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Farmer's adaptation to climate change in Ondo State, Nigeria: A gender analysis

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In combating the problem created by adverse climatic change, farmers in the areas had been introduced to climate change adaptation practices for the purposes of increasing yields for better livelihood and food security. The study used multi-stage sampling technique to collect information from 120 respondentsts. Data collected were subjected to descriptive, gross margin and multinomial logit analyses. Results of the descriptive analyses reveal that the mean age of the male farmers was 46.3 years while that of the female farmers was 45.5 years. The mean farm sizes were 3.8 hectare and 1.4 hectare for male and female farmers, respectively. The results of the gross margin analysis reveal that the total revenue to an average male maize farmers was N101,443.8 and that of an average female farmer was N78,551.1. The gross margin for and average male farmer was N71,905.8 while that of an average female farmer was N58,098. Multinomial logit analysis revealed that credit access positively influenced mulching, irrigation and tree planting practices. Extension visits positively influenced varying time of planting and tree planting practices. Government and development agencies should introduce policies and programme that would enhance strong and virile extension and credit units.

Key words: Climate change, adaptation, multinomial logit, gender.

INTRODUCTION

Agriculture is an important sector in Nigeria as it provides employment for over 60 percent of the entire population. This population operates subsistence agriculture which is almost entirely weather dependent (Sofoluwe et al., 2011). The declining productivity of agricultural crops and food wastes had been traced to adverse climatic change and variability. Climate change and variability (CC and V) is rapidly emerging as one of the most serious global problems (Mary and Majule, 2009). Rising temperature and changes in rainfall patterns have direct effects on crop yields, as well as indirect effects through changes in irrigation water availability. These as well affect many sectors in the world and are considered to be one of the most serious threats to sustainable development with adverse impact on environment, human health, food security, economic

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activities, natural resources and physical infrastructure (IPCC, 2007; Huq et al., 2006, Adeloye and Sotomi, 2013).

Studies have shown that the developing countries, in which Nigeria is one, are the most vulnerable regions to climate change and variability in the world because of their dependence almost on weather. Previous assessments (IPCC, 1998; Hulme, 1996) concluded that Africa is particularly vulnerable to the impacts of climate change because of factors such as widespread poverty, recurrent droughts, inequitable land distribution and over dependence on rain-fed agriculture. Ngana (1983) in his study on drought and famine in Dodoma District asserted that the presence of dry spells in critical periods for most crops contributed considerably to crop failure and famine. Given the over-dependence on rain-fed agriculture by the majority of people living in rural areas, CC and V has been one of the major limiting factors in agriculture production thus resulting in food insecurity and low-income generation (Sofoluwe et al., 2013). For example, droughts and floods have been reported to cause failure and damage to crops and livestock leading to chronic food shortages (Liwenga et al., 2007; Kangalawe and Liwenga, 2005). The studies conducted by Rosenzweig et al. (2002) revealed that changes in rainfall patterns and amounts have led to loss of crops and reduced livestock production. Because of concerns for the growing threat of global climate change from increasing concentrations of greenhouse gases in the atmosphere to incessant high temperature and consequent reduction in rainfall which had called the attention of the international organizations such as Framework Convention on Climate Change (FCCC), United Nations (UN) and FAO on the needs for adaptation for the purposes of conserving the world bio-diversity and hence achieving food security through maintaining agricultural productivity (UNEP, 2002). Adaptation has been variously defined by authors. According to Kreft et al. (2010), it is an initiative, approach, measures or practices to reduce the menace of or vulnerability of natural or human resources to climate change.

Fakoya et al. (2006) established the involvement of farmers of both sexes in farming activities. They added that there are variations in the level of involvement across gender depending on the technology and energy needed. It therefore becomes imperative that the evolving trend in climate change adaptation practices among farmers looks at the attitude of men and women towards maintaining sustainable agricultural productivity in arable food crop production as a pathfinder to understanding the sustainability of the system. According to Verma (1992), farmers of both sexes engage in both pre-planting, planting and post-planting activities but vary is the level and time of involvement. Studies (Kreft et al.,2003; Parry et al., 2004; Burke and Lobell, 2010) examined the effects of climate change on agricultural productivity and farmers' adaptation in Nigeria's agriculture and Sofoluwe et al. (2011) investigated the perception of farmers to climatic changes and factors influencing the choice of adaptation methods. However, no known study has been conducted on farmers' adaptation to climate change on gender basis. The study therefore achieves the following objectives. Broadly, the study examines farmers' adaptation to climate change in Ondo State on gender basis. The specific objectives are to analyze the socio-economic characteristics of maize farmers in the study area on gender basis; identify adaptation strategies on gender basis; determine farmers' costs of adaptation practices; determine the gross margins on maize as well as examining the factors influencing farmers' choice of adaptation practices in the study area.

METHODOLOGY

Area of the study

The study area is Ondo state. The study was conducted in the southern part of the state. The southern part of the state comprises of six local Government Areas (LGAs) - Irele, Okitipupa, Ilaje, Ese-Odo, Odigbo and Ile-Oluji/Oke-Igbo. The state is located in the Southwestern part of Nigeria. It is in the rainforest belt with an average annual rainfall of over 2000mm and daily temperature of between 230^0C to 300^0C (Ojo and Afolabi, 2003). Ondo state with a land area of about 14,769 square kilometer was carved out of the defunct old Western Region on the 3^{rd} February 1976 out of which Ekiti state emerged in October 1996. Geographically, the state is located within longitude 4^0 and 6^0 E of the Greenwich Meridian and latitude 6^o and 8^0 N of the Equator. It is bounded by Kogi and Ekiti states in the North; Edo and Delta states in the East; Ogun and Osun states in the West and in the south by the Atlantic Ocean. Two distinct vegetation belts predominate in the state, the southern rainforest in which the southern part of the state falls and the northern derived savanna. Food crops such as cassava, maize, cocoyam, plantain, yam and vegetables, etc., are widely grown in the area. Both men and women engage in farming in the area.

Sampling procedure and data collection

A multistage sampling procedure was used to collect data from the respondents. The first stage involved purposive selection of three LGAs based on the predominance of agricultural activities. These were Irele, Odigbo and Okitipupa LGAs. The second stage involved a random selection of two villages in each of the LGAs. The final stage involved random selection of 20 respondents per village. A total of 120 respondents were selected in all for interview. Data were collected with the aid of structured questionnaires which were administered to farmers across sexes. Out of the 120 questionnaires administered, 117 of them were suitable for analysis. Data were collected on the socio-economic characteristics such as sex, age, educational information, family size, costs and returns associated with crops grown and knowledge about climate change adaptation practices among others.

Analytical techniques

Data collected were analysed using descriptive statistics; budgetary technique and multinomial logit model.

Table1. Description of expectation signs of independent variables

Variable	Expected sign
Age	+/-
Number of adult male	+
Level of education	+
Farm size	+
Employment income	+
Credit access	+
Extension visit	+
Crop income	+
Farming experience	+
Social capital	+

Descriptive statistics

Descriptive statistics such as mean and percentages were employed to describe the selected socio-economic variables and the average cost of adaptation practices.

Budgetary techniques

Budgetary technique was used to compute the costs and returns to selected arable crops by estimating the revenue, gross margin and the net farm income realized at the end of production process. Gross margin is the difference between the total revenue and total variable cost. According to Alimi and Manyong (2000), a budget is the quantitative expression of total farm plan summarizing the income, cost and profit (a residual of total cost from total revenue). The total cost component is expressed as:

TC = TFC + TVC
Where;
TC = Total Cost; TFC) = Total Fixed Cost; TVC = Total Variable Cost
To calculate gross margin GM,
GM = TR – VR;
Where;
TR = Total Revenue; VC = Variable Cost
Multinomial legit model

The Multinomial logit model was employed to package the various categories of adaptation practices into a five-model scenario. The model was employed instead of Tobit model because Tobit model assumes that non-adopter of a given practice does not adopt any other. This is because when there is more than one practice choice to choose from, that the farmer does not pick one does not mean he is a non-adopter. Hence, non-adoption of one does not necessarily puts the farmer in non- adopter category. This supports the model appropriateness.
The model was specified as

$$U_i = \beta_i X_i + \varepsilon_i$$

Which implies that the utility, U_i, of choosing a particular

practice is a stochastic linear function of farm, farmers and practice specific attributes (X_i). In this Multinomial logit, the probability,

Prob(choice j) = $\dfrac{\exp(\beta_j X)}{\sum_j^n \exp(\beta_j X)}$

of choosing a given practice, j, is equal to the probability that the utility of that particular technology is greater than or equal to the utilities of all other soil fertility technology in the model. The dependent variable in this model was a discrete variable taking the value 0, 1, 2, 3 and 4 for cases of non-adaptation, mulching, irrigation, varying time of planting and tree planting.
The empirical model specified is:

$Y_i = \beta_O + \beta_1$ *AGE*+ β_2 *ADULTMAL* + β_3 *EDULEV* +β_4 *FARMSIZE* +β_5 *CREDIT* + β_6 *EXTVIST* + + β_8 *CROPINCM* + β_9 *FARMEXP* + β_{10} *SOKAL*
Where; Y_i = Adaptation to climate change. (0= non-adaptation 1=mulching, 2= irrigation, 3=varying time of planting, 4= tree planting.
β_O = constant
β_1 *AGE* = age of respondents in year)
β_2 *ADULTMAL* = number of adult male
β_3 *EDULEV* = level of education extension visit
β_4 *FARMSIZE* β_7 *EMPLINCM* = land size owned
β_5 *CREDIT* = credit access
β_6 *EXTVIST* = extension visits
β_7 *EMPLINCM* = extension visits
β_8 *CROPINCM* = crop income
β_9 *FARMEXP* = farming experience
β_{10} *SOKAL* = social capital (proxy by members of association)

The multidisciplinary independent variables included farmer, farm and institutional factors postulated to influence adaptation practices. These variables include were age of farmers (*AGE),* number of adult male *(ADULTMAL),* level of education *(EDULEV),* farm size *(FARMSIZE),* employment income *(EMPLINCM),* credit access *(CREDIT*), extension visits *(EXTVIST),* crop income *(CROPINCM),* farming experience *(FARMEXP)* and social capital *(SOKAL).* It is hypothesized that a farmer's decision to either adapt or otherwise to climate change is influenced by the combined effect of a number of factors related to farmers' objectives and constraints. (Sofoluwe *et al.,*2011). The variables in the model were hypothesized to influence farmers adaptation positively (+), negatively (-), or both positively and negatively (+/-). The expected signs of the independent variable are shown below. (Table 1).

RESULT AND DISCUSSION

Descriptive analyses of socio-economic characteristics of respondents

The results of the descriptive analyses (Table 2) reveal that the mean age of the male farmers was 46.3 years while that of the female farmers was 45.5 years. The mean farming experience was 21.1 years for male and 14.7 years for female farmers, respectively. The mean farm sizes were 3.8 hectare and 1.4 hectare for male and female farmers respectively. The mean employment income among male farmers was ₦ 23,211.4 and that of female farmers was ₦13,768.7. This implies that farmers of both sexes engaged in non-agricultural activities. The mean cost of adaptation practices incurred was highest (₦ 4,664.3) among the male farmers compared to

Table2. Demographic and socio-economic characteristics of respondents

Variable	Mean	
	Male (68)	**Female (49)**
Age (years)	46.3	45.1
Farming experience (years)	21.1	14.7
Farm size (ha)	3.8	1.4
Emloyment income (~~N~~)	23,211.4	13,768.8
Cost of adaptation practices(~~N~~)	4,664.3	489.7
	%	
Extension Visits		
Yes	9.6	2.6
No	90.4	97.4
Total	100	100
Credit access		
Yes	3.8	0
No	96.2	100
Total	100	100
Perceived temperature		
Too hot	78.9	84.3
Hot	21.1	15.7
As before	0	0
Total	100	100

Source: Field survey, 2011

Table 3. Farmers' adaptation technique across gender

Adaptation practices	%		
	Male	**Female**	**Difference**
None	21.4	56.3	-34.9
Mulching	44.8	29.7	15.1
Irrigation	4.1	0	4.1
varying time of planting	12.4	11	1.4
tree planting	17.3	3	14.3
Total	100	100	

Source: Field survey, 2011

Table 4. Gross margin analysis for maize production (average)

Items	Male	Female	Pooled
Total revenue (~~N~~)	101, 443.8	78, 551.5	89,9977
Variable cost			
Seed	2,122.8	2,119.4	2121.1
Labour	19,339.6	9,566.7	14,453.2
Chemicals	4,632.4	3,878.9	4,255.7
Others	3,443.3	4,888.5	4,165.9
Total variable cost(~~N~~)	29,538.3	20,453.5	24,995.9
Gross margin	71,905.8	58,098	65,001.9

Source: Field survey, 2011

₦ 489.7 for female farmers. This implies that farmers of both sexes adapt to changes in the climate but the investment rate is low among female farmers compared to their male counterpart based on the result of the cost of adaptation practices. The contact farmers had with extension agents in the last production season was low. Analyses reveal that only 9.6% of the male farmers had contact with the extension agents while few 2.6% of the female farmers had contact with extension agents in the last production season. Results also reveal that while 3.8% of the male respondents had access to credit, none of the female respondents had access to credit. This implies that female respondents still do not have equal access with their male counterparts to productive resources. Analyses further revealed that none of the respondents of both sexes responded that temperature remained as before. Approximately 79 and 84% of male and female farmers responded that the weather proxy by temperature is too hot.

Farmers' adaptation technique across gender

Table 3 reveals the farmers' adaptation technique across gender. Results in the table reveal that greater proportion of the female respondents (56.3%) were never involved in any adaptation practices while just 21.4% of the male respondents did adapt to changes in climate. Mulching was the mostly employed technique by the farmers of both sexes as 44.8 and 29.7% of male and female farmers employed the technique. While 4.1% of the male farmers employed irrigation, none of the female respondents did. This might be due to the skills and cost involvement in the technique. Analysis further revealed that 12.4 and 11% of male and female farmers employed tree planting, respectively. However, while 3% of the female farmers employed tree planting, 17.3% of the male farmers employed tree planting. The results above conform with Verma (1992) that female farmers involvement in farming operation is dependent on skills and energy involved. This might be the reason for the non-employment of irrigation by the female farmers.

Gross margin analysis

The results of the gross margin analysis (Table 4) reveal that the total revenue to an average male farmers was ₦ 101,443.8 and that of an average female farmer was ₦ 78,551,1. The labour cost incurred by an average male farmer was higher (₦ 19,339.6) than that of an average female farmer. The higher cost of labour might be due to the cost incurred in adapting to climate change. The gross margin for and average male farmer was ₦ 71,905.8 while that of an average female farmer was 58,098. It can be deduced that adapting to climate change enhances better income.

Table5. Multinomial Logit model for the determinants of choice of adaptation options

Variable	Mulching	Irrigation	Varying planting time	Tree planting
AGE	-0.0175	-0.1325*	0.3374	-0.0778
ADULTMAL	-0.3533**	0.1107	0.2166	0.0056
EDULEV	0.2188	0.0055	0.0007	0.0045
FARMSIZE	0.4339	0.2432	0.0023	0.0441*
CREDIT	0.2221***	0.7878**	0.0256	0.0190**
EXTVISIT	0.0064	0.3035	0.1038**	0.0435*
EMPLINCM	-0.3452	-0.2868*	2.1101	0.0031
CROPINCM	0.0133	0.04421	-0.0253	0.0138
FARMEXP	0.0397	0.0067	0.3486***	0.0601
SOKAL	0.0691*	0.0286	0.2438	0.0122
Log likelihood Function = -53.6587				
Chi-square value 21.0076				

Source: Field survey, 2011
Note: ***=significant at 1%; **= significant at 5%; *=significant t 10%

Multinomial Logit model of the determinants of choice of adaptation practices

The results of the multinomial logit (Table 5 reveal that the log likelihood function was -53.6581 and the chi-squared value was 21.0076. These support the fitness of the model. The results reveal that credit access and social capital increased probability of adaptation to climate change by mulching. An increase in credit accessed by ₦1 would increase the probability of adaptation by 22.21% and an increase in the number of association a farmer belongs to by 1 would increase probability of adaptation by 35.33. These agreed with the expectation of the study. Number of adult male reduced the probability of adaptation to change in climate by mulching application. An increased in the number of adult male by 1 would reduce the probability of adaptation by 35.33%. This is contrary to the expectation of the study. The increased number of adult male might be diverted to activities other than farming. While credit access increases irrigation adaptation, age of household head and employment income reduced probability of adaptation. An increase in the credit accessed by ₦1 would increase adaptation 78.78%. However, an increase in the age of household head by 1 year would reduce probability of adaptation by 13.25%. This agreed with the expectation of the study that age could take either sign. In the same vein, an increase in employment income by ₦1 would reduce probability of adaptation by 28.68%. This did not agree with the expectation of the study. The reason for this might be due to the diversion of income from employment to enterprises other than farming for the purpose of ensuring uninterrupted inflow of income or guide against crop failure. Analyses further reveal that just extension visits and farming experience positively influenced probability of adaptation by varying the time of planting. An increase in the extension contacts by 1 would increase the probability of adaptation by 10.38% and an increase in the farming experience by 1 year would increase the probability of adaptation by 34.84%. This agreed with the expectation of the study. Finally, farm size, credit access and extension visits positively influenced farmers adaptation by tree planting. An increase in farm size by 1 hectare would increase the probability of adaptation by 4.41%. Also, an increase in credit accessed by ₦ 1 and extension contacts by 1 would increase probability of adaptation by 1.9 and 4.35%, respectively.

CONCLUSION

The study has revealed clearly the difference between men and women adaptation options. Men in the area invested more on adaptation technique than their female counterpart. Credit access affected mulching, irrigation and tree planting. Extension visits also positively influenced varying time of planting and tree planting. Therefore, there is need to encourage farmers of both sexes on the needs to adapt to climate change through the cheap but effective practices available to them and a policy thrust that makes extension and credit available and affordable.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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