Analysis of Climate Change Perception and Adaptation among Arable Food Crop Farmers in South Western Nigeria.

By

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Abstract

Agriculture places a heavy burden on the environment in the process of providing humanity with food and fibres. It is recognized that agriculture has positive externalities such as the environmental services and amenities that it provides, for example through the creation or maintenance of rural landscapes which is given high priority by some developed countries. Trade-offs between food security and the environment is what is being practiced in most developing countries. There are strong indications and already evidence that the agricultural and food system as well as the rural areas across the world are experiencing major change. This change has drastically reduced soil fertility and poor agricultural outputs particularly in Sub-Saharan Africa. This is evidenced in some notable towns and communities in South Western Nigeria that are noted for the production of a peculiar agricultural commodity. Recently, these commodities are gradually going into extinction and the community involved cannot explain why this is so, majority of the respondents attached this incidence to spiritual dimension and not changes in climate. This study therefore examined the people's perception about climate change and strategies employed to adapt. This study conclude that there is a need for agricultural economists and other stakeholders in environmental management and agricultural sustainability in developing countries to come to terms with negative impacts of climate change and likely positive and beneficial response strategies to global warming.

Keywords: Environmental impact, agricultural occupation, perception, adaptation.

JEL Classification

Introduction

Agriculture places heavy burden on the environment in the process of providing humanity with food and fiber, while climate is the primary determinant of agricultural productivity. Given the fundamental role of agriculture in human welfare, concern has been expressed by federal agencies and others regarding the potential effects of climate change on agricultural productivity. Interest in this issue has motivated a substantial body of research on climate change and agriculture over the past decade (Lobell *et al*, 2008; Wolfe *et al*, 2005; Fischer *et al*, 2002). Climate change is expected to influence crop and livestock production, hydrologic balances, input supplies and other components of agricultural systems. However, the nature of these biophysical effects and the human responses to them are complex and uncertain.

It is evidenced that climate change will have a strong impact on Nigeria-particularly in the areas of agriculture; land use, energy, biodiversity, health and water resources. Nigeria, like all the countries of Sub-Saharan Africa, is highly vulnerable to the impacts of Climate Change (IPCC 2007; NEST 2004). It was also, noted that Nigeria specifically ought to be concerned by climate change because of the country's high vulnerability due to its long (800km) coastline that is prone to sea-level rise and the risk of fierce storms.

In addition, almost 2/3 of Nigeria's land cover is prone to drought and desertification. Its water resources are under threat which will affect energy sources (like the Kainji and Shiroro dam). Moreover, rain-fed agriculture practiced and fishing activities from which 2/3 of the Nigerian population depend primarily on foods and livelihoods are also under serious threat besides the high population pressures of 140 million people surviving on the physical environment through various activities within an area of 923,000 square kilometers (IPCC 2007; NEST 2004).

Food crop farmers in South Western Nigeria provide the bulk of arable crops that are consumed locally, also, major food crop supplies to other regions in the country. The local farmers are experiencing climate change even though they have not considered its deeper implications. This is evidenced in the late arrival of rain, the drying-up of stream and small rivers that usually flows year-round, the seasonal shifting of the "Mango rains" and of the fruiting period in the Southern part of Oyo State (Ogbomosho), and the gradual disappearance of flood-recession cropping in riverine areas of Ondo state are among the effects of climate disturbances in some communities of South-Western Nigeria (BNRCC, 2008).

To approach the issue appropriately, one must take into account local communities' understanding of climate change, since they perceive climate as having a strong spiritual, emotional, and physical dimension. It is therefore assumed that these communities have an inborn, adaptive knowledge from which to draw and survive in high-stress ecological and socio-economic conditions. Thus, the human response is critical to understanding and estimating the effects of climate change on production and food supply for ease of adaptation. Accounting for these adaptations and adjustments is necessary in order to estimate climate change mitigations and responses.

Problem Statement

Africa is generally acknowledged to be the continent most vulnerable to climate change. West Africa is one of the most vulnerable to the vagaries of the climate, as the scope of the impacts of climate variability over the last three or four decades has shown (IPCC, 2007). Recent food crises in countries such as Nigeria are reminders of the continuing vulnerability of the region to the vicissitudes of climatic conditions. This is in large measure due to weak institutional capacity, limited engagement in environmental and adaptation issues, and a lack of validation of local knowledge (SPORE, 2008; BNRCC, 2008; Royal Society, 2005; Adams *et al*, 1998). Accordingly, there is the need to gain as much information as possible, and learn the positions of rural farmers and their needs, about what they know about climate change, in order to offer adaptation practices that meet these needs

Much of the Niger-delta wetlands areas of Nigeria are now endangered due to climate variability, as witnessed by the significant reduction of their size in recent years. The maximum flooded area of the inner Niger Delta, which is the second largest wetland area in Africa, has dropped from approximately 37,000 km^2 in the early 1950s to 15,000 km^2 in 1990, coupled with the environmental degradation of crude-oil exploration has done to Niger-delta wetlands areas (BNRCC, 2008).

Evidences in literature revealed the intrusion of salt water in the water table of coastal zones of Ayetoro Community in Ilaje LG of Ondo State, Nigeria, and thus, led to increased salinity in soils. Already, the encroaching water is making life very hard. It is “extremely difficult now for food crops to grow on the island”. Salt water sweeps through the land, making it impossible for food to grow (Apata, 2006). Residents lamented that “although they have always lived in harmony with the sea, they are now frightened and scared of living on these atolls”. The atolls are sinking and despite not knowing the sciences people can see with their naked eyes the impact of the rising sea levels (BNRCC, 2008).The community now have the feeling that the waves will just come one day and swept them over; the community is now feeling restiveness. This area and the people are victims of climate change and rising sea levels.

Recent research has focused on regional and national assessments of the potential effects of climate change on agriculture (Lobell, *et al*, 2008; Hassan and Nhemachem, 2008; Fischer *et al*, 2002). These efforts have, for the most part, treated each region or nation in isolation and do not integrate (i.e. combined biophysical and economic) assessment of the potential effects of climate change on proletariat agriculture but mostly focus on world agriculture (ODI, 2007; Segerson and Dixon, 1998). Consequently, this research intends to investigate the effects of climate change at the grassroots’ also, the communities’ perception and adaptation to changing in climate. This will helps to have a better understanding of the communities’ perception of climate change and existing adaptation strategies.

Methodology

Area of Study

Nigeria is one of the Sub-Saharan Africa (SSA) nations located in the western part of Africa. The country has 36 states plus the Federal Capital Territory (FCT)-Abuja. Nigeria shares its boundary with Republic of Benin to the west, Niger republic to the north, Republic of Cameroon and Chad republic to the east, and the Atlantic Oceans. The ocean forms a coastline of about 92, 377,000 hectares, out of which about 91,077,000 hectares are solid land area. The National Population Commission (NPC) put the country population to be over 140 Million Nigerians in 2006 (FRN, 2007). Area of study is South-Western Nigeria and is known for its arable food crop production (NPC, 2006).

Simple purposive random sampling was used to select two states out of six states. Random sampling was used to select Ondo and Oyo States, while communities that are prone to climate change were purposively selected (BNRCC, 2008 and Apata, 2006). The communities selected are, Ayetoro and Mahintedo in Ondo State and Fiditi and Ogbomosho in Oyo states respectively.

Data and Methods

The study administered questionnaire and held Focus Group Discussions to elicit information, where 350 valid responses were used for further analysis. Both structured questionnaire and interviews were held with indigent and local government officials and all other stakeholders on climate change knowledge and adaptation. The study uses logit regression analysis to examine the characteristics that best explain variation in the measures of attitudes of the indigent perception and adaptation level to climate change and factors that influences such decisions. The study decomposes various measures of climate change adaptation. In addition, the study also uses Focus Group Discussions (FGDs) to find out the level of understanding of climate change and the communities perception and level of preparedness'. Panel data was adapted and data were collected during the late rain of September – October 2006 and early rain of march-April, 2007. This is done to have an understanding of the variation of climatic conditions and its effect on agricultural outputs and other form of activities of food crop farmers.

Analytical approaches

Logit model was adopted and used to analyze the determinants of the perception and adaptation level of climate change. The choice of the explanatory variables in the model was based on literature review (Ghazouani and Goaied 2001; Rodriquez and Smiths, 1994; Mendels and Nordhaus, 1994). The basic Logit model is given by

$$Pi\ (Di = 1) = \frac{1}{1 + e^{ii}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (1)$$

Where Ii is a linear combination of the explanatory variable of interest in this study (X_1 to X_{23}). Therefore,

$$Ii = ß_0 + ß_1\ X_1 + ß_2 + X_2 +, \ldots, + ß_{19}\ X_{19} \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (2)$$

However,

$$Pi\ (Di = 0) = 1 - Pi\ (Di = 1) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$$1 - Pi\ (Di = 1) = \frac{e^{-z}}{1 + e^{-z}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Dividing equation (1), the probability expressions can be transformed to determine the log-odds in favour of being poor or not. This manipulation results into:

$$\frac{Pi\ (Di = 1)}{[1 - Pi\ (Di = 1]} = \frac{1}{e^{-Ii}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

But $\frac{1}{e^{-Ii}} = e^{-Ii}$

$$\text{Therefore; } \frac{Pi\ (Di = 1)}{[1 - Pi\ (Di = 1]} = e^{-Ii} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

$$In;\ \left[\frac{Pi\ (Di = 1)}{[1 - Pi\ (Di = 1)}\right] = {}^{-Ii} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

In the context of equation (7), the left hand side is the odd ratio of the probability of being poor in the level of perception and adaptation to climate change.

The estimating logarithmic equation is

$$Ii = ß_0 + ß_1 In_1\ X_1 + ß_2 In_2 2X_2 +, \ldots, + ß_{19}\ In_{19} X_{19} \quad \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

The dependent variable Di is a dichotomous variable, which is one when a respondent perceive any of the climate change variations and adapt to the changes and zero otherwise.

The explanatory variables used in the Logit Models and hypothesized as determinants of respondents poor in the level of perception and adaptation to climate change (that is specialized in only (mono) cropping *)*are:, 1 for mono and 0 otherwise. Increased temperature (X_1), fall temperature (X_2), altered climate range (X_3), changed timing of rains (X_4), frequency of droughts (X_5), noticed climate change (X_6), cereal/legume intercropping (X_7), mulching (X_8), practiced zero tillage (X_9), making ridges across farms (X_{10}), farm size (X_{11}), own heavy machines (X_{12}), household size (X_{13}), farming experience (X_{14}), education (X_{15}), age of farmers (X_{16}) access to extension facilities (ACEXT) (X_{17}) Dummy, if access 1, otherwise 0, access to credit facilities (ACCRE) (X_{18}) and Sex (X_{19})

Results and Discussions.

Table 2 presents farmers' *actual* adaptation measures and practices actually followed, thus, grouped into ten categories (Table 3). These strategies, however, are mostly followed in combination with other strategies and grouped into the following adaptation options: diversifying into multiple and mixed crop-livestock systems, and switching from crops to livestock and from dry land to irrigation, practicing zero tillage, making ridges across farms and cereal/legume intercropping.

Table 3 reveals that multiple cropping mixed with livestock rearing under dry land conditions is the dominant system (25.75%). Cereal/legume intercropping is the second most common strategy (21.28%), and multiple cropping without livestock under dry land (13.51%) comes third.

Diversification from farming to non-farm the most common adaptation practice (59%) (Table 2). The implication is farmers are gradually moving away from farming to non-farm activities. The main adaptation strategic measures followed Food and Agriculture Organization (FAO) classification (Dixon et al., 2001) and were used to classify the strategic measures into thirteen.

Table 4 presents the estimated marginal effects and t-levels from the logit model. The results show that most of the explanatory variables considered are statistically significant at 10%. This study uses specialized (mono) cropping as the base category for no adaptation and evaluates the other choices as alternatives to this option. The results show that altered climate change, noticed climate change frequency of droughts, age and sex all had no significance effect on adaptation. While the increased temperature, intercropping of cereal/legume, mulching, zero tillage making ridges, farm size, farming experience, educational status access to extension and credit facilities are factors influencing adaptation positively (Table 4). However, fall in temperature, change timing of rains, own heavy machines and household size are also significant factors but influence adaptation negatively. This result suggests that the larger the occurrence of these variables, the poorer the adaptation.

. Summary of the results revealed that fall in temperature influences the probability of switching away from mono-cropping more than changes in increased temperature. Similarly, the magnitudes of the marginal coefficients suggest that low outputs warming is a strong factor influencing the probability of switching to other systems that are better adapted to changes in temperature. Better accesses to extension and credit services seem to have a strong positive influence on adaptation.

In addition, access to other farm assets such as heavy machinery is found to promote the use of large –scale farming. These results suggest that capital, land and labor serve as important factors for coping with adaptation. The choice of the suitable adaptation measure depends on factor endowments (i.e. family size, land area and capital resources). The more experienced farmers are, the more likely to adapt. Sex of the farmer did not seem to be of significance in influencing adaptation, as the marginal effect coefficient was statistically insignificant and signs do not suggest any particular pattern. These results suggest that it is the experience rather than sex that matters for adapting to climate change.

Summary of the Reports of the Focus Group Discussions (FGDs)

The people were asked whether they noticed changes in their environments; below are their responses: The temperature is higher (89%); Water evaporation from the ground is so fast (72%) Spread of agricultural pests and weeds on crop land (71%); Violent rain and hailstorms (68%); Delayed rainfall (65%); Less clearly defined seasons (rains sometimes arrive a month late or finish early, rains quickly gave way to sun or dry periods during the rainy season) (65%). Respondents (95%) were convinced that the vagaries of the climate are a sign of divine anger, “as there are many sinners in our midst and God is trying to punish us; like floods with serious consequences”.

The costs associated with crops damaging weather events double each decade as the people (85%) indicated that their crops were devastated by torrential rains and a series of freak hailstorm. Downpours (Rainfall) were more intense in the past years that always leave a trail of destruction on the farms (76%). On the other hand lack of water or delayed downpours threatened crop production activities. The adverse effect of this is that many (68%) have abandoned their crop farming activities due to low outputs to other sectors. Many of the communities/farmers (82%) do not attribute these changes to climate change but the soil no longer productive. Respondents (72%) confirmed these incidences as curses from their ancestors who are unhappy due to lack of appeasement to these gods.

Solutions suggested as documented from FGDs.

Need agricultural insurance (74%), Weather alert (Radio and Television for daily weather forecast and relevance to agricultural activities) (71%) to help for effective adaptation. Also, effective Meteorological facilities in keeping adequate records of weather forecast are provided. Need Extension agents to educate more on zero tillage, organic agriculture, and better land management techniques.

Conclusion

Due to low outputs from farms, as a result of low rainfall and increased temperature, farmers appear to be abandoning mono-cropping for mixed and mixed crop-livestock systems. Farmers in the area of study rely on rain fed agriculture, while considering risky, mono-cropping practicing under dry land. Farming experience and access to education were found to promote adaptation. This implies that education to improve awareness of potential benefits of adaptation is an important policy measure.

Focus Group Discussions revealed lack of effective access to information on climate change. Thus, there is need for effective and reliable access to information on changing climate to dissuade farmers mind from spiritual angle. In addition, empowerment (credit or grant facilities) is crucial in enhancing farmers' awareness. This is vital for adaptation decision making and planning. Combining access to extension and credit ensures that farmers have the information for decision making and the means to take up relevant adaptation measures.

Recommendations

Policies must aim at promoting farm-level adaptation through emphasis on the early warning systems and disaster risk management and also, effective participation of farmers in adopting better agricultural and land use practices

There is an urgent need for meteorological reports and alerts to be made accessible (when necessary) to farmers in an understandable forms.

Massive campaign on the reality of climate change and its serious consequences on food production is highly recommended so as to persuade against farmers' believe from spiritual angle.

Need of readily availability emerging technologies and land management practices that could greatly reduce agriculture's negative impacts on the environment and enhancement of its positive impacts.

It is evidenced from this study that arable food crop farmers are experiencing change in climate and they have already devised a means to survive. It is from this point that policy of reliable and effective measures of adaptation need to be implemented and must be accessible to the end users. Looking at the issue of climate change adaptation, the role of agricultural economics in this regard is significant to raise both the consciousness of the need to climate change adaptation and possible methods of mitigation to both the end users and policy makers. The fulcrum of agricultural economists is cost minimization and profit/output maximization. Therefore, agricultural economists must locate enterprise combination or resource use substitution in terms of human and physical in the realization of this objective.

The case study research undertook clearly showcases that majority of the respondents still believe in spiritual angle rather than the global warming, but the results indicated presence of change in climate, though people responses to the issue of climate change is at low pace. Thus, there is a need by agricultural economists to design strategies that could help the farmers/rural communities' responses effectively to global warming. This is in line with the recognition that other stakeholders in agricultural sustainability must be worked with: like the Agro climatologist, Meteorologists, Agricultural Extensions and Rural Sociologists for early warming alerts and interpretations in the language useful to farmers/rural communities

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List of Tables

Table 1: Farmer perceptions of long-term temperature and unclear/undefined variable changes

Variable	%of Respondents
(a) Temperature	
Increased temperature	21
Decreased temperature	5
Altered climatic range	9
Other changes	7
No change	44
Don't know	14
(b) Unclear/undefined variable	
Increased precipitation	5
Decreased precipitation	30
Changed timing of rains	28
Frequency of droughts	16
Other changes	5
No change	13
Don't know	3
Number of responses	**350**

Table 2: Farmers' perceived adaptations

Variable	% of Respondents
Planting different crops	11
Planting different varieties	17
Practising crop diversification	8
Different planting dates	16
Shorten length of growing period	13
Move to different site	4
Change amount of land	3
Changes from crops to livestock	2
Changes from livestock to crops	1
Adjust livestock management practices	1
Farming to non-farming	59
Non-farming to farming	2
Increase irrigation	3
Change use of chemicals, fertilizers and pesticides	5
Increase water conservation	18
Soil conservation	15
Shading and shelter	21
Use insurance	7
Prayer	15
Other adaptations	22
No adaptation	37
Number of responses	**350**

*** Multiple Responses indicated**

Table 3: Actual adaptation measures used by farmers

Adaptation measures	**% of Respondents**
Specialized crop under dry land	2.21
Specialized crop under irrigation	1.03
Specialized livestock under dryland	1.02
Specialized livestock under irrigation	0.00
Multiple crops under dryland	13.51
Multiple crops under irrigation	0.27
Mixed mono-crop/livestock under dryland	6.95
Mixed mono-crop/livestock under irrigation	2.04
Mixed multiple crops/livestock under dryland	25.75
Mixed multiple crops/livestock under irrigation	4.24
Practiced zero Tillage	10.31
Making ridges across farms	12.38
Cereal/legume intercropping	21.28
Number of observations	**350.00**

Table 4: Results of the Logit Regression Model

Variable	Estimate	t-value
Increased Temperature (X_1)	.090E-02	4.324***
Fall in Temperature (X_2)	-.308E-01	-2.8923**
Altered Climate Range (X_3)	.4211	1.421
Changed timing of rains (X_4)	-.161E-01	-3.3461***
Frequency of Droughts (X_5)	-.8851	-.2883
Noticed Climate Change (X_6)	.6272	1.7061
Cereal/legume Intercropping (X_7)	.5783	2.7412**
Mulching (X_8)	.22E-05	2.1371*
Zero Tillage (X_9)	933E-06	3.122***
Making Ridges across Farms (X_{10})	.717	2.762**
Farm size (X_{11})	.827E-07	2.1262*
Owned heavy machines (X_{12})	-.923E-01	- 4.4262***
Household size (X_{13})	-.135E+11	-4.4262***
Farming experience (X_{14})	.5196E-04	2.5931*
Educational status (X_{15})	.1162	4.1201***
Age (X_{16})	.2364	.3472
Access to extension facilities (X_{17})	.3681	2.7272**
Access to credit facilities (ACCRE) (X_{18}).	.2606	1.9621*
Sex (X_{19})	-.5190	-.9428

Source: Computer Printout of Logit Regression Analysis

*** = Significant at p<0.01, ** = Significant at p<0.005, * Significant at p<0.001

Log-likelihood function: -198.86, Significance level: . (P<00001) Constant = 0.62