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Analysis of Climate Change Adaptation Strategies Among Food Crop Farmers In Oshimili North Local Government Area of Delta State

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Abstract

Agricultural production remains the main source of income for most rural communities, adaptation of the agricultural sector is imperative to protect the livelihood of the poor and to ensure food security. The study ascertained analysis of climate change adaptation among food crop farmers in Oshimili North Local Government area of Delta State. The study identified and described climate change adaptation strategies used by food crop farmers and determined the factors that influence the choice of climate change adaption strategies used by food Crop farmers. Primary data was collected through the use of structured questionnaire administered to the food crop farmers in the study area. Data for this study were analyzed using descriptive, multinomial logistic regression analysis. Results of the analysis showed that age,sex were significant at 10% and 5% respectively, education at 10%, experience on climate change is at 5% % 1%, farm income is at 1% and 10% and farm size is at5%.Data analysis carried out on climate change adaptation strategies used by food crop farmers shows that 18.6% of the respondents used mulching as the main adaptation strategy, 10.7% of them chose irrigation as the main adaptation strategy, 7.1% of the farmer were using tree planting. The result also reveals that 20.7%, 6.4%, 12.9% and 10.0% of the respondents were using intercropping, change in farm size, crop diversification and multiple planting dates as their main adaptation strategy.The likelihood ratio statistics from multinomial Logit regression model indicated that $\chi 2$ statistics (211.71492) was significant at 1% (P<0.0000) level of probability, suggesting that the model has a strong explanatory power and pseudo R^2 value of 0.1213. It is recommended that policy makers should enlighten the farmers more on the danger of climate change to productivity of crops and livestock and provide necessary logistics to support various alternative course of action.

Key Words: *Climate change, Adaptation strategies, Food crop farmers and Multinomial Logistic Regression*

Introduction

Agricultural production remains the main source of livelihood for most rural communities in developing countries, and Nigeria in particular. Agriculture provides a source of employment for more than 60% of the population and contributes about 30% of Gross Domestic Product (GDP) (Kadlinker and Risbey, 2000). The performance of the agricultural sector is determined by crop production, which depends on a large number of climatic factors.

There is a growing consensus in the scientific literature that in the coming decades the world will witness higher temperatures and changing precipitation levels. The effects of this will lead to low/poor agricultural products (Deressa*et al.*, 2008). Evidence has shown that climate change has already affecting crop yields in many countries (IPCC, 2007; Deressa*et al.*, 2008; BNRCC, 2008). This is particularly true

in low-income countries, where climate is the primary determinant of agricultural productivity and adaptive capacities are low (SPORE, 2008; Apata *et al*., 2009). Many African countries, which have their economies largely based on weather-sensitive agricultural productions systems like Nigeria, are particularly vulnerable to climate change (Dinar *et al.*, 2006). This vulnerability has been demonstrated by the devastating effects of recent flooding in the Niger Delta region of the country and the various prolonged droughts that are currently witnessed in some parts of Northern region. Thus, for many poor countries like Nigeria that are highly vulnerable to effects of climate change, understanding farmers' responses to climatic variation is crucial, as this will help in designing appropriate coping strategies.
Climate change is perhaps the most serious environmental threat facing mankind worldwide. It affects agriculture for instance in several ways, one of which is its direct impact on food production. Climatic change, which is attributable to natural climate cycle and human activities, has adversely affected agricultural productivity in Africa (Ziervogel*et al.*, 2006). As the planet warms, rainfall patterns shift, and extreme events such as droughts, floods, and forest fires become more frequent (Zoellick, 2009), which results in poor and unpredictable yields, thereby making farmers more vulnerable, particularly in Africa (UNFCCC, 2007).
Climate is considered to be the average of the observed pattern of weather in an area over a relatively long period of time (Intergovernmental Panel on Climate Change, 2009). The United Nation Framework on Climate Change defines climate change as a "change that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods (United Nations Framework on Climate Change, 2007). Bello *et al*. (2012) identify climate change as one of the environmental life- threatening to economic development and sustainability of man-kind worldwide. Natural climate cycle and human activities have contributed to an increase in the accumulation of heat-trapping "greenhouse" gases in the atmosphere thereby contributing to increase in temperature in the global climate - global warming(Bello *et al.,* 2012).
More also evidence from literature and past studies has revealed that the recent global warming has influenced agricultural productivity leading to declining food production (Kurukulasuriya and Mendelsohn, 2006; IISD, 2007; Lobell *et al.*, 2008). In order to meet the increasing food and non-food needs due to population increase, man now rapidly depleting fertile soils, fossil groundwater, biodiversity, and numerous other non-renewable resources to meet his needs. This resource depletion was linked with other human pressures on the environment. Possibly the most serious of human impacts is the injection of greenhouse gases into the atmosphere. The reality of the impact of climate change on agricultural development has started showing signs (Adams *et al.,* 1988; Fischer *et al.*, 2002; Spore, 2008). A substantial body of research has documented these wide-ranging effects on many facets of human societies (Wolfe *et al.*, 2005; ODI, 2007; Apata *et al.*, 2009) Recently,

international tensions and concerns are heightening over what the impact of climate will have on the environment and agricultural produce (NEST, 2004; BNRCC, 2008; Apata, *et al.*, 2009). Also, how agricultural and food-distribution systems will be further stressed up by the shifting of temperatures and precipitating belts, especially if changes are rapid and not planned for (NEST, 2004).

Methodology

The study Area for this study was conducted inOshimili North Local Government Area in Delta State, Nigeria. Oshimili North is one of the twenty five local Governments that make up Delta State, South – South Geo-political zone of Nigeria. Oshimili North Local Government Area is located along longitude 6^0 and62^0 east also 6^0 and 64^0 east of the Greenwich meridian and latitude 6^0 and40^0 north and 6^0 and32^0 North of the Equator. The study area is a boundary Town having boundaries with several Local Government Areas. It has boundary in River Niger, in the South with Oshimili South local Government Area and in the western part by Aniocha North local Government and Aniocha south Local Government Areas of Delta State, Nigeria. Oshimili North Government is a highly populated Local Government Area with a population of 143,361 people (NPC, 2006). The major occupation of the people of Oshimili North local Government area is farming.

The respondents used for this study were food crop farmers from Oshimili North local Government area of Delta State. A total of 140 respondents were used for the study using simple random sampling technique. Firstly, 5 villages were randomly selected for the study, secondly, four (4) farming communities were selected and thirdly, from each community, seven (7) farmers were selected given a total number of respondents of 140.

Data used for this study were mainly from primary sources. Primary data was collected through the use of a structured questionnaire administered to the food crop farmers in the study area.

The data for this study were analyzed using both descriptive and inferential statistics.identify and describe climate change adaptation strategies used by food crop farmers, determine the factors that influence the choice of climate change adaption strategies used by food Crop farmerswere aanalysedusing both descriptive statistics and multinomial logistic regression.

Analytical Technique

Empirical model

The empirical multinomial logit model for this study is specified as:

$Y\,i = f\,(X1, X\,2 \ldots X\,9)$

Where Yi, the dependent variable is polychotomous and it is the method of adaptation chosen by the farmer; xi are the explanatory variables. The dependent variable (Yi) is defined as 1 for inter cropping, 2 for tree planting, 3 for multiple planting dates, 4 for bush fallow, 5 for crop diversity and 6 for cover cropping. The independent variables are:

X1 = age
X2 = sex
X3 = education
X4 = household size
X5 = extension visit
X6 = experience of climate change
X7 = off farm income
X8 = farm income
X9 = farm size

Results and Discussion

Climate Change Awareness and Adaptation Strategies Used By Food Crop Farmers

The awareness of climate problems and the potential benefits of taking action is important. Table 1shows that 94% of the farmers are aware of climate change while 5.7% of the farmers are not aware. This awareness is due to the educational level of the respondents and years of farming experience of most of the farmers. Farming experience improves awareness of change in climate, the potential benefit and willingness to participate in local natural resource management of conservation activities. This result agrees with that of Maddison, (2006) who found that educated and experienced farmers have more knowledge and information about climate change and agronomic practices that they can adopt in response.

Climate change adaptation strategies are changes in agricultural management practices in response to changes in climate condition (Nhemachena and Hassan, 2007). The result on table 2 shows that 18.6% of the respondents was using mulching as the main adaptation strategy, 10.7% of them were using irrigation as the main adaptation strategy, 7.1% of the farmer were using tree planting. About 10.0% used resistant variety while 10.7%, 10.0%, 2.1% and 3.6% of the respondent used land expansion, increased fertilizer application, increase manure application and use of chemicals as their main adaptation strategy. The result also reveals that 20.7%, 6.4%, 12.9% and 10.0% of the respondents were using intercropping, change in farm size, crop diversification and multiple planting dates as their main adaptation strategy.17.9% and 9.3% of the farmers used cover cropping and sheltering while 21.4% and 11.4% of the respondents used fallowing and land fragmentation as their main adaptation strategy. Nhemachena and Hassan (2007) reported different crop varieties, crop diversification and different planting dates as main farm-level adaptation strategies in Southern Africa.

Table 1: Awareness Level of Food Crop Farmers on Climate Change

Awareness on climate change	Frequency	Percentage
Aware	132	94.3
Not aware	8	5.7
Total	140	100

Source: Field Survey, 2015

Table 2: Climate Change Adaptation Strategies Used By Food Crop Farmer

Types of measures taken	Frequency*	Percentage
Mulching	26	18.6
Irrigation	15	10.7
Tree planting	10	7.1
Resistant variety	14	10.0
Land expansion	15	10.7
Increased fertilizer application	14	10.0
Increase manure application	3	2.1
Use of chemical	5	3.6
Intercropping	29	20.7
Change in farm size	9	6.4
Crop diversification	18	12.9
Multiple planting date	14	10.0
Cover crop	25	17.9
Sheltering	13	9.3
Fallow	30	21.4
Land fragmentation	16	11.4

Source Field Survey, 2015 multiple responses*

Factors Influencing the Choice of Climate Change Adaptation Strategies Used By Food Crop Farmers in the Study Area

Table 3 shows the multinomial logit regression analysis of the influence of food crop farmers' socioeconomic characteristics on their choice of various adaptation strategies to climate change. The adaptation options set in the multinomial logit regression model include the use of intercropping, tree planting, multiple planting date, bush fallow, crop diversity and cover cropping. The estimation of the multinomial logit regression model for the study was undertaken by normalizing one category, which is usually referred to as the base category. In the analysis, the first category (intercropping) was the base category.

The likelihood ratio statistics from multinomial logit regression model indicated that χ^2 statistics (211.71492) was highly significant at 1% (P<0.0000) level of probability, suggesting that the model has a strong explanatory power. The significance of the likelihood ratio statistics revealed that the food crop farmers' socio-economic characteristics have a significant influence on their adaptation strategies to climate change.

The pseudo R^2 value of 0.1213 also confirms that the entire slope coefficient is not equal to zero. In other words the explanatory variables are collectively significant. The estimate of the MNL model provides only the direct of the effect of the independent variable on the dependent variables. The calculated marginal effect measures the expected changes in the probability of both the effect of climate change and adaptation with respect to a unit change in an independent variable.

Age

The age of the farmers was negatively related to tree planting (0.07) and bush fallow (0.08) and significant at10% and 5%. The marginal effect for tree planting and bush fallow was both 0.01. The marginal effect implies that an increase in age of the farmers decreased the use of tree planting and bush fallow by 0.01% relative to intercropping technique as adaptation measures to climate change. In other words, farmers are more likely to use intercropping technique than the use of tree planting and bush fallow with increase in age. The probability of adoption of a recommended agricultural-practice reduces marginally as a farmer ages. Most elderly farmers do not usually want to try new techniques until they have been proven to be effective. Also, most elderly farmers do not usually have the physical strength and wealth to invest in recommend agricultural-practice.

This shows that young food crop farmers have ability to cope with climate change and climate variability risk in food crop production than the older food crop farmers. This result agrees with the finding of Deressa*et al.*(2008). And also Bayard *et al.*(2006) who observed that the age of farmers had negative influence on adoption of rock walls as soil management practice in fort-Jacques in Haiti.

Sex

Sex has a significant but negative correlation with the use of multiple planting dates (1.41) as an adaptation measure and significant at 10% while positive relationship exists between sex and choosing crop diversity technique (2.22) as an adaptation measure and significant at 5%. A unit increase in male participant is associated with multiple planting date being 0.01 % less likely to adapt and crop diversity being 0.09% more likely to adapt. The negative relationship between adaptation and sex reveals that female farmers were more likely to take up adaptation strategies than male farmers. The possible reason for this observation is that agricultural production in rural areas is gradually been taken-up by women while the male migrate to the city for white collar job. The result is in consistence with the finding of Deressa*et al*. (2008) on the study conducted in the Nile Basin of Ethiopia to analyze farmer's choice of adaptation methods of climate change. On the other hand, Nhemachena and Hassan(2008) found that female are more likely to take up climate change adaptation methods than male in assessing determinant of African farmers strategies for adapting to climate change.

Education

The educational level of the farmers had a negative influence on crop diversity (0.13). A year increase in the farmers' level of education is associated with crop diversity being 0.01% less likely to adapt. This implies that an increase in the year of education of a farmer decreases the probability of choosing crop diversity as an adaptation measure. Thus, as farmers advance in years of educational level, the adoption of intercropping technique is preferred to crop diversity as an adaptation method to climate change. It could be deduced that the education acquired by these farmers are not formal education, farmer with formal education will be more likely to innovate due to the higher associated skill level. This result support the findings of Birungi and Hassan (2010)

Experience of climate change

Experience of climate change has a positive and significant relationship with the probability of choosing multiple planting dates (0.08) as adaptation measures. While negative relationship exists between farming experience and choosing of crop diversity (0.14) as adaptation measures. They are both significant at5% and 1% respectively. A year increase in the farmers' experience is associated with multiple planting date being 0.00% more likely and crop diversity being 0.01% less likely to adapt. The positive relationship between adaptation and farming experience revealed that experienced farming households have an increase likelihood of choosing multiple planting dates as an adaptation measure. Experience has taught most of the farmers on the various farm management practices and techniques that can be used in the face of anticipated climate change. This has really helped farmers in the study area to switch from one adaptation measures to another based on the situation of climate variables. The result is in consistent with the findings of Deressa*et al*.(2008) and Hassan and Nhenmachena(2008) who found the experience of climate change as significant in influencing farmers adaptation choice.

Off farm income

Off farm income has a highly significant but negative correlation with the use of multiple planting dates (3.38) as an adaptation measure. While positive relationship exists between off farm income and choosing crop diversity technique (1.73) as an adaptation measure. They are both significant at 1% and 10% respectively. A unit increase in off farm income is associated with multiple planting date being 0.14% less likely and crop diversity being 0.18% more likely to adapt. The negative relationship between adaptation and off farm income revealed that entry into off-farm activities are constrained by barriers such as start -up capital and skills.

Farm size

The coefficient on farm size is significant and positively correlated with the probability of choosing tree planting (1.39) as an adaptation measure. A unit increase in farm size is associated with tree planting being 0.21% more likely to adapt. Indeed, large-scale farmers are more likely to adapt because they have more capital and resources. Therefore, they can easily invest in tree planting technique, which demand high investment costs.

Table 3: Parameter Estimate of Multinomial Logit(MNL) Analysis of Factors that influence the farmers' Choice of Climate Change Adaptation Strategies

	Coefficient				
	Tree planting	Multiple planting date	Bush fallow	Crop diversity	Cover cropping
Age	-0.07 (1.69)*	-0.07 (-1.41)	-0.08 (1.67)**	0.03 (0.55)	-0.00 (-0.09)
Sex	-0.03 (-0.96)	-1.45 (1.77)*	-0.07 (-0.10)	2.22 (2.34)*	0.12 (0.16)
Education	0.05 (0.69)	0.08 (0.90)	0.07 (1.10)	-0.13 (1.19)*	0.01 (0.10)
House hold size	-0.29 (-1.40)	-0.25 (-1.55)	0.03 (0.13)	0.25 (1.15)	-0.02 (0.18)
Extension visit	0.02 (0.13)	-0.07 (-0.37)	-0.08 (-.049)	-0.13 (-0.57)	-0.05 (-0.26)
Experience of climate change	0.02 (0.64)	0.08 (2.32)**	0.02 (0.45)	0.14 (1.89)*	-0.01 (-0.33)
Off farm income	-0.39 (-0.44)	-3.38 (-52.97)***	-0.05 (-0.06)	1.73 (1.74)*	-0.37 (0.032)
Farm income	2.24 (1.38)	1.52 (0.8)	-2.83 (-0.19)	-1.69 (-1.03)	-1.07 (-0.69)
Farm size	1.39 (2.39)**	0.86 (1.33)	0.12 (0.18)	-0.38 (-0.32)	0.15 (0.21)
Constant	2.50 (1.23)	1.90 (0.86)	2.66 (1.56)	-2.02 (-0.91)	-0.16 (0.06)

Number of Observation 139
Wald $chi^2(45)$ = 10404.26
Prob> chi^2 = 0.0000
Log pseudo likelihood = -211.71492
Pseudo R^2 = 0.1214
*,**,*** = Z- test significant at 10%,5% and 1%

Source: Field Survey, 2015

Table 4: Marginal Effect from Multinomial Logit Analysis of Factors that Influence the Choice of Climate Change Adaptation strategies used by food crop farmers in Oshimili North Local Government Area of Delta State

	Marginal effect					
Variables	**Inter cropping**	**Tree planting**	**Multiple planting date**	**Bush fallow**	**Crop diversity**	**Cover cropping**
Age	0.01	-0.01	-0.00	-0.01	0.00	0.00
Sex*	0.02	-0.12	-0.01	-0.01	0.09	0.03
Education	-0.01	0.01	0.00	0.01	-0.01	-0.00
House hold size	0.02	-0.05	-0.00	0.02	0.01	0.00
Extension visit	0.01	0.01	-0.00	-0.01	-0.00	-0.00
Experience on climate change	0.00	0.00	0.00	0.00	-0.01	-0.00
Off farm*	0.03	-0.05	-0.14	0.01	0.18	-0.04
Farm income	-4.54	4.37	1.09	-6.38	-7.95	-2.90
Farm size	-0.11	0.21	0.00	-0.04	-0.03	-0.03

Source: Field Survey, 2015

Conclusion and Recommendations

Farmers adapts to climate change by using different methods, of which the major ones were intercropping, mixed cropping , mulching, bush fallow system, irrigation as well fertilizer application. Based on the findingsthe following recommendations were made;

Policy makers should enlighten the farmers more on the danger of climate change to productivity of crops and livestock and provide necessary logistics to support various alternative course of action and policy towards increasing farmer's access to weather information should also be created. More weather centers should be created to increase farmer's access to current weather information. This will help the farmers in planning weather adaptation strategies by farmers.

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