ANALYSES OF DETERMINANTS OF ADAPTATION TO CLIMATE CHANGE AMONG ARABLE CROP FARMERS IN THE FEDERAL CAPITAL TERRITORY, ABUJA

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ABSTRACT
The study examined the factors influencing arable crop farmers' adaptation to climate change in the Federal Capital Territory, Abuja, Nigeria. Using multistage random sampling technique, 120 respondents were selected for detailed study. Focus Group Discussion and structured questionnaire were used to elicit information from the respondents. Data obtained were analyzed using Binomial Logit regression model, descriptive and inferential statistics. The respondents were within the mean age of 38years and majority (60.1%) of them were male. Farmers' perception of climate change were increasing temperature ($\bar{x}$=4.7), increasing rainfall ($\bar{x}$=4.3) and unpredictable weather ($\bar{x}$=4.6). Farmers' major sources of information on climate change were personal experiences (92.5%) and radio (43.3%). The perception of the effect of climate change on arable crop production were increased heat stress on crops ($\bar{x}$=4.5), high incidences of pest and diseases ($\bar{x}$=4.5), increased frequency of flooding ($\bar{x}$=3.6) and reduced yield of crops ($\bar{x}$=3.8). Identified adaptation strategies used by farmers' to mitigate climate change included multi-crop agriculture (100%), mulching of crops to reduce water loss (99.2%) and changes in planting dates (95%). Results of the Logit regression analysis showed that farm size, extension contact and farming experience were positive and significantly influenced adaptation to climate change at 1%, 5% and 10% level of significance respectively. The study recommended that agricultural extension service should brace up to the new challenges posed by climate change by promoting awareness programmes, engaging in a multi-media enlightenment campaign on climate change and the retraining of extension agents to acquire the new knowledge in climate change management.

Keywords: *Climate change, Adaptation, Mitigation, Perception.*

INTRODUCTION
Climate is defined as the average weather conditions of a particular place over a long period of time usually a period of thirty years (Adejuwon, 2004). Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity (Inter-governmental panel on climate change (IPCC), 2001). The main cause of climate change has

been attributed to anthropogenic (human) activities (Ozor and Nnaji, 2011). For example, the increased industrialization in the developed nations has led to the introduction of large quantities of greenhouse gases (GHGs), including carbon (IV) oxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) into the atmosphere. These GHGs are the primary causes of global warming (IPCC, 2007). The global increases in CO_2 concentration are due primarily to fossil fuel use and land use change, while those of CH_4 and N_2O are primarily due to agriculture (IPCC, 2007). Agriculture is therefore the main culprit of climate change producing significant effects through the production and release of GHGs.

The term arable refers to any land that is suitable for growing crops. It includes all land where soil and climate is suitable for agriculture, including forests and natural grasslands, and areas falling under human settlement. Any crop that is grown on such land is therefore referred to as arable crops (FAO, 2007). Arable crops are crops which are cultivated on ploughed land, and used for food, fuel, feed, fiber, and reclamation. They are annual crops and include cereals, legumes and root crops. Although constrained by land mass and topology, the amount of arable land, both regionally and globally, fluctuates due to human and climatic factors such as irrigation, deforestation, desertification, terracing, landfill, and urban sprawl (FAO, 2007).

According to Tologbonse, Auta, Jaliya, Onu and Isa (2010), climate change is a major challenge to agricultural development in Africa and the world at large. It is not only a challenge to agricultural development but to food security and the general livelihood conditions of the population. Agriculture, being one of the most weather-dependent of all human activities, is highly vulnerable to climate change. African countries are particularly vulnerable to climate change because of their dependence on rain-fed agriculture, high levels of poverty, low levels of human and physical capital, inequitable land distribution and poor infrastructure (Sambo, 2010).

Adaptation refers to adjustment or intervention which takes place in order to moderate potential damages or take advantage of the opportunities presented by, or cope with the consequences of changing climate (IPCC, 2001). It is the process of improving society's ability to cope with changes in climatic conditions across time scales, from short term (e.g. seasonal to annual) to the long term (e.g. decades to centuries). It is one of the policy options for mitigating negative impact of climate change (Kurukulasuriya and Mendelsohn, 2006). In order to sustain the agricultural sector that plays pivotal roles in human existence in terms of the provision of food, fiber, fun, fuel and income, strategies of change need to be urgently initiated to cope with the changing climate. Agricultural extension has key roles to play in initiating this change. This is because adaptations to climate change impacts require changes in knowledge, attitudes, resilience capacities, and skills of the people and agricultural extension can bring this change.The overall objective of the study was to determine factors influencing arable crop farmers' adaptation to climate change in the Federal Capital Territory, Abuja, Nigeria.

METHODOLOGY

The study covered all the six area councils of the FCT. Arable crop farmers' in the study area constituted the population of the study. Using multistage random sampling technique, all the Area Councils in the FCT namely, Abaji, Bwari, Gwagwalada, Kuje, Kwali and Municipal were selected in the first stage. In the second stage, two farming communities were randomly selected from each of the Area Councils, giving a total of twelve communities. The third stage involved

the random selection of ten crop famers from each of the communities, giving a total of one hundred and twenty respondents for the study. Focus Group Discussions (FGDs) and structured questionnaire were used to obtain primary data from the respondents with the help of trained enumerators who understand the local languages. Data collected were analyzed using both descriptive and inferential statistics. Descriptive statistics such as frequency counts, percentages, and means and were used to analyze objective 1, 2, 3, 4, and 5. While objective 6 was achieved by the use of binomial Logit regression analysis.
The model is expressed implicitly as

$$Y=F(X_1,X_2,X_3,X_4,X_5,X_6,X_7,X_8,X_9,X_{10},X_{11})\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Explicitly the model is specified as

$$Y(\text{Adaptation})=b_0+b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5+b_6X_6+b_7X_7+b_8X_8+b_9X_9+b_{10}X_{10}+b_{11}X_{11}+U..\ (2)$$

Where,
Y (Adaptation) = (1 for high adaptation, 0 for low adaptation).
X_1: Age of farmers' (years)
X_2: Sex (male=1, female=0)
X_3: Household size (Number of people feeding from the same pot)
X_4: Educational status (years of formal schooling)
X_5: Farming experience (in years)
X_6: Membership of cooperative or farmers' association (membership=1, 0=otherwise)
X_7: Total farm size (hectares)
X_8: Contact with extension agent (1=yes, 0= no)
X_9: access to credit (naira)
X_{10}: Ownership of radio (1=yes, 0= no)
X_{11}: Land tenure (1=land owner, 0= otherwise)
Where:
b_0 = constant
b_1 –b_{11} = coefficient to be estimated.
U: Error term

RESULTS AND DISSCUSSION

Socioeconomic characteristics

As indicated in Table 1, majority (31.8%) of the farmers' were young, between the ages of 31-48 years, which is the active productive age bracket (Tologbonse *et al*., 2010). Most of the farmers were male (55.8%) and had a mean farm size of 3.7 hectares. The likelihood to adapt to climate change increases with increase in farm size (Gutu, *et al*., 2012). The farmers' major sources of information on climate change were personal experience (92.5%) and radio (43.3%). Focus Group Discussions (FGDs) revealed the absence of climate information institutions and irregularity of the news on weather from the radio stations, they rely more on their peers for climate information.

Farmers Perception of the effect of Climate Change on Arable Crop production

Table 2 shows that the variables listed were all perceived to be the effect of climate change on arable crop production in the area. They include reduced yield of crops (mean=3.8), increased frequency of flooding (mean=3.6), high incidence of pest and diseases (4.5) etc. The result is in line with the findings of Tologbonse *et al.* (2010) who discovered that farmers' perceived the effect of climate change to include increase in flooding, drought and reduced yield of crops. In a similar study Ayanwuyi *et al.* (2010) found that, the dominant impact of climate change include low yield of crop, stunted growth, ease of spread of pest and diseases attack on crops.

Interactions during the FGDs showed that gully erosion in farm lands, decrease in soil fertility and the increase in the rate of crops spoilage particularly vegetables are the perceived effect of climate change on crop production.

Adaptation Strategies used to mitigate the effect of Climate Change

Results in Table 3 show that 98.3% of the respondents did not engage in agricultural insurance of crop enterprise as a means to reduce or adapt to the effect of climate change. Strategies adapted by farmers to mitigate the effect of climate change include the planting of disease and pest resistant crops (94.2%), mulching of crops to reduce water loss (99.2%), planting of early maturing varieties (100%), changes in planting dates (95.0), increase in the use of organic manure(99.2%), increase in irrigation (37.5%), increase in land size cultivated(98.3%) etc. These results are in line with Molua (2008), Rudolf and Hermann (2009) and Apata *et al.* (2009) who reported that main strategies for reducing climate risk is to diversify production and livelihood systems like soil and water management measures and plant protection measures that are varied to maintain adequate crop yields.

Level of adaptation strategies adapted by farmers'

Table 4 show the classification of farmers' into high and low adaptation level based on the number of adaptation strategies used by each farmer to mitigate climate change effects. The results show that majority of the farmers' (65%) had high level of adaptation to climate change, while 35% of the farmers had low level of adaptation. This therefore imply that most of the farmers' in the study area have highly adapted to climate change by making use of many adaptation strategies that mitigate the effects of climate change on arable crop production.

Farmers' Perception of the Roles of Agricultural Extension in Adaptation to Climate Change

Table 5 shows that the farmers' agreed with most of the identified roles of extension in mitigating the effects of climate change. They include the retraining of extension staff to acquire the new knowledge and skills in climate risk management (Mean=4.6), setting up of emergency management unit byextension agencies that will attend to victims of climate change effects (Mean=4.4), dissemination of innovations on best practices and building resilient capacities of vulnerable people in climate risk management (mean=4.4), use of information communication technology (ICTs) such as the internet, radio, television, media vans, leaflets and posters to create awareness on climate change issues (mean=4.3). However the respondents did not agree with the use of law enforcement agents against persons that deliberately indulge in practices that contribute to climate change such as bush burning (2.8) as a perceived role of extension. This is probably because of the great respect they have for the rural institutions such as the chiefs/district heads in resolving conflicts and punishing offenders.

Socioeconomic factors Influencing Adaptation to Climate Change

The determinants of adaptation to climate change by the respondents are presented in table 6. The results showed that age, farm size, extension contact and farming experience were positive and significantly influenced the level of adaptation to climate change at 1%, 1%, 5% and 10% level respectively. This implies that increase in age, farm size, extension contact and farming experience significantly increases the probability of adaptation to climate change. However contrary to a priori expectation ownership of radio was negative and significant at 10% level. The implication is that increase in ownership of radio among farmers' significantly reduces the probability of adapting strategies that mitigate the effect of climate change.

CONCLUSION

The findings of this study revealed that most of the farmers' in the FCT were aware of the concept of climate change as they agreed that increasing temperature, increasing rainfall and unpredictable weather are indicators of a changing climate. Respondents perceived the effect of climate change to be reduced yield of crops, increased incidence of drought, high incidence of pest and diseases etc. Radio, personal experience, and fellow farmers' were their major source of information on climate change. It is recommendedthat agricultural extension service should brace up to the new challenges posed by climate change by promoting awareness programmes, engaging in a multi-media enlightenment campaign on climate change and the retraining of extension agents to acquire the new knowledge in climate change management. There should also be serious enforcement of laws and regulations by communal heads/chiefs at the local level to prevent indiscriminate bush burning and felling of tress and the administration of the relevant penalties necessary to prevent repeated offences and safeguard the environment.

Table 1: Distribution of respondents by socioeconomic characteristics

Variables	Percentage (n=120)	Mean
Age (years)		
21-30	28.3	
31-40	31.8	
41-50	28.3	
51-60	10.8	
>60	0.8	
Sex		
Female	44.2	
Male	55.8	
Marital status		
Single	11.7	
Married	84.2	
Divorced	3.3	
Widowed	0.8	
Household size		
1-5	23.4	
6-10	52.5	
11-15	20.8	
16-20	3.3	
Educational level		
No formal education	15	
Quranic education	20.8	
Adult education	32.5	
Primary	2.5	
Secondary	26.7	
Tertiary	2.5	
Farm size(hectares)		3.5
1-3	52.5	
4-6	40.8	
>6	6.7	
Farming experience (years)		18.3
1-15	42.5	
16-30	46.7	
31-45	10.8	
Sources of information on climate change*		
Extension agent	15	
Radio	43.3	
Television	4.2	
Newspaper	1.7	
Fellow farmers	30.8	
Personal experience	92.5	

Table 2: Farmers' Perception of the effect of Climate Change on Arable Crop Production

Possible effects	Mean	Overall perception
Reduced yield of crops (n=120)	3.8	Agree
Increased frequency of draught (n=119)	4.5	Agree
Increased frequency of flooding (n=120)	3.6	Agree
Increased effect of heat stress on crops (n=120)	4.5	Agree
Intense weed growth (n=120)	4.2	Agree
High incidences of pest and diseases (n=120)	4.5	Agree
Soil erosion (n=120)	3.6	Agree
Post harvest losses due to climate variability (n=120)	4.5	Agree
Reduction in vegetation cover (n=120)	4.5	Agree
Late fruiting of crops (n=119)	3.9	Agree
Reduced harvest (n=111)	4.5	Agree

∗Figures in parenthesis are percentages
*Based on a 5 point scale of strongly agree, agree, indifferent, disagree, and strongly disagree.

Table 3: Adaptation Strategies used to mitigate the effect of Climate Change

Adaptation strategy used	Frequency* (n=120)	Percentage
1) Planting of many different types of crops (multi-crop agriculture))	120	100
2) Planting of early maturing varieties	120	100
3) Mulching of crops to reduce water loss	119	99.2
4) Avoid selling remaining food stock	119	99.2
5) Increase in land size cultivated	118	98.3
6) Undertake non-farm economic activities	118	98.3
7) Changes in planting dates	114	95.0
8) Planting of disease and pest resistant crop varieties	113	94.2
9) Contour cropping across hills/slopes	113	94.2
10) Increase in use of inorganic manure	111	92.5
11) Water harvesting and storage	107	89.2
12) Changes in harvesting dates	105	87.5
13) Early harvest when dry soil is expected	87	72.5
14) Adoption of zero or minimum tillage	84	70
15) Planting of trees	78	65
16) 1ncrease in irrigation	45	37.5
17) Planting of drought resistant/tolerant crop varieties	44	36.7
18) Reduced land size cultivated	23	19.2
19) Rearing of resistant/tolerant animal species	15	12.5
20) Stopping the use of chemical fertilizer	8	6.7
21) Agricultural insurance	2	1.7

*Multiple responses
Source: Field survey, 2012

Table 4: Distribution of Farmers' by Level of Adaptation Strategies Adapted

Adaptation level	Frequency	Percentage	Mean score
Low adaptation (1-14)	42	35	15
High adaptation (15-21)	78	65	
Total	120	100	

Source: field survey, 2012

Table 5: Farmers' Perception of the Roles of Extension in Adaptation to Climate change

Roles	mean	Overall perception
1) Re-training of extension staff to acquire the new knowledge and skills in climate risk management (n=120)	4.6	Agree
2) Setting up of emergency management unit by extension agencies that will attend to victims of climate change effects (n=120)	4.4	Agree
3) Dissemination of innovations on best practices and building resilient capacities of vulnerable people in climate risk management (n= 120)	4.4	Agree
4) Providing feedbacks to government and interested agencies with situation reports on various causes of climate change, its effects and local knowledge and practices of the rural people (n=120)	4.3	Agree
5) Use of demonstration methods in teaching farmers' the measures used to mitigate or adapt to the effects of climate change (n=120)	4.3	Agree
6)Organizing seminars, workshops and field days to sensitize farmers' and the public on climate risk management (n=120)	4.3	Agree
7)Use of farmer to farmer extension strategy to promote awareness and adoption of best practices in climate risk management (n=120)	4.3	Agree
8)Use of information communication technology (ICTs) such as the internet, radio, television, media vans, leaflet and posters etc to create awareness on climate change issues (n=120)	4.3	Agree
9) Formation of young farmers' club (YFC) in schools to educate and encourage young farmers' in learning about climate change. (n=120)	4.2	Agree
10) Use of farmer field schools (FFS) to promote faster learning by farmers' on the measures used to mitigate and adapt to the effects of climate change. (n=120)	4.2	Agree
11) Denying farmers' who indulge in poor agricultural practices that contribute to climate change such as bush burning access to extension services (n=118)	3.2	Agree
12) Use of law enforcement agents against persons that deliberately indulge in practices that contribute to climate change such as bush burning (n=118)	2.8	Disagree

∗Figures in parenthesis are percentages. Source: Field survey, 2012.

Table 6: Logit Estimates of Determinants of Adaptation to Climate change

Variables	Coefficient	Z value
Age (yrs)	.070	2.64***
Sex	.140	0.28
House hold size	-.114	-1.57
Farm size (hectares)	.970	2.92***
Education (yrs)	-.044	-1.17
Farming experience (yrs)	.056	1.65*
Cooperative	.208	0.30
Extension contact	1.416	2.18**
Access to credit	1.421	1.41
Ownership of radio	-1.242	-1.91*
Land tenure	.229	0.37
Constant	-5.086	-3.06***

Source: field data, 2012

***=1%, **= 5%, *=10% significant level.

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