Global Journal of Science Frontier Research
Agriculture and Veterinary Sciences
Volume 12 Issue 8 Version 1.0 Year 2012
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

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GJSFR-D Classification : FOR Code: 070104, 070105

Strictly as per the compliance and regulations of :

Constraints to the Implementation of Climate Change Adaptation Measures by Farmers in Delta State, Nigeria

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Abstract - This study examined constraints to the implementation of climate change adaptation measures by farmers in Delta North Agricultural Zone of Delta State, Nigeria. Crop farmers in three purposively selected extension blocks served as respondents of the study. A sample of 321 respondents was used for the study. A list of farmers in contact with extension served as sampling frame. Data for the study were collected from the respondents of the study through the use of a detailed, carefully designed and validated interview schedule. Trained field assistants selected in each location in addition to the researchers collected the data for the study. Data generated by the study were analyzed using descriptive statistics. Results show that there were more male crop farmers in the area of study. Also, majority (92%) of the respondents had formal education and many years of farming experience. The study found that respondents were using some adaptation measures which include: the use of crop rotation, use of sandbags at river banks, use of bamboo stakes, planting of cover crops and the construction of drainages. Constraints to the implementation of adaptation measures that were identified by the study include: limited availability of land for farming, lack of access to weather forecast information, poor access to information sources, limited income, high cost of irrigation facilities, traditional beliefs and practices, high cost of improved and resistant varieties and government irresponsiveness to climate risk management. Recommendations of the study include first, the establishment of climate information management system that will manage issues relating to awareness creation, information on weather forecast, early warning signs and training of farmers on how to cope with climate change. Secondly, the establishment of a sustainable credit scheme which will enhance farmers' capacity to implement appropriate adaptation measures and thirdly, the creation of a separate unit by the extension service agency to handle climate change issues relating to building farmers' resilience.

I. Introduction

Climate is the average weather condition of an area over a given period of time usually 30years. There are some worries that over the years, the pattern of these weather conditions such as rainfall, temperature and others have not been stable. This instability in climate variables is what gave rise to the concept of climate change.

Climate change was defined by Miller and Edwards (2010) as change in earth's atmospheric process and other parts of the earth such as oceans. Mavi (2004) identified the basic causes of climate change to be associated with human activities such as deforestation and gas flaring related activities which result to accumulation of the greenhouse gases in the atmosphere. The European Union report on climate change (2008) showed that global warming followed the pattern predicted by earlier scholars. The report stated that the earth's temperature has undergone an annual increase of 0.6^{0c} in the past 10years as a result of the accumulation of the greenhouse gases.

Greenhouse gases are gases that cause increase in the earth's temperature by trapping heat from the sun and concentrating it on the lower vapour atmosphere. Examples of the gases are methane, nitrous oxide, ozone, carbon- dioxide, nitrous oxide, carbon monoxide, water vapour and chlorofluorocarbons. Earlier studies have shown that the accumulation of these gases in the atmosphere is a major factor causing change in the global climate and in the climate of regions around the globe (Crosson, 1997). For instance, it was reported that livestock is responsible for 18% of the world's greenhouse emission as measured in CO_2 equivalents. Livestock produces 65% of human – induced nitrous oxide, which has 296 times the global warming potential of CO_2 and 37% of human-induced methane which has 23 times the global warming potential of CO_2 (Owolabi, 2010).

According to Mckeown and Gardner (2009), greenhouse gases are generated by the following processes: a) carbon-dioxide generated by fossil fuel combustion, land clearing for agriculture, and cement production; b) methane generated by livestock production, extraction of fossil fuel, rice cultivation, landfills, and sewage; c) nitrous oxide generated by industrial process and fertilizer use and; d) the f gases made up of hydro fluorocarbons generated by: i) leakage from refrigerators, aerosols and, air conditioners; ii) aluminum production, semi-conductor industry; and iii)electrical insulation and magnesium smelting. Greenhouse gases arise from a wide range of human activities. The Intergovernmental panel on Climate Change (IPCC, 2007) gave the share of greenhouse gas emissions by sector as follows: energy supply (25%); industry (19.4%); forestry (17.4%); agriculture (13.5%) transport (13.1%); building (heating and cooling, 7.9%).

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Climate change adversely affects the socio-economic sector which includes water resources, agriculture, food security, forestry, fisheries, ecological systems, human health and settlements. The projected impact of climate change on the earth's environmental stability and hence changes in global climate would include disruption of temperature distribution, precipitation, evapo-transpiration, clouds, air-currents and consequential shifts in the vegetation belts, melting of polar ice-caps, rise in sea level that could adversely affect low-lying areas. Climate change affects crop production in many ways. For instance, uncertainty and variations in the pattern of rainfall and flood cause pest and diseases infestation in response to climate change. Irregular and unpredictable rainfall and sunshine hours affect yield of most staple crops such as maize, cassava, melon, sorghum and yam by about 2.5% per annum. Cash crops such as cocoa, cashew, orange, kola-nut, oil palm, rubber, cotton and coffee suffer severe setback under reduced photoperiods with flower and fruit abortion trends that reduce yield by 5.5metric tons per hectares. Livestock production is also affected by climate change in the following ways: Climatic stress reduces feed, water intake, grazing time and hence growth rate and productivity. High temperatures retard reproductive cycles in goats, sheep, cattle and poultry. Meat and milk outputs as well as grazing land have been reduced due to the effect of climate change Climate change also impact on forest resources through losses medicinal plants, mushrooms and bush meat.

Nigeria has been reported to likely be one of the most negatively impacted countries in the world as a result of climate change. According to DIFD (2009), Nigeria's risks are particularly high due to its low lying coastline that is highly populated with a heavy concentration of GDP generating industry and infrastructure. A DIFD preliminary Integrated Assessment Model report relating to sea level rise in Nigeria, predicted that climate change could result in a loss in GDP of between 6% and 30% by 2050 with an estimated US$ 100 to 460 billion dollars. If no adaptation is implemented by 2020, a further 2 to 11% of GDP could potentially be lost (DIFD, 2009).

The impact of climate change on the population and livelihood of Nigeria's farming communities include floods, sand deposition, mud- accumulation, salination of irrigated farmlands and ocean surges (ocean surge cause erosion of farm land and landslide of between 250 – 270m^2/ year). According to Idowu, et al. (2011), the impact of climate change on the health of farming communities in Nigeria include:

- Respiratory diseases due increase in the level of pollutants
- Malaria in more widespread levels within the population (70% annually)
- Skin ailments (45% annually)
- Heat stroke (40% annually)
- Loss of productivity (40% annually)
- Portable water shortages due to flood and/or saltwater intrusion (60% annually).

Climate change has also influenced the wind distribution patterns resulting in storm surges that usually cause losses in housing units (40% annually), loss in post-harvest sheds(30% annually), loss in poultry/piggery sheds(30% annually) and loss in farmstead stores(40% annually) Adaptation to environmental change is not new to mankind. Societies have demonstrated strong capacity for adapting to different climatic and environmental changes. According to (IPCC, 2007), examples of adaptation and coping strategies in different sectors include the following:

Human Health

- Many diseases and health problems that may be exacerbated by climate change can be effectively prevented with adequate financial and human public health resources, including training, surveillance and emergency response, and prevention and control programs.
- Urban tree planting to moderate temperature increases
- Weather advisories to alert the public about dangerous heat conditions
- Grain storage, emergency feeding stations
- Adjusting clothing and activity levels, increasing fluid intake

Coastal Areas and Sea Level Rise

- Developing county-scale maps depicting which areas will require shore protection (e.g. dikes, bulkheads, beach nourishment) and which areas will be allowed to adapt naturally
- Analyzing the environmental consequences of shore protection
- Promoting shore protection techniques that do not destroy all habitat
- Identifying land use measures to ensure that wetlands migrate as sea level rises in some areas
- Engaging state and local governments in defining responses to sea level rise
- Improving early warning systems and flood hazard mapping for storms
- Protecting water supplies from contamination by saltwater

Agriculture and Forestry

- Altering the timing of planting dates to adapt to changing growing conditions

- Altering cropping mix and forest species that are better suited to the changing climatic conditions
- Breeding new plant species and crops that are more tolerant to changed climate condition
- Promoting fire suppression practices in the event of increased fire risk due to temperature increases
- Controlling insect outbreaks

Ecosystems and Wildlife

- Protecting and enhancing migration corridors to allow species to migrate as the climate changes
- Identifying management practices that will ensure the successful attainment of conservation and management goals
- Promoting management practices that confer resilience to the ecosystem

Water Resources

- Altering infrastructure or institutional arrangements
- Changing demand or reducing risk
- Improving water use efficiency, planning for alternative water sources (such as treated wastewater or desalinated seawater), and making changes to water allocation
- Conserving soil moisture through mulching and other means
- Protecting coastal freshwater resources from saltwater intrusion

Energy

- Increasing energy efficiency to offset increases in energy consumption due to warming
- Protecting facilities against extreme weather events
- Diversifying power supply in the event of power plant failures due to excess demand created by extreme heat, or by extreme weather events

Implementation of any of these adaptation measures is limited by a myriad of constraints. Such constraints could be environmental, economic, informational, social, attitudinal and behavioural. These constraints which negatively influence farmers' adaptive capacity have not been fully understood. A proper understanding of these constraints is critical to the fight against the scourge of climate change. This study is therefore important as it aims at identifying and articulating these constraints.

II. Methodology

The study was carried out in Delta State, Nigeria. The state is located within longitude 5`$^0$ and 6.4$^0$E and 5`00 and 6.30`. Delta State is bounded Northwards by Edo State, on the east by Anambra State, on the southwest by the Bight of Benin which covers approximately 160km of the state's coastline. The state has a wide coastal belt inter – laced with rivulets and streams which form part of the Niger Delta.

The state occupies an area of 16,842km^2 and has a population of 4,098,391 persons (National Population Commission, NPC, 2006). Delta state has an annual rainfall of 266.5cm in the coastal areas and 190.5cm in the southern fringes. The temperature is high ranging between 28^{0c} and 34^{0c} with an average temperature of 30^{0c}. The Vegetation of Delta state varies between the mangrove swamps along the coast to evergreen forests and savannah in the north. The state is blessed with fertile soils and favourable climate, which makes it an important producer of food and cash crops. The state produces rubber, oil palm, yam, cassava, maize, rice, plantain and citrus amongst others for local consumption and for export. Its livestock production includes poultry, goats, pigs, sheep and cows, while it has a vast and rich fisheries resource. Delta state has 25 Local Government Areas (LGA_S) grouped into 3 Agricultural Zones as follows:

a) Delta North Agricultural Zone comprising Ika North East, Ika South, Ukwuani, Oshimili South, Oshimili North, Ndokwa East, Ndokwa West, Aniocha North and Aniocha South LGA_S.

b) Delta Central Agricultural Zone comprising Ughelli South, Ughelli North, Uvwie, Isoko South, Isoko North, Ethiope East, Ethiope West and Sapele LGA_S.

c) Delta South Agricultural Zone comprising Warri South, Warri North, Warri South East, Patani, Bomadi and Burutu LGA_S.

Delta North Agricultural Zone was purposively selected for this study because it is situated along the coastal area of the state. Three LGA_S within the zone namely, Oshimili South, Ndokwa East and Oshimili North were randomly selected for the study. From each of the selected LGA_S, one community was randomly selected for the study. Respondents were selected by use of systematic sampling. This involved selection of alternate households. This is particularly suitable in communities where exact population size is not known. A total of 321 respondents were used for the study. Their distribution is shown in Table 1.

Table 1 : Sample distribution

LGA$_S$	Communities	No. of respondents
Oshimili South	Oko-amakom	102
Ndokwa East	Abari	113
Oshimili North	Illah	106
	Total	321

Data for the study were collected through the use of structured interview schedule. Focused group discussion was conducted for community members to generate more information which helped to improve the quality of items contained in the interview schedule. Data generated by the study were analyzed using descriptive statistics such as mean scores, percentage and frequencies. For the purpose of the study, level of implementation of climate change adaptation measures was categorized into 3 as follows: a) low implementation (for adaptation measures with 0 to 39%); b) moderate implementation (for adaptation measures with 40 to 69%) and; c) high implementation (for adaptation measures with 70 to 100%). Constraint to the implementation of climate change adaptation measures was determined as follows: a) not important (for constraints with mean score of 0 to 2.9); b) important (for constraints with mean score of 3 to 3.9) and; c) very important (for constraints with mean score of 4 to 5).

III. Results and Discussion

a) Socioeconomic characteristics of respondents

Entries in Table 2 show the distribution of respondent according to their socioeconomic characteristics. Results reveal that 190 (or 59%) of the respondents were males, while 131(or 41%) are female. This indicates that more males are involved in farming than females. Information on respondents' age show that 86% of them were within the age bracket of 20 and 60 years. This suggests that most of the famers are still in their productive age and could cope adequately with the drudgery involved in farming.

Data in Table 1 further reveal that 295 (or 92%) of the respondents had one form of formal education or the other ranging from primary to tertiary education. This level of education can be a good base for understanding the issues associated with climate change and its adaptation measures. Results on responds' farming experience indicate that 247 (or 77 %) of them had farming experience ranging between 6 and 25 years. This range of experience could proved opportunity for farmers to become knowledge about climate change phenomenon

Table 2 : Distribution of respondent according to their socioeconomic characteristics

Socioeconomic characteristics	frequency	percentage
Gender		
Male	190	59
Female	131	41
Age (years)		
20 – 30	16	5
31 – 40	55	17
41 – 50	73	23
51 – 60	132	41
61 – 70	26	8
71 – 80	19	6
Educational Status		
No formal status	26	8
Primary education	87	27
Secondary education	138	43
Tertiary education	70	22

Farming experience (years)		
1 – 5	32	10
6 – 10	51	16
11 – 20	83	26
16 – 20	68	21
21 – 25	45	14
26 – 30	42	13
Marital status	253	79
Single	51	16
Divorced	16	5
Household size		
2 – 5	138	43
6 – 9	154	48
10 – 13	25	8
14 – 17	4	1
Annual income (N)		
Less than 100,000	61	19
100,000 – 199,999	54	17
200,000 – 299,999	64	20
300,000 – 399,999	87	27
400,000 – 499,999	42	13
More than 500,000	13	4

b) Implementation of climate change adequate measures by respondents

Entries in Tables 3 show the level of implementation of climate change adaption measures by respondents. Results reveal that there was a low implementation of 10 of the 18 adaptation measures investigation by the study. There was also a moderate implementations of 5 of the measures and a high implementation of only 3 measures.

Climate changes adaptation measures with low level implementation include: use of weather forecast (14%); use of resistant varieties (22%); Early planting and early harvesting of crops (26%); and sand filling for land reclamation (29%); construction of drainage systems (19%); construction of artificial lakes (28%); use of irrigation systems (38%) Use of infiltration ditches (37%); use of water harvesting (33%) and use of afforestation /tree planting (18%).

The low implementation of these adaptation measures is expected in light of the challenges faced by farmers in rural communities of Nigeria with respect if agricultural production. Farmers lack weather information which if available can be effecting used in handling some climate charge issues. Similarly, improved crop varieties that are resistant to climate change variable such as flood and high temperature regimes are expensive such that most farmers could not afford to use them since most of the farmers usually operate with low capital base and do not have access to production credit.

The above situation makes it difficult for farmers to use adaptation measures that require some financial commitment. This could be a major reason for the moderate and high implementation of the less expensive adaptation measures such as: the use of mulching and cover crops; the use of bamboo takes to divert excessive runoff water; use of crop rotation; use of sandbags by the river bank and the construction of water channels to farmland.

Table 3 : Respondent' level of implementation of climate change adaptation measures (n = 321)

	Adaptation measures	frequency	percentage	Remark
1.	Use of weather forecasting	46	14	low
2.	Use of crop rotation	282	87	High
3.	Use of resistant varieties	72	22	low
4.	Early planting and harvesting	84	26	low
5.	Sand filling and land	249	77	High
6.	Use of bamboo stakes to divert excessive runoff water	156	48	Moderate
7.	Use of sandbag by river bank	241	75	High
8.	Sand filling land reclamation	96	29	low
9.	Construction of drainage system and culvert	96	29	low
10.	Construction of water channels and farmland	174	54	Moderate
11.	Construction of artificial lakes	92	28	low
12.	Use of irrigation scheme	124	38	low
13.	Planting of cover crops	204	63	Moderate
14.	Use of mulching	146	45	Moderate
15.	Use of infiltration	121	37	low
16.	Use of water harvesting	108	33	low
17.	Use of inter cropping	168	52	Moderate
18.	Use of afforestation/ tree planting	58	18	low

- *Multiple responses recorded*

c) Constraints to the implementation of climate change adaption measures to the implementation measures

Entries in Table 4 show the mean scores of constrains to the implementations of climate change adaptation measures as perceived by respondents. Results reveal that 11 of the constraints investigated by the study were considered to be "important" only 2 constraints were identified as not important.

Among the very important constraints identified in this study are: limited available of land for farming ($\bar{X}$= 4.3); poor access to information sources ($\bar{X}$ = 4.2); non availability of credit facilities ($\bar{X}$ = 4.1); inadequate knowledge of how to cope or build resilience ($\bar{X}$= 4.4); lack of access to weather forecast information ($\bar{X}$ = 4.2); government irresponsiveness to climate risk management ($\bar{X}$ = 4.6); limited income ($\bar{X}$ = 4.3); poor agricultural extension services delivery ($\bar{X}$= 4.2); lack of capacity of extension to build resilience's of farmers on climate change ($\bar{X}$ = 4.1); poor information on early warning systems ($\bar{X}$ = 4.5) and lack of information on what to do ($\bar{X}$ = 4.4).

In the group of important constraints are: high cost of farmland ($\bar{X}$ = 3.3); inherited system of land ownership ($\bar{X}$ = 3.3); high cost of fertilizer and other inputs ($\bar{X}$ = 3.8); high cost of improved and resistant varieties ($\bar{X}$ = 3.3); non availability of storage facilities ($\bar{X}$ = 3.8); non-availability of processing facilities ($\bar{X}$ = 3.6); high cost of processing facilities ($\bar{X}$ = 3.2) traditional beliefs and practices ($\bar{X}$ = 3.5); and high cost of irrigation facilities ($\bar{X}$ = 3.5).

These constraints identified by the respondents in this obviously pose as challenges to the implementation of climate change adaptation measures. It is therefore the expectation of the researchers that urgent attention should be given to remove these constraints so that the effect climate change on agricultural production in the study area can be ameliorated.

Table 4 : Mean Scores constrains to the implementation of climate change adaptation measures

	Constraints	Mean score	Remarks
1.	limited availability of land for farming	45	low important
2.	High cost of farmland	3.7	important
3.	Inherited system of land ownership	3.3	important
4.	Communal system of land ownership	2.5	not important
5.	Poor access to information sources	4.2	very important
6.	Non-availability of credit facilities	3.5	important
7.	Non-availability of farm input	2.8	not important
8.	High cost of irrigation facilities	3.5	important
9.	High cost of fertilizer and other inputs	3.8	important
10.	Inadequate knowledge of how to cope Or build resilience	4.4	very important
11.	High cost of improved and resistant varieties	3.3	important
12.	Non-availability of farm inputs	2.7	not important
13.	Lack of access to weather forecast information	4.2	very important
14.	Government irresponsiveness to climate Risk management	4.6	very important
15.	Non-availability of storage facilities	3.5	important
16.	Limited income	4.3	very important
17.	Non- availability of processing facilities	3.6	important
18.	High cost of processing facilities	3.8	important
19.	Traditional beliefs and practices	3.5	important
20.	Poor agricultural extension service delivery	4.2	very important
21.	Lack of capacity of extension service to Build resilience of farmers	4.1	very important
22.	Poor information on early warning system	4.5	very important
23.	Lack of information on what to do	4.4	very important
24.	High cost farm labour	2.6	not important

IV. Conclusion and Recommendations

Adaption is the adjustment in natural r human systems in response to expected climate hazards or their effects. Adaptation is not new to human history as man has had to adapt to changes in climate and environment. Some adaptation measures formed to have been used y respondents in study include the use of crop rotation method, use of sandbags at river banks, the use of bamboo stakes, planting of cover crops and the construction of drainages.

Constructions to implementation of climate change adaptation measures include: limited availability of land for farming; lack of access to weather forecasting information, limited income; poor access to information sources; high cost of irrigation facilities, traditional beliefs and practices, poor information on early warning system, poor agricultural extensions service delivery, high cost of improved and resistant varieties, inadequate knowledge of how to cope or build resilience and government irresponsiveness to climate risk management.

Based on the findings of the study, the following recommendations were made: firstly the establishment of climate change information system that will manage issues relating to awareness creation, information on weather forecast, early warning signs and training of farmers on climate change coping strategies. Secondly, the establishment of a sustainable credit scheme which will empower farmers financially to be able to implement appropriate adaptation measures. Thirdly, Delta State Agricultural Development Programme (DTADP), which is the agency charged with the provision of extension services should be empowered by the government create a separate unit to handle climate change issues. Such a unit will be charged with providing relevant and up to date information to farmers on how to build resilience to confront any climate change problem.

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