation

Variable	Coefficient	Std. Error	P-Value
Sex	0.622***	0.193	0.001
Education	-0.038***	0.008	0.000
Household size	-0.016**	0.008	0.040
Experience	0.016***	0.004	0.000
Extension	-0.009	0.006	0.129
FBO	0.116	0.098	0.233
Off-farm	0.472***	0.089	0.000
Credit	0.721***	0.133	0.000
Perception	0.364***	0.114	0.001
Wald chi2(9)	167.93***		

***, ** and * indicates significance at 1%, 5% and 10%, respectively

Source: Authors 'estimation

4. Conclusion and Policy recommendations

Climate change is one of the most challenging global phenomenon in recent periods. While the rains are becoming erratic, temperatures and winds especially associated with rains are increasing. In line with global commitment of mitigation and adaptation, farmers on their small scale have also resorted to responding to the changing climates by introducing adaptation strategies into their farm plans. This is the only food can be produced to feed the increasing the population. The objective of this study is to examine farmer's perception of climate change and

the effects of perception on farmer's adaptation strategies. Respondents were drawn from maize and sorghum communities in Benin and Nigeria. Unlike other studies that modelled perception as dichotomous variable, this study defined perception as an ordered response considering three climate variables as precipitation, temperature and wind. The study concluded that farmers' perception has positive effect on their adaptation decisions. What it means is that to increase adaptation, more education is needed to given to farmers on the direction of change in the climate variables. The study also concluded that adaptation is higher for male farmers, less educated farmers, farmers with less household members, experienced farmers, farmers with off-farm activities and farmers who had access to credit. However, a number of factors was also responsible for the farmers' perception and this include education, years of farming, access to extension service and country of the farmer. To enhance adaptation of the farmers therefore, factors that influence the farmers' perception of climate have to be given a prime consideration. Extension and education services are vital. However, this study did not examine the impact of adaptation of farmers on crop production despite the fact that the objective of these farmers is to increase their farm outputs. Therefore, further studies could consider considering estimating the response of output to adaptation.

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