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THE CHOICE OF CLIMATE CHANGE ADAPTATION STRATEGIES PRACTICED BY CASSAVA-BASED FARMERS IN SOUTHERN NIGERIA

Adanna HENRI-UKOHA*

Department of Agricultural Economics and Extension, University of Port Harcourt, Choba, Nigeria
*Corresponding author: adanna.henri-ukoha@uniport.edu.ng

ABSTRACT

The study on choice of climate change adaptation strategies practiced by cassava-based farmers was conducted in Southern Nigeria. The following specific objectives were achieved: to ascertain the perceived effects of climate change in the study area and to determine factors influencing the choice of using climate change adaptation strategies by cassava-based farmers in the study area. Data were obtained through the administration of questionnaire to 300 randomly sampled cassava-based farmers in the study area. Data were analyzed using descriptive statistics such as mean, frequencies, percentages and inferential statistics such as Multinomial Logit Regression technique. The result revealed that farmers perceived increase in flood incidence (91.33%), drought (90.67%), high incidence of pests and diseases (55%) and low yield (50%) as the effects of climate change in the study area. Also, from the results, 58% of the farmers chose not to employ the use of climate change adaptation strategies while only 42% decided to choose using climate change adaptation options in the study area. The result also showed that age of the farmer, farming experience, gender, marital status, level of education, household size, access to credit, access to agricultural extension services and membership of association were the factors influencing the choice climate change adaptation strategies used by the farmers. The study concluded that socio-economic attributes of the farmers affected their choice of climate change adaptation strategies. Policy should be targeted at designing climate change adaptation technology to farmers as well as providing the enabling environment that would encourage them to employ it.

Keywords: *Choice, Climate Change, Adaptation Strategies, Cassava-based Farmers.*

INTRODUCTION

Agriculture is the springboard and engine of economic growth in developing countries which according to Ozor (2009) contributes about 40% of the gross domestic product and provides employment to 70% - 80% of the population.

Climate is crucial for agricultural production. However, climate is changing and is already affecting agricultural production, economy and livelihood of the population of developing countries (Kandy et al. 2006). Climate change is the most unprecedented threat in human history (Ozor et al. 2012). For instance, Henri-Ukoha, Ugwuja and Uhuegbulam (2017) re-iterated that climate and weather-related issues have impeded agricultural development in Nigeria. Zievogel et al. (2008) confirmed that climate change has affected agricultural productivity adversely. Sub Saharan Africa including Nigeria is highly vulnerable to climate change impact due to their overdependence on rainfed agriculture and low adaptive capacity (Bolaji et al. 2010). Climate change will continue to affect agricultural production, water scarcity (Liwenga, 2015) and food security adversely thereby increasing the risk of hunger by additional 80 million people in Africa and Asia by 2020 (Nwafor, 2007).

Climate change will frustrate farmers' effort to achieve food security unless adaptation measures are put in place (Adebayo et al. 2012). Moreso, as climate is a natural phenomenon, it is impossible for man to stop it, but measures can be used to reduce the effects (Singer and Avery, 2007). Mitigation and adaptation are two central issues to tackle climate change (Enete, 2014). Adaptation is one of the policy responses projected or actual changes in climate, with the goal of maintaining the capacity to deal with current future changes (Dixon, 2003). "Adaptation to climate change could be defined as an adjustment in human, ecological or physical system in response to actual and or would be stimuli or their effects, which moderate harm or exploits beneficial opportunities" (Shongwe, 2013). Adaptation includes anticipatory and reactive activities (Ifeanyi-Obi et al. 2012).

Therefore, with adaptation, vulnerability will be reduced (Rosenweig, Smith and Skinner, 2002). Several adaptation strategies are being practiced by farmers. These include changing crop variety(Saguye, 2016), soil and water conservation (Debela, 2017); diversification of livelihood activities, adjustments in farming operations (Intergovernmental Panel on Climate Change, IPCC, 2007); planting different crop varieties, changing planting dates (Maddison, 2007); increasing irrigation (Gbetibuo, 2008); change in crop cultivar (Akponikpe et al. 2010); drought resistant varieties (Mburu et al, 2015) and mixed cropping (Ndamani and Watanabe, 2006; Haji and Sani, 2014). Other adaptation practices adopted by farmers include: intercropping/multiple cropping, agroforestry, mulching, irrigation (Enete et al. 2011); tree planting, early planting, small scale irrigation and mulching (Adebayo et al. 2011).

However, the choice of using any of the climate change adaptation strategies is paramount. Enete (2014) conducted a study on the choice of climate change adaptation strategies among food crop farmers in South West Nigeria. Onubuogu and Esiobu (2014) also used multinomial logit to ascertain the trends, perceptions and adaptation options of arable crop farmers to climate change in Imo State, Nigeria. Deressa et al. (2008) analyzed the determinants of farmers' choice of adaptation methods and perceptions of climate change in the Nile Basin of

Ethiopia. Marie eta la (2020) studied farmers' choices and factors affecting adoption of climate change adaptation strategies: evidence from Northwestern Ethiopia. None of these looked at the drivers of the choice of a suitable and efficient adaptation options by cassava-based farmers in Southern Nigeria, leading to gap in knowledge which this study intends to fill. This study will help farmers, policy makers and other stakeholders to know the possible adaptation responses to suit the local needs of cassava farmers in the study area.

MATERIALS AND METHODS

The study was conducted in Southern Nigeria. The area is made up of South East, South West and South-South Nigeria. Multi-stage random sampling procedure was employed in sample selection. In the first stage, two regions, South East and South-South geo-political regions were selected purposively from Southern Nigeria based on areas where cassava farming is most predominant. In the second stage, one state each was purposively chosen from each of the two geo-political regions making two states. This was states that have upland (Abia) and riverine areas (Rivers). In the third stage, five Local Government Areas, (LGA) randomly selected from each state making 10 LGAs. Fourthly, five communities were selected from each LGA making 50 communities. Finally, six cassava-based farmers were selected from a list of registered cassava-based farmers in each community using simple random sampling. This gives a total of 300 cassava-based farmers in the study area. Primary data were obtained through administration of questionnaire, interview schedule and Focus Group Discussion (FGD). Validation of the survey instruments were done using a pilot survey where ten percent of the questionnaire were given to the respondents to fill with the help of trained enumerators who were employed in data collection. Data were analyzed using descriptive and inferential statistics. Descriptive statistics include percentages, mean and frequency distributions while inferential statistics involve the use of Multinomial Logit regression model (Greene, 2003). The model is expressed as;

$$Pr(Y_1 = j) = \frac{e\beta_j . x_{ij},}{1 + \sum_{m=0}^{6} e^{\beta_m x_{ij}}} \quad j = 0,1,2,3,4,5,6 \quad \text{..................} \text{ eqtn 1}$$

$e\beta_j$ is a vector of parameters that relate the socio-economic, farm and institutional characteristics X_i to the probability $Y = X_j$

Since the probability of the five climate change adaptation strategies will aggregate to one

Where,

Y denotes the random variable taking on the values of (0,1,2,3,4,5) for a non-negative integer j, while "x" denotes a set of conditioning variables. In this study, Y represents the climate change adaptation strategies while x represents the cassava-based farmers' socio-economic characteristics. The study assumes that probability of choosing a single climate change adaptation strategy by any cassava farmer is independent of the probability of choosing another type of climate change adaptation strategy.

The parameter estimates of the MNL model provides direction of the effect of the independent variables on the dependent (choice) variable; hence the estimates represent neither the actual magnitude of change nor the probabilities (Greene, 2000).

Where,

$Y_{i=0,1\ldots,n} = \delta_0 + \delta_1X_1 + \delta_2X_2 + \delta_3X_3 + \delta_4X_4 + \delta_5X_5 + \delta_6X_6 + \delta_7X_7 + \delta_8X_8 + \delta_9X_9 + \delta_9X_9 + \delta_{10}X_{10} + \delta_{11}X_{11}$

Where,

Y_0 = Choice of using no climate change adaptation practice (Y = 0)
Y_1 = Choice of using improved cassava variety (Y = 1)
Y_2 = Use of minimum tillage (Y = 2)
Y_3 = Use of change in planting dates (Y = 3)
Y_4 = Mixed cropping (Y = 4)
Y_5 = Use of conservation technique (Y = 5)

The explanatory variables are:

X_1 = Age of the farmer (Years)
X_2 = Farm Experience (Years)
X_3 = Gender (Dummy: Male=1; Female =0)
X_4 = Marital Status (Dummy: Married = 1; Single = 0)
X_5 = Level of Education (Years spent in school)
X_6 = Household Size (Number)
X_7 = Access to Credit (D: Access = 1; No access = 0)
X_8 = Access to Extension (D: Access = 1: No access = 0)
X_9 = Membership of Association (D: Member = 1; Non-member = 0)
X_{10} = Farm Income (Naira)
X_{11} = Non-farm Income (Naira)

RESULTS AND DISCUSSION

Perceived Effects of climate change in the study area

Fig 1 below shows the perceived effects of climate change in the area. Majority of the cassava farmers 91.3% indicated high incidence of flood as the most perceived effects of climate change in the area. In recent times, there has been high incidence of flood recorded in Southern agricultural zones which has left millions of farm land impoverish and un-sustainable leading to poor yields in outputs and income of the crop farmers in general. Again, high incidences of pests and diseases have ravaged most of the agricultural crops including cassava plants leading to low yields and income as perceived by 54% of the cassava farmers (Osuji et al. 2017). About 43% of the cassava farmers pointed crop failure as an effect of climate change noting that a lot of farmers have experienced adverse crop failure since the emergence of climate change. More than 37% of cassava farmers perceived irregular temperature and unpredicted rainfall as vital impacts of climate change

(Braimoh et al. 2016). Temperature and rainfall have been unstable and ever fluctuating indicating a negative trend in relation to crop production. Low yields, low rain and seasonal changes accounted for 55%, 7% and 8% of the cassava farmers and were seriously noted as consequences of climate change. These variables as occasioned by climate change influences agricultural productions to a large extent deprive farmers their only source of livelihood (Shongwe, 2013).

However, less than 15% of cassava farmers experienced hunger/food security as well as high incidence of rainfall. Again, these factors have been a source of concern to majority of the farmers implying that most farm households cannot afford a three consecutive square meal per day not to talk of providing a balanced diet for their dependents. In addition, these farm households also suffered financial lack due to climatic changes and this further result to their impoverishment. Furthermore, destruction of nature 16% and poor stem survival 14% were also perceived as effects of climate change in the area. Due to the nature of most farm lands triggered by climate change, hardly viable stems survive in the soil leading to low harvest and food shortage (Buchner et al. 2017). Conclusively, 90.67% and less than 24% of the cassava farmers opted for drought and poor plant performance as negative consequences of climate change in the area.

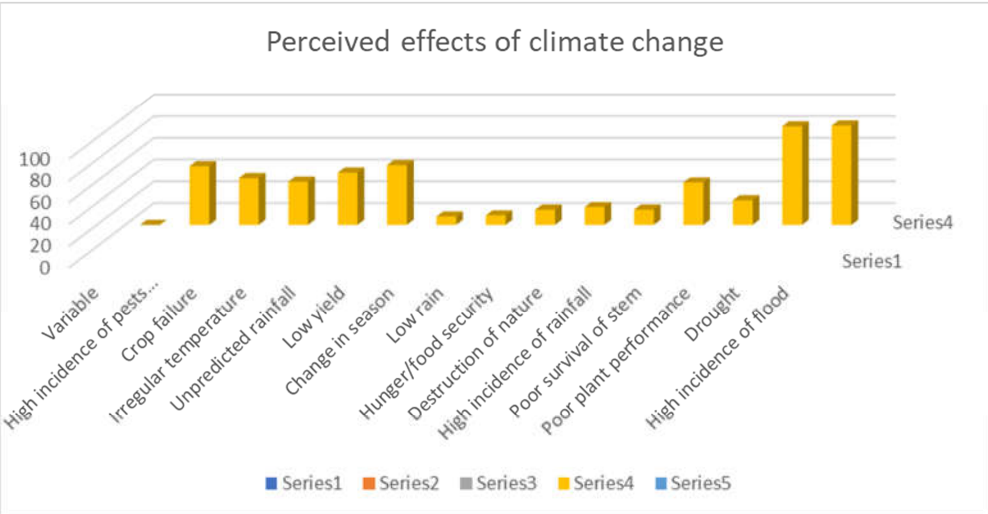

Figure 1. Perceived effects of climate change in Southern Nigeria

Choice of using Climate Change Adaptation Strategies

The cassava-based farmers' choice of using climate change adaptation strategies is shown in fig 2. From the results, majority (58%) of the farmers did not choose the use of climate change adaptation strategies while 42% of the farmers chose using climate change adaptation strategies. This indicates that a good proportion of the farmers in Southern Nigeria chose not to practice effective climate change adaptation strategies in their farms. The choice of employing climate change adaptation strategies will help the farmer to cope with the devastating effects of the changing climate, which has implications for food security in the study area. However, failure to choose the use of effective climate change adaptation strategies could be attributed to inadequate resources required to practice the adaptation technologies.

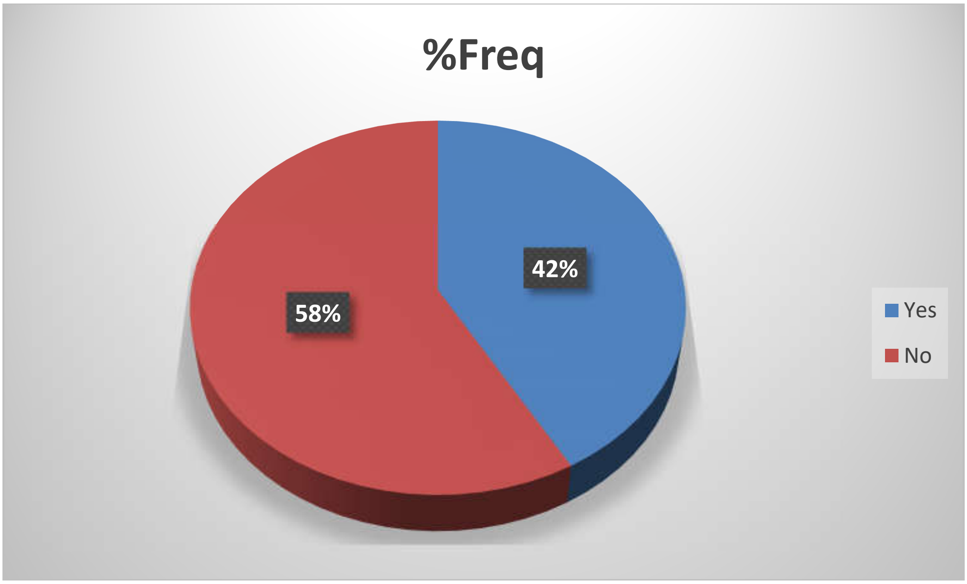

Figure 2. Farmers' choice of using climate change adaptation strategies

Result of the Multinomial Logit of factors influencing the choice adaptation strategy

Table 1. Result of the Multinomial Logit of factors influencing the choice adaptation strategy in the study area.

Variables	Use of Improved Varieties	Zero Tillage	Change in Planting dates	Use of Conservation Technique	Construction of drainage channels
Age	-0.2133	-0.0093	-0.3292	-0.0118	-0.0271
	(-3.3750)**	(-0.0145)	(-5.0336)**	(-0.1764)	(0.3875)
Farm	-0.0053	0.0639	0.0654	0.0671	0.0700
Experience	(-0.0501)	(2.8069)**	(2.7442)**	(2.7243)**	(0.3875)
Gender	0.9194	0.8490	0.6230	0.8224	0.5242
	(1.0934)	(3.3871)**	(0.7136)	(0.9085)	(0.5392)
Marital	0.9696	0.5035	0.2258	0.0572	0.4883
Status	(1.0229)	(3.0430)**	(1.3443)	(2.5854)*	(1.4295)
Education	0.3548	0.5307	-0.0695	-0.1051	-0.0584
Level	(2.7355)**	(4.0419)**	(-0.5223)	(-0.7745)	(4.0775)**
Household	0.5578	0.2980	0.8266	0.9716	-0.2150
Size	(2.0181)*	(0.3377)	(0.9299)	(3.1783)**	(4.5648)**
Farm Size	-3.2836	-3.5369	-1.5681	3 .0409	3 .1592

	(1.0229)	(3.0430)**	(1.3443)	(2.5854)*	(2.6202)**
Access to	1.7738	1.9292	3.0372	3.1020	1.7645
Extension	(1.2040)	(1.5968)	(2.4938)*	(2.5242)*	(1.4046)
Access to	5.1299	11.0502	11.1022	11.0961	11.4716
Credit	(2.1670)*	(0.0162)	(0.0163)	(0.0163)	(0.0169)
Membership	1 .1117	-.0230	-.3962	-.2992	4.2903
of Association	(4.6379)**	(0.0185)	(-0.3150)	(0.2650)	(3.1827)**
Farm income	11.89e- 06	7.53e-06	8.76e-06	7.11e-06	4.51e-06
	(0.0189)	(1.2264)	(1.4151)	(1.1304)	(0.6854)
Non-farm	-2.71e-06	-2.11e-06	-1.93e-06	-9.27e-07	-1.98e-06
Income	(1.2604)	(0.9679)	(0.8694)	(-4.0650)**	(-0.7952)
Constant	-4.372	-.5335	9 .6708	-6.2792	-4.4756
	(-3.2967)**	(0.1225)	(2.8374)**	(-2.5018)*	(1.6469)

Number of observations	300
LR Chi Square	37.21
Probability	0.7889
Pseudo R^2	0.0376
Log-likelihood R^2	-476.41

*Source: Field Survey, 2020

From the result in Table 2, using no adaptation as the base category, the result of the Multinomial Logit show that different farm household characteristics (age of farmer, farming experience, gender, marital status, level of education, household size; farm specific variables (farm size) and institutional variables (access to extension, access to credit, membership of association) affected farmers' choice of using climate change adaptation strategies. This is agreement with the findings of Onubuogu and Esiobi (2014) who reported that socioeconomic characteristics of farmers affected their choice of climate change adaptation strategies in Imo Sate, Nigeria. The log-likelihood chi square (X^2) is significant at ($P<0.01$) indicating that the model has a good fit.

Age of the farmer

The result shows that there is a significant negative relationship between age of the farmer and the probability of choosing the use of improved cassava varieties($P<0.01$) and change in planting dates($p<0.01$) as climate change adaptation strategies. This suggests that older farmers choose to use these adaptation strategies while younger farmers do not choose to use these climate change adaptation strategies in the study area. This implies that a unit increase in the age of cassava farmers will decrease the probability of choosing the use improved cassava varieties and change in planting dates by (21.33%) and (32.92%) respectively in the study area.

Farming Experience of the farmer

The result in Table 2 shows that there is a significant positive relationship between farming experience of the farmer and the probability of choosing the use of minimum tillage ($P<0.01$), change in planting date ($P<0.01$) and use of mixed cropping ($P<0.01$). This indicates that experienced farmers choose minimum tillage, change in planting dates as well as mixed cropping as climate change adaptation strategies in the study area. This implies that a unit increase in farm experience of the farmer will increase the choice of using the use of minimum tillage, change in planting date and use of mixed cropping by (63.90%), (65.40%) and (67.10%) respectively as climate change adaptation strategies.

Gender of the farmer

The result shows that there is a significant positive relationship between gender of the farmer and the probability of choosing minimum tillage ($P<0.01$) as climate change adaptation strategy, indicating that male farmers choose to use minimum tillage while female farmers choose not to use climate change adaptation strategies. This implies that a unit increase in the gender of cassava farmers will increase the probability of choosing use of minimum tillage by (84.90%) as climate change adaptation strategies. This suggest that gender of the households had a positive impact on farmer's decision to choose adaptation options. This implies that male-headed households had better opportunities to practice adaptation measures and access to technologies and climate change information than female-headed households, hence place them in a better position to practice diverse adaptation strategies. This result was in agreement with (Belay et al. 2017).

Marital Status

Table 2 shows a positive relationship between the marital status of farmers and the probability of choosing the use of minimum tillage ($P<0.01$) and mixed cropping ($P<0.05$) in adapting to climate change in the study area. This shows that married farmers chose to use zero tillage and mixed cropping as climate change adaptation practices in the study area. Hence one unit increment in being a married will increase the probability of choosing to use minimum tillage and use of mixed cropping by (50.35%) and (57.20%) as climate change adaptation strategies in the study area.

Level of Education

The result shows that level of education has a positive effect on the probability of choosing the use of improved cassava varieties ($P<0.01$), use of minimum tillage ($P<0.01$) and conservation techniques ($P<0.01$). This suggests that the number of years spent in school by the farmer influences the choice of using improved cassava varieties, use of minimum tillage and conservation techniques as climate change adaptation strategies by the cassava-based farmers in the study area. This implies that a unit increase in the number of years spent in school increase the probability of choosing and using improved cassava varieties, use of minimum tillage and conservation techniques by (35.48%), (53.07%) and (58.40%) as climate change adaptation strategies.

Household Size

From the result, household size influences the probability of choosing the option of using improved cassava varieties ($P<0.05$), mixed cropping ($P<0.01$) and conservation practices ($P<0.01$), suggesting that the larger the household size, the higher the chances of choosing improved cassava varieties, conservation practices and conservation practices as climate change adaptation strategies in the study area. This suggests that a unit increase in the size of the household increases the probability of choosing the option of using improved cassava varieties, mixed cropping and conservation practices by (55.78%), (97.16%) and (21.50%) respectively as climate change adaptation strategies. Household size had a positive impact on farmer's decision to choose adaptation options (Marie et al. 2020).

Farm Size

Also, from Table 2, the size of farm correlates with the probability of choosing the minimum tillage ($P<0.01$), mixed cropping ($P<0.01$) and use of conservation measures ($P<0.01$). Hence, the larger the farm, the higher the probability of choosing minimum tillage, mixed cropping and the use of conservation techniques as climate change adaptation strategies in the study area. A unit increase in farm size will increase the probability of choosing to use minimum tillage, mixed cropping and use of conservation measures (35.37%), (30.41%) and (31.59%) respectively as climate change adaptation strategies by cassava-based farmers in the study area. This implies that farmers who have large farms are more likely to take these adaptation decisions as they have enough resources to implement the effective adaptation options. This result is in agreement with the study by Kide (2014) pointed out households with relatively large farm sizes were more likely to take up new adaptation strategies when compared to farmers with small farm sizes.

Access to Extension

Table 2 shows that access to agricultural extension services increase the probability of choosing change in planting dates ($P<0.05$) and mixed cropping ($P<0.01$) as climate change adaptation strategies. This shows that the more contact cassava farmers have with agricultural extension services, the higher the probability of choosing the use of change in planting dates and mixed cropping as climate change adaptation strategies in the study area. This implies that a unit increase in access to extension will increase the probability of choosing and using change in planting dates and mixed cropping by (30.37%) and (31.03%) respectively as a climate change adaptation strategy.

Access to Credit

Table 2 also shows that access to agricultural credit increases the probability of choosing the use of improved cassava variety ($P<0.05$) as a climate change adaptation strategy. This shows that the more cassava farmers have access to credit facilities, the higher the probability of using improved cassava varieties as a climate change adaptation strategy and that farmers who do not have access to credit may not use improved variety as an adaptation strategy in the study area. This implies that a unit increase in access to credit will increase the probability of choosing and using improved cassava variety by (51.29%) as a climate change adaptation strategy.

Membership of Association

The result in Table 2 shows that membership of association influences the choice of using improved cassava varieties ($P<0.01$) and conservation techniques ($P<0.01$) as climate change adaptation strategies. This indicates the more the number of associations a farmer belongs to, the higher the probability improved cassava varieties and conservation techniques. This implies that a unit increase in membership of association will increase the probability of choosing and using improved cassava varieties and construction of drainage channels by (11.12%) and (42.90%) respectively as climate change adaptation strategies in the study area.

Non-Farm Income

Table 2 also shows that the ability to get income from non-farm sources increases the probability of choosing the use of mixed cropping ($P<0.01$) as a climate change adaptation strategy. This shows that the more cassava farmers acquire money from non-farm sources, the higher the probability of using mixed cropping as climate change adaptation strategy and that farmers who do not get funds from non-farm income sources may not use conservation technique as a adaptation strategy in the study area. This implies that a unit increase in the ability to get non-farm income will increase the probability of choosing and conservation technique by (51.29%) as a climate change adaptation strategy.

CONCLUSION

The study revealed that the cassava-based farmers perceived high incidence of flood, drought, high incidence of pests and diseases and low yield as the effects of climate change in the study area. Most of the farmers chose not use practice adaptation technologies. Also from the study, such socio-economic attributes of the farmers such as age, farming experience, gender, marital status, household size, farm size, access to credit, access to extension, membership of association and non-farm income affect the choice of climate change adaptation strategies used by the cassava-based farmers in the study area.

POLICY IMPLICATIONS

Farmers ability to choose effective climate change adaptation strategies are dependent on the such household socio-economic characteristics as age of the farmer, farming experience, gender, marital status, level of education, household size, access to credit, access to agricultural extension services and membership of association. These should therefore be taken into consideration when formulating climate change policies. Climate policy should focus on climate adaptation across gender lines, promoting awareness creation and increasing capacity building on climate change through knowledge and skill sharing platforms such as training, conferences, and seminars. Again, facilitating the availability of credit; institutional, policy, and technology support for agricultural extension services for adaptive technologies and membership of co-operatives could improve smallholder farmers' ability to spread their adaptation strategies across a range of adaptation portfolios and the level of adaptation measures.

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REFERENCES

Akpan, S.B., Patrick, I.V., Udoka, S.J and Udo, U.J. (2014). Choice of soil management techniques as adaptation to climate change among fluted pumpkin farmers in Akwa Ibom State, Nigeria. *African Journal of Agricultural Economics and Rural Development*, 2(2), 112-120.

Akponikpe, P.B.I., Johnson, P and Agbossou, K.U. (2010). Farmers' perception of Climate Change and Adaptation Strategies in Sub Saharan West Africa 2nd International Conference: Climate, Sustainability and Development in semi-Arid Regions, August 16-20, 2010, Fortaleza-Ceara, Brazil.

Adebayo, A.A., Onu, J.I., Adebayo, E.F and Anyanwu, S.O (2012). Farmers' awareness, vulnerability and adaptation to climate change in Adamawa state, Nigeria. *British Journal of Arts and Social Sciences*, 9(2), 104-115

Belay, A., Recha, J.W., Woldeamanuel, T and Morton, J.F. (2017). Smallholder farmers' adaptation to climate change and determinants of their adaptation decisions in the Central Rift Valley of Ethiopia. Agriculture Food Security, 6 (1), 24

Bolaji-Olatunji, K.A., Olufolaju, A.D and Awe, F. (2010). Climate Change, Adoption and Natural Resources Management in Nigeria. Proceedings of the 44th Annual conference of Agricultural Society of Nigeria (ASN), pp 1449-1451

Dasmani, I., Darfor, K. N and Karakara, A. A and Hardman, M. (2020). Farmers' choice of adaptation strategies towards weather variability: Empirical evidence from the three agro-ecological zones in Ghana, *Cogent Social Sciences*, 6:1, DOI: 10.1080/23311886.2020.1751531

Debela, B (2017). Gender and climate change: determinants of female farmer's adaptation strategies to climate change; A survey study in Atsbi Womberta, Ethiopia. *Journal of Citizen Moral*, 1 (1) (2017), 14-40

Deressa, T., Hassan, R.M., Alemu, T., Yusuf, M and Ringler, C. (2008). Analyzing the determinants of farmers' choice of adaptation methods and perceptions of climate change in the Nile Basin of Ethiopia. IFPRI Discussion Paper 00798, International Food Policy Research Institute, Washington, DC; 2008.

Enete, A.A., Madu, I.I., Mojekwu, J.C., Onyekuru, A.N., Onwubuya, E.A and Eze, F. (2011). Indigenous agricultural adaptation to climate change: study of South East Nigeria (ATPS Research Paper No.6), Nairobi, Kenya, African Technology Policy Network.

Enete, A.A., Otitoju, M.A and Ihemezie, E.J. (2015). The choice of using climate change adaptation strategies among food crop farmers in Southwest Nigeria, Nigerian Journal of Agricultural Economics, 5(1)

Gbetibouo, G. A. (2009). Understating Farmers' Perceptions and Adaptation to Climate Change and Variability: The Case of the Limpopo Basin. IFPRI, Discussion Paper (Washington, DC: International Food Policy Research Institute).

Greene, W.H. (2000). *Econometrics* (4th ed) Prentice Hall, New Jersey

Greene, W.H. (2003). *Econometrics* (4th ed) Prentice Hall, New Jersey

Haji, J and Sani, S. (2014). Climate change Adaptation Strategies of Smallholder Farmers: The Case of Assosa District of Benishangul Gumuz Regional State, Western Ethiopia Haramaya University (2014)

Henri-Ukoha, A., Ugwuja, V.C and Uhuegbulam, I.J. (2016). Climate Smart Agriculture: A panacea for coming out of Economic Recession in Nigeria, *Agricultural Economics and Extension Research Journal*, 5(2), 54-67

Ifeanyi-Obi, C.C., Etuk, U.R and Ododobari, J. (2012). Climate change, effects and adaptation strategies: Implications fro agricultural extension system in Nigeria. *Greener journal of Agricultural Sciences,* 2(2), 53-60

IPCC (Intergovernmental Panel on Climate Change) (2007). Synthesis Report Summary for Policymakers. *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK, accessed at http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-spm.pdf

Kandji, S.T., Verchot, L and Mackenson, J. (2006). Climate change and vulnerability in the Sahel region: impact and adaptation strategies in the agricultural sector. ICRAF-UNEP.

Kide, G.T. (014). Smallholder Farmers' Adaptation Strategies to Climate Change in Ethiopia: Evidence from Adwa Woreda of Tigray Region Mekelle University (2014)

Kurukulasuriya, P and Mendelson, R. (2006). Crop selection: Adapting to Climate Change in Africa CEEPA Discussion Paper, No.26

Liwenga, E.T. (2015). Climate change adaptation: synthesis of findings on research and policy in agriculture in the Sub-Saharan Africa. International conference on research evidence and research policy linkages for adaptation to climate change in Africa, Hilton hotel, Nairobi, Kenya held in 10th March, 2015.

Madison, D. (2007). The perception and adaptation to climate change in Africa. The World Bank Development Research group, Sustainable and Rural Development Team, policy Research Working paper 4308.

Marie, M., Yirga, F., Haile, M and Tquabo, F (2020). Farmers' choices and factors affecting adoption of climate change adaptation strategies: evidence from Northwestern Ethiopia, *Heliyon* 6(4), 110

Mburu, B.K., Kung'u, J.B and Muriuki, J.N. (2015).Climate change adaptation strategies by small-scale farmers in Yatta District, Kenya. African Journal of Environmental Science and Technology, 9 (9), 712-722

Ndamani, F and Watanabe, T. (2016). Determinants of farmers' adaptation to climate change: a micro level analysis in Ghana. Science of Agriculture, 73 (3), 201-208

Nwafor, J.C. (2007). Global climate change: the driver of multiple causes of flood intensity in Sub-Saharan Africa. Paper presented at the International conference on Climate Change and economic Sustainability held at Nnamdi Azikiwe University, Enugu held in 12 to 14th June, 2007.

Onubuogu, GC and Esiobu N. (2014). Trends, perceptions and adaptation options of arable crop farmers to climate change in Imo State, Nigeria; Multinomial Logit Model Approach. *Scholarly Journal of Agricultural Science*, 4(7), 370-385.

Ozor, N. (2009). Implications of climate change for National development: the way forward, Debating Policy Options for National Development: Enugu Forum policy paper 10; African Institute for Applied Economics (AIAE); Enugu, Nigeria: 19-32. Available at: https://www.aiaenigeria.org/Publications/Policypaper10.pf

Ozor, N., Urama, K and Mwangi, W. (2012). Climate change technologies and the use of indigenous Technologies for Adaptation among Smallholder farming Communities in Sub-Saharan Africa. *Journal of Agricultural Extension*, 16(2), 161-182

Shongwe, P. (2013). Cost-benefit analysis co climate change adaptation strategies on crop production systems: A case of Mpolongeni Area Development Programme (ADP) in Swaziland, an MSc thesis at the Department of Agriculture and Applied Economics, University of Swaziland.

Singer, S.F and Avery, D.T. (2007). Unstoppable global warming: Every 1000 years. Newyork: Rowman and Littlefield Publishers Inc, 114pp

Saguye, T.S. (2016). Determinants of Smallholder Farmers' Adoption of Climate Change and Variability Adaptation Strategies: Evidence from Geze Gofa District, Gamo Gofa Zone, Southern Ethiopia.

Zievogel, G., Cartwright, A., Tas, A., Adejuwon, J., Zermoglio, F, Shame, M and Smith, B. (2008). Climate change and adaptation in African agriculture. Prepared for Rockfeller Foundation by Stockholm Environment institute.