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Analysis of Coping Strategies Adopted against Climate Change by Small Scale Farmers in Delta State, Nigeria

Pius Chinwuba Ike Lillian Chinwe Ezeafulukwe
Department of Agricultural Economics, Delta state university, Asaba Campus, Nigeria
Corresponding email: ikepeecee@yahoo.com

Abstract
This study analyzed the coping strategies adopted against the effects of climate change by small scale cassava and yam farmers in Delta State, Nigeria. It examined the socioeconomic characteristics of yam and cassava farmers and identified the various climate change factors that are prevalent in the study area. It also ascertained the coping methods adopted by the farmers in adjusting to the impact of variations in climate and also estimated the effect of the farmer's socioeconomic characteristics on the number of coping methods adopted. 180 respondents made up of 90 cassava farmers and 90 yam farmers were randomly sampled for the study. Data were collected through the use of structured questionnaire and analyzed using descriptive and inferential statistics. Results showed that the majority of the farmers (82.8%) fell below the age of 50 years, 71.6% are married and mostly females (66.7%). Majority (53.9%) had post primary education, 33.9% had farming experience of 16-20 years, 53.9% had 1-5 household members and 39.4% had farm size between 0.1- 1 hectare. Most of the farmers observed high temperature (81.8%), less rainfall (77.8%) and shorter rainy season (22.2%) as signs of climate change. Four variables including farm size (0.05), farming experience (0.05), education (0.01) and income (0.01) have significant positive effect on the number of strategies adopted. Government policies and programmes should be geared towards addressing imperfections such as access to information and linking farmers with extension services.
Keywords: climate change, coping strategies, rainfall, temperature, small scale farmers

INTRODUCTION

Nigeria is generously endowed with abundant natural resources and has the potential to build a prosperous economy and provide for the basic needs of the population. Agriculture provided 41.8% of the Nigeria's total gross domestic product (GDP), provides employment for 70% of the population and it is a major source of economic activities (FAO, 2007). Nigeria's climate permits the cultivation of a variety of crops such as maize, yam, cassava, wheat and so on. The variations in climatic factors and agriculture are interrelated processes both of which takes place on a global scale. Global warming is projected to have significant impacts on condition affecting agricultural production, including temperature, carbondioxide, glacial runoff, precipitation and other elements (Pahl-wostl, 2007). These conditions determine the carrying capacity of the biosphere to produce enough food for the human population and domesticated animals.

The continuous variations in climatic factors over time bring about climate change. Climate change as defined by the Wikipedia dictionary and encyclopedia is a change in statistical distribution of weather over period of time that ranges from decades to billions of years. It can be a change in the distribution of weather events around an average for example, greater or fewer extreme weather events. Climate change may be limited to a specific region or may occur across the whole earth. It could be caused by recurring often cyclical climate patterns or in the form of more singular events such as the "dust bows" (FAQ, 2008). Climate change, simply put is the change in global weather patterns and it is unarguably the biggest environmental issue of our time. It is global in its causes but its consequences are far more reaching in developing countries particularly Nigeria whose biodiversity and ecosystems are already faced with other threats like habitat degradation, ecology mismatch and escalating population growth (Obioha, 2009).

In general, variations in climatic factors affects change in plant growth and productivity by promoting spread of pests and diseases, increased exposure to heat stress, changes in rainfall patterns, greater leaching of nutrients from soil during intense rains, greater erosion due to stronger winds and more wild fires in the drier regions (Yusuf *et al*, 2008)

Crop production is highly sensitive to climate variability and weather extremes such as droughts, floods and severe storms. The forces that shape our climate are also critical to farm productivity. Human activities have already changed atmospheric activities such as temperature, rainfall, levels of carbondioxide (CO_2) and ground level ozone. The increased potential for drought, floods and heat waves poses challenge for farmers. Additionally the enduring variations in climate, water supply and soil moisture could make it less feasible to continue crop production in certain regions. Agriculture in industrialized countries is expected to be less vulnerable to climate change than agriculture in developing nations, where farmers have limited ability to adapt. The effects of climate crop production will depend not only on the varying climate conditions, but will also depend on agricultural sector ability to adapt through future change in demand for food, environmental conditions such as water availability and soil quality (Adejuwon, 2004).

The concern with variations in climate is heightened given the linkage of the agricultural sector to poverty. In particular it is anticipated that adverse impacts on the agricultural sector will exacerbate the incidence of rural poverty. Impacts on poverty are likely to be especially severe in developing countries where the agricultural sector is an important source of livelihood for a majority of the rural population. The awareness of variations in these climatic factors by the rural farmers remains in doubt as their farming activities tend to portray.

Crop production is highly sensitive to variations in climatic factors from hours of sunshine to rainfall, soil condition and particularly to temperature due to effects of evapotranspiration. Climate variability could alter stages of rates of development of crop pests and pathogens modify host resistance and results to changes in physiology of host, pathogen or pest interaction. This can alter crop yields, resulting to crop losses which will impact on socio-economic variables such as farm income, farm level decision making, marketability and farmers livelihoods (Oyerinde and Osantande, 2012).

Rural communities across the developing world use various coping strategies in response to poverty, food insecurity, conflict as well as environmental stresses; all challenges which are compounded by climate change and variability (Berman *et al*, 2012). The Intergovernmental Panel on Climate Change reports that parts of Africa may experience longer and more intense droughts, with other areas experiencing more erratic rainfall (IPCC 2012). As a result, communities may experience environmental stressors that are beyond their previous understanding (Adger *et al.* 2003). Amongst the most vulnerable will be communities who depend on rain-fed agriculture and natural resource related activities. These communities will not only be impacted by changes in mean climate, but may experience greater impact from climate variability, including extreme events (Smit and Pilifosova 2001).

Most farmers in Delta state, Nigeria are highly sensitive to variations in climatic factors most especially rainfall and temperature. Hence, the coping strategies adopted against these adverse climatic variables as well as the socioeconomic factors that predisposes the farmers to adopt those strategies need detailed assessment. Thus the study has the following specific objectives; to:

i. examine the socioeconomic characteristics of yam and cassava farmers in the study area;
ii. identify the various climate change factors that are prevalent in the study area;
iii. ascertain the coping methods adopted by the farmers in adjusting to the impact of variations in temperature and rainfall, and
iv. estimate the effect of farmers' socioeconomic characteristics on the number of coping methods adopted;

Hypothesis of the Study

The following hypothesis was tested.

Ho. Farmers' socioeconomic factors do not have any significant effect on the number of coping strategies adopted against variations in temperature and rainfall.

METHODOLOGY

Area of Study

The study was conducted in Delta State which is one of the nine states of the Niger Delta Region of Nigeria. The State lies between Longitudes $5^0$00 and $6^0$45' East and Latitudes $5^0$00 and $6^0$30' north of the equator. It has a total land area of 17,440 square kilometers, about one-third of this is swampy and water logged (Delta State Diary, 2003). Delta State is bounded in the north by Edo State, in the east by Anambra and Rivers State and in the south by Bayelsa State. The Atlantic Ocean forms the western boundary while the North-West boundary is Ondo State. The State is made up of 25 Local Government Areas and has a population of 4.1 million (National Population Census, 2006).

Delta State has a tropical climate marked by two distinct seasons: the rainy and dry season. The dry season occurs between November and April, while the rainy season begins in April and last till October. The average annual rainfall in the coastal areas is about 266.5mm and 190.5mm in the northern fringes of the state.

The temperature is high ranging between 28^0 C and 34^0 C with an average of 30^0 C (80^0 f). The natural vegetation in the state varies from the mangrove swamp forest in the south, to the fresh water swamp forest and rain forest in the central ecological zone, and the derived savannah belt in the northern part of the state. The state is blessed with fertile soil and favourable climate which makes it an important producer of food and cash crops.

Sampling Procedure

A simple random sampling technique was used for the study. Three Local Government Areas were randomly selected from each of the three agricultural zones. This gave nine local government Areas that were selected from the agricultural zones. One community was chosen from each of the Local Government Areas. These gave nine communities that were selected for the study. Ten cassava farmers as well as ten yam farmers were selected from each of the communities making a total of one hundred and eighty (180) respondents that were interviewed for the study.

Data Collection/Analysis

Data on temperature and rainfall for the past thirty years (1980 to 2009) were collected from Asaba station of Nigeria Meteorological Agency to determine their variation over time. Also the output of cassava and yam from within the same period were collected from Delta State Agricultural Development Programme (ADP). The primary data for the survey were collected through the use of structured questionnaire designed to obtain information from the identified respondents. The questionnaire survey elicited information on the socioeconomic profile of the respondents such as age, Sex, marital status, household size education, farm size, years of faming experience and level of income. Others were the different coping strategies adopted by them to mitigate crop yield losses in the area as well as the different constraints to adopting the various coping strategies.

Descriptive and inferential statistics were used to analyse the data collected. Descriptive statistics such as tables, mean, frequencies were used to summarize the socioeconomic variables of the respondents. Ordinary Least Square Regression analysis (OLS) was to determine the effect of the rural farmers' socioeconomic variables on the number of coping strategies adopted against the variations in the climatic factors.

The regression equation model was implicitly specified as:

$Y = f(X_1\ X_2, X_3, X_4, X_5, X_6, X_7, X_{8,}\ \mu)$

Where

Y = Number of coping strategies adopted

X_1, = Age (Years)

X_2 = Farm size (Number of hectares planted)

X_3 = Marital status (Dummy variable; 1 if married, 0 otherwise)

X_4 = Gender (Dummy variable; 1 if male, 0 otherwise)

X_5, = Education (Number of years spent in formal education)

X_6 = Household size (Number)

X_7 = Farming experience (Years)

X_8 = Farmers' income (Naira)

μ = error term

The regression equation was explicitly specified and tried in the functional forms of linear, semi-log, exponential and double log models.

These are as specified below:

Linear model

$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + \mu$

Semi-log model

$Y = \log b_0 + b_1\log X_1 + b_2\log X_2 + b_3\log X_3 + b_4\log X_4 + b_5\log X_5 + b_6\log X_6 + b_7\log X_7 + b_8\log X_8 + \mu$

Double log model

$\text{Log}Y = \log b_0 + b_1\log X_1 + b_2\log X_2 + b_3\log X_3 + b_4\log X_4 + b_5\log X_5 + b_6\log X_6 + b_7\log X_7 + b_8\log X_8 + \mu$

Exponential model

$\text{Log}Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + \mu$

Where:

$X_1 – X_8$ are as earlier defined,

b_0 = Intercept

$b_1 – b_8$ = coefficient of the independent variables

The model with the best fit was chosen as the lead equation and this is based on the size of the coefficient of multiple determination (R^2) as well as the number of significant variables in line with *a priori* expectations.

RESULTS AND DISCUSSION

The Socioeconomic Characteristics of Farmers

The various socioeconomic variables of the farmers as examined in this study are as presented in Table 1. As depicted in the table it could be seen that 66.7% of the respondents are female 33.3% are males. This is in line with the findings of Ugwu (2009) which stated that women put in 70% of all the time expended on food production and undertake 60-80% of the work load in agriculture making up more than 40% of the estimated labour force in the sector and grow about half of the food supply in the world.

Data on respondents' marital status show that majority of them are married. Married respondents constitute about 70% of the sampled respondents while 9.4% are single. About 7.8% of the respondents are divorced and 12.8% are widowed. Their occupational role in the family as parents did not clash with their crop production. The age distribution of farmers showed that 52.2% of the farmers are within 21-40 years. Respondents within the range of 41 and 50 years constituted 30.6%, while those over 50 years are 17.2%. Implicit in these findings is that a large proportion of respondents are middle aged (over 82%) and able bodied and can therefore be regarded as active, agile and physically disposed to pursue economic activities.

The majority (about 93.3%) of the respondents have formal education. This implies that farmers in the study area are literates; they attempted at least a primary education. This is an advantage since education is generally considered as an important variable that enhances the farmers' adoption of new technologies (Olowoya, 1994). Most respondents also have had many years of practical experience on farming. For example 33.9% had 16 to 20 years of farming experience. This made them familiar with the changes in the climatic phenomenon, improved practices, which in turn, exerted a positive impact on the adoption of new mitigation measures.

Result gathered from the respondents showed that 53.9% farmers has less than 6 persons in each of their homes, while 46.1% farmers has 6 persons and above in their families. According to the respondents, the size of their farms as in Table 4.1 reveals that more than 71% of the farmers had farms ranging from 0.1-2.0 hectares while a small fraction of 28.9% owns farmlands ranging from 2.1 -4.0 hectares. Most of the farmlands are not contiguous plots but are scattered in different locations.

Findings revealed that the mean annual income in the study area is ₦71, 951.75 (Table 4.1). This translates to about $449.70 per annum or $1.23 per day which is less than $2.00 a day recognized as the global poverty line. The low mean annual income of the farmers in the area is partly a direct consequence of variations in temperature and rainfall.

Climate Change Factors Prevalent in the Study Area

The various climatic change factors prevalent in the area as observed by the respondents are as shown in Table 2. Findings indicate that most of the respondents observed high temperature (87.8%), less rainfall (77.8%) and shorter rainy season (22.2%) as signs of climate change. This is congruent, with the findings of Deressa *et al* (2009) who observed the same results in their study in the Nile basin of Ethiopia. These farmers claimed to have been observing variations in these climatic factors for so many years and have come to terms with the attendant impact on agricultural output. This is an indication that agriculture (cassava and yam production) in the study area is affected by variations in climatic factors such as temperature and rainfall.

The consequence of this variation in climatic factors as observed by the respondents include soil erosion, increased incidence of pests and diseases, soil infertility and poor yield (Table 3). Poor yield and drought are brought about as a result of delayed onset of rainy season as the vegetative cover of soil withers and the soil become exposed to the vagaries of weather. With the heavy leaching that occurs when the rains start, the soil is eroded and rendered infertile. The prolonged delay in the onset of rains causes the hibernation of pest and disease vectors. At the eventual onset of rain, these organisms become voraciously active. This is as a result of long period of deprivation they experienced (LEISA, 2008). According to LEISA (2008), farmers need to be able to cope with sudden flood which contribute heavily to erosion. Shah and Ameta (2008) opined that variations in climatic factors are directly linked with reduced soil productivity and to a higher incidence of pests and diseases.

Coping Methods Adopted by Farmers against Variations in Temperature and Rainfall

The major strategies adopted by the farmers to cope with the impact of the variations in temperature and rainfall in the area indicates that alteration of planting date, mulching /cover cropping, mixed farming/cropping, use of different crop varieties and construction of flood barriers are more prevalent (Table 4). A closer analysis show that over 83 percent of the farmers adopted alteration of planting date while more than 95 percent of them adopted mixed farming (rearing livestock and crop production) as well as mixed cropping system to cope with the probable failure of one of the major crops planted. However, about 4 percent of the respondents claimed not to have adopted any strategies against variations in climatic factors. The limited use of tree planting could be associated with the need for more capital for the purchase of tree seedlings. More so, limited use of irrigation could be attributed to its capital intensive requirements and the total dependence on rainfed agriculture. It was also noted that in addition to the use of agricultural practices as coping strategies, farmers in the area also adopts economic activities as well. Economic activities included non-farm income generating activities such as market, trading, fishing and employment outside the village.

These adaptation strategies are in line with the findings in climate change adaptation literature (Bradshaw et al, 2004; Maddison, 2006; Nhemachena and Hassan, 2007; Hassan and Nhemachea, 2008). The reason for farmers not choosing any adaptation option is as a result of certain constraints associated with level of information and insufficient fund.

Effect of Farmers' Socioeconomic Factors on the Number of Coping Strategies Adopted

The socioeconomic variables of the farmers were examined to isolate those which could enhance increased number of coping strategies adopted by the farmers against the consequences of climate factor variations. The Ordinary Least Square Regression Analysis (OLS) was applied as the analytical tool. The number of coping strategies adopted by the farmers formed the dependent variable while the various socioeconomic factors of the farmers were the independent variables. The multiple regression equation was run in four functional forms of linear, semilog, double log and exponential forms as previously explained.

The lead equation was chosen on the basis of the magnitude of the coefficient of determination (R^2) as well as the number and signs of the significant variables in line with the *apriori* economic expectation. The Double log function was chosen as the lead equation and presented in Table 5.

The coefficient of determination R^2 which show the extent of fitness of the regression equation was 0.692. This implies that the explanatory variables explained 69.2% of the variations in the number of coping strategies adopted by the farmers. The R^{-2} (Adjusted R square) was 0.688% and indicated inclusion of 68.8% of important factors in the model. The remaining 30.8% was unexplained variation not included in the whole model. A test of the significance of the whole model using F-test showed that F calculated (35.085) was significant at the 0.01 level. The significance of the individual regression coefficients was shown by their t-values.

Farm size, Level of educational attainment, Farming experience and Farmers' income all contributed significant positive effect on the number of coping strategies adopted by the farmers against the consequences of variations in temperature and rainfall. While farm size and farming experience were significant at the five percent level, the level of education and farmers' income were significant at the one percent level. The various significant variables are discussed as follows:

Farming Experience

This has a positive relationship with the number of strategies adopted by the farmers to cope with the vagaries of nature. The farmers tend to be technically efficient in the use of resources and adoption of new ideas with more years of farming experience. This is congruent with *apriori* expectation. Ofuoku, (2011) argue that a well experienced farmer will have a good knowledge of climatic factors as they relate to their farming operations. The information on climate variations will help the farmer to improve his crop production by adopting various climate change adaptation measures such as the use of different crop varieties and planting of tress. This will exert a positive impact on the production process.

Farm Size

Farm size has a coefficient of 0.241 with a t-value of 2.199 and significant at the 0.05 level of significance. This implies that the larger the size of farms, the more the number of strategies adopted by the farmers. This could be because the farmers that have large farms are those who are still very highly experienced, hence the tendency for them to adopt more strategies than those managing small sized farms.

Level of Education

The level of education variable has a coefficient of 0.865 and a t-value of 12.609. It is significant at the 0.01 level. This is in line with the *a priori* expectation as a well educated farmer has the capacity to adopt more strategies to deal with variations in climatic factors. The role of education in technology adoption has been variously documented in literature (Ike, 2011).

Level of Income

The level of income of the farmers with a coefficient of 0.523 and a t-value of 11.247 is significant at 0.01 percent level. It is positively signed and in line with *a prior* expectation. This implies that a farmer with more levels of income will have the capability to adopt as many measures as possible to deal with variations in temperature and rainfall.

Constraints to Adaptation of Coping Strategies

The reasons for some farmers not adopting strategies to cope with variations in climatic factors ranged from lack of information, low income, and shortage of labour as well as inadequacy of land. Lack of information is attributed to the dearth of extension agents and use of poorly trained personnel at the local level. According to Agbamu (2005), there is a disproportional extension agent to farm family ratio in Nigeria and poorly trained personnel are used at the field level as most of them were poorly trained in tertiary institutions that are ill-equipped for grooming agricultural graduates and imparting information and communication skills to them.

The issue of inadequacy of land and low income as constraints to adoption of some coping strategies against variations in climatic factors are related. Inadequacy of land limits the farmer from adopting mixed farming technique which could act as insurance against crop failure. In the same vein, low income farmers are constrained from adopting strategies against flooding occasioned by excess rainfall. It also limits the farmer's ability to adopt and apply the improved technologies such as improved crop varieties.

CONCLUSION

Rural communities across the developing world use various coping strategies in response to poverty, food insecurity, conflict as well as environmental stresses; all challenges which are compounded by climate change and variability. Most farmers in Delta state, Nigeria are highly sensitive to variations in climatic factors most especially rainfall and temperature. Hence, they adopt coping strategies against these adverse climatic variables. Farmers' socioeconomic factors affect the number of these strategies adopted amongst which are farm size, experience, education and income. It is therefore recommended that Government policies and programmes should be geared towards addressing imperfections such as access to information and linking farmers with extension services. The extension programme can play a key role in information sharing by transferring technology, facilitating interaction, building capacity among farmers, and integration of indigenous and modern knowledge on climate change adaptation strategies. Farmers should also be encouraged to form their own informal social networks such as cooperative societies and other farmers association. This will ensure effective information sharing mechanism and exchange of ideas on climate issues among themselves.

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Table 1: Socioeconomic Characteristics of Respondent Farmers

Variable	Frequency	Percentage
Gender		
Male	60	33.3
Female	120	66.7
Marital Status		
Married	126	70
Single	17	9.4
Divorced	14	7.8
Widowed	23	12.8
Age		
21-30	23	12.7
31-40	71	39.5
41-50	55	30.6
51-60	29	16.1
61-70	2	1.1
Formal Education		
No formal Education	18	10.0
Primary Education	53	29.4
Post Primary Education	97	53.9
Higher	12	6.7
Farming Experience		
Under 5 years	21	11.7
6 – 10 years	32	16.8
11 – 15 years	51	28.3
16 – 20 years	61	33.9
Above 20 years	15	8.9
Household Size		
1 – 5	97	53.9
6 – 10	72	40.0
11 – 15	11	6.1
Farm Size		
0.1-1	71	39.4
1.1-2.0	57	31.6
2.1-3.0	32	17.8
3.1-4.0	20	11.1
Annual Income		
₦20,000 – 59,000	47	26.1
₦60,000 – 99,000	67	32.7
₦100,000 – 139,000	21	11.7
₦140,000 – 179,000	13	7.2
₦180,000 – 219, 000	13	7.2
₦220,000 – 259,000	12	6.7
₦260,000 and above	7	3.9

Table 2: Climate Change Symptoms Observed by the Respondents

Variable	Frequency	Percentage
High temperature	158	87.8
Low temperature	3	1.7
Heavy rainfall	29	16.1
Less rainfall over the years	140	77.8
Shorter rainy season	40	22.2
Delayed rainfall	34	18.9
Flood (recent flood)	96	53.3
Erosion	80	44.4
Heavy wind	8	4.4

Multiple responses recorded

Table 3: Consequences of Variations in Temperature and Rainfall

Effect of change climate	Frequency	Percentage
Soil erosion	115	63.8
Pest and disease	160	88.8
Drought	20	11.1
Soil infertility	152	84.4
Poor yield	140	77.8

Multiple responses recorded

Table 4: Coping Methods Adopted by Farmers to Cope with Variations in Temperature and Rainfall

Strategies	Frequency	Percentage %
Change of planting Date	150	83.3
Irrigation	7	3.9
Mulching/cover cropping	162	90.0
Mixed farming/cropping	172	95.6
Changed timing of land preparation	133	73.9
Using different crop varieties	157	87.2
Construction of flood barriers	110	61.1
Zero or minimum tillage	70	38.9
Planting of tress	10	5.6
No Strategy adopted	8	4.4

Multiple responses recorded

Table 5: Determinants of Number of Coping Strategies Adopted

Variables	Coefficients	Standard Error	T-values	Sig
Constant	4.275	.255	16.771	000***
Age	-0.124	.186	-.667	-.506
Marital status	0.067	.094	.709	.479
Farm size	0.241	.110	.2.199	.029**
Household size	0.063	.100	.636	.525
Sex	-0.061	.082	-.749	-.455
Education	0.865	.069	12.609	000***
Farming experience	0.210	.079	2.658	.016**
Income	0.523.	0.0465	11.247	000***

*** = significant at 1% level ** = significant at 5% Level

R^2 = 0.797 F – ratio = 35.085