Journal of Agricultural Extension and Rural Development Vol. 3(3), pp. 42-50, March 2011
Available online http:// academicjournals.org/JAERD
ISSN 2141-2154 ©2011 Academic Journals

Full Length Research Paper

The role of extension in agricultural adaptation to climate change in Enugu State, Nigeria

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Accepted 13 March, 2011

The clear evidence that climate change is already a reality calls for actions not just to slow down the process or enhance the sinks of greenhouse gases (mitigation) but also to assist those affected or threatened already to adjust in natural and human systems to a new or changing environment (adaptation). The paper examined the role of extension in agricultural adaptation to climate change in Enugu State. A multi-stage random sampling technique was used in selecting 120 respondents. Descriptive statistics were used in analyzing data from the study. Results show that the most significant effect of climate change in the area was intense weed growth ($\bar{X}$= 4.52) while the most popular adaptive measure adopted by respondents was the use of resistant crop and animal varieties/species (95.43%). The study proposed that the key roles of extension in agricultural adaptation to climate change were in the re-training of extension staff to acquire new capacity in climate risk management ($\bar{X}$= 3.93), setting up of emergency management units in extension agencies ($\bar{X}$= 3.91), dissemination of innovations on best practices and building resilience capacities of vulnerable people in climate risk management ($\bar{X}$= 3.90), and providing feedbacks to governments and interested agencies on climate change issues ($\bar{X}$= 3.9). The paper recommends a change in the extension service agenda to accommodate the challenges currently posed by climate change by adopting new roles identified in the study and the need for increased research and innovation for sustainable adaptation to climate change.

Key words: Role, extension, agricultural adaptation, climate change.

INTRODUCTION

Climate change refers to any change in climate overtime, whether due to natural variability or as a result of human activity (inter-governmental panel on climate change, IPCC, 2001). It can also be seen as change in climate which is attributed directly or indirectly to human activities that alter the composition of the global atmosphere and which are in addition to natural variability observed over comparable time periods (IPCC, 2007). Climate change has become a global issue in recent times manifesting in variations of different climate parameters including cloud cover, precipitation, temperature ranges, sea levels and vapour pressure (Ministry of Environment of the Federal Republic of Nigeria, MOE FRN, 2003). The variations in climate parameters affect different sectors of the economy such as agriculture, health, water resources, energy etc. The main cause of climate change has been attributed to anthropogenic (human) activities. 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

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significant effects through the production and release of GHGs.

Clearing of forests for agricultural production replaces forests with crops thereby reducing the rate at which carbon sequestration (trapping and absorbing carbon (IV) oxide gas) occurs. There is no doubt therefore that the earth is getting warmer and human beings are mainly to be blamed (Spore, 2008). With reference to sub-Saharan Africa, there is growing interest on the likely impacts of climate change on agriculture, economic growth and sustainable development. Incidences of climate change include changes in soil moisture, soil quality, crop resilience, timing/length of growing seasons, yield of crops and animals, atmospheric temperatures, weed insurgence, flooding, unprecedented droughts, sea level rises and many more. More than 70% of those living in African, Caribbean and Pacific (ACP) countries work in the agricultural sector and climate change for these people are not a theoretic discussion; it is the difference between life and death (Spore, 2008). There are projecttions of increases in rainfall in the humid regions of southern Nigeria, which are accompanied by increases in cloudiness and rainfall intensity particularly during severe storms (IPCC, 2007). Similarly, the savannah areas of northern Nigeria were projected to experience less rainfall, which coupled with temperature increases, reduces soil moisture availability. Changes in climate are severely affecting agricultural production in many African countries (UNEP, 2007). Increased temperatures and accompanying decrease in water availability reduce the length of growing seasons and yield potential and hence the areas suitable for agriculture, further adversely affecting food security over the continent (Thornton et al., 2006).

An increase in temperature is also conducive for a proliferation of pests and diseases, which are detrimental to crop production. Climate change affects livestock productivity directly through effects on the availability of feed and fodder. In coastal regions that have major lagoons or lake systems, changes in fresh water flows and greater intrusion of salt water into lagoons, as a result of climate change, affect inland fisheries or aquaculture (Cury and Shannon, 2004). Sea levels are rising because of high temperatures, glacial retreat and increased rainfall in some areas. A rise in the sea level results in an agricultural land loss. Erosion, sub-mergence of shorelines, salinity of the water table due to the increased sea level mainly affects agriculture through inundation of low-lying lands (MOE FRN, 2003). The rise in sea level in Atlantic Ocean for instance may have catastrophic impacts on large coastal cities such as Banjul (Gambia), Lagos and the Niger Delta regions (Nigeria) and Alexandria (Egypt) (Nicholls and Tol, 2006). In order to sustain the agricultural sector that plays pivotal roles in human existence in terms of the provision of food, fibre, 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.

Agricultural extension according to Leeuwis (2006) is a series of embedded communicative interventions that are meant, among other things, to develop and/or induce innovations which supposedly help to resolve (usually multi-actor) problematic situations. It has been observed that agricultural extension is involved in public information and education programmes that could assist farmers in mitigating the effects of climate change (MOE FRN, 2003). According to them, such involvements include awareness creation and knowledge brokerage on the issues of climate change; building resilience capacities among vulnerable individuals, communities and regions; encouragement of wide participation of all stakeholders in addressing climate change issues; and developing appropriate frameworks for coping/adapting to climate change effects/impacts. Besides, there is very little documentation on local adaptation to climate change (Pandey, 2006) especially when it is known that some African communities have developed traditional adaptation strategies to cope with climate variability and extreme events (Osman-Elasha, 2007). It is pertinent therefore to ascertain what effects or impacts climate change has on agricultural productivity in the study area?

What adaptive measures have farmers adopted in cushioning the effects or impacts of climate change? And what roles can agricultural extension play in building the adaptive capacities of vulnerable people in the area?

Purpose and objectives

The overall purpose of the study was to ascertain the role which agricultural extension can play in climate change adaptation in Enugu State. Specifically, the objectives were to:

i) Ascertain the different effects or impacts of climate change on agriculture in the study area;
ii) Identify the adaptive measures adopted by respondents in cushioning the effects of climate change in the area; and
iii) Ascertain the role of agricultural extension in building adaptive/resilience capacities of vulnerable people to climate change effects/impacts.

METHODOLOGY

The study was carried out in Enugu State of Nigeria. Enugu State is one of the 36 states in Nigeria and is located between latitude 5° 56'N and 7° 06'N and longitude 6° 53'E and 7° 55'E (Ezike, 1998).

The State has a population of 2,452,996 (NPC, 2006). The vegetation of the state is mainly forest type but stretches out into derived savannah in the northern fringes. Enugu State experiences distinct wet and dry seasons with a total annual rainfall of about 1,700 mm (Enugu State Government Official Gazette, No. 25, 1997). The major occupation of people in the state is farming. Major crops cultivated include, cassava, yam, cocoyam, vegetables, oil palm etc, while major livestock reared are poultry, goat, sheep and cattle. The State has seventeen local government areas (LGAs) and is divided into three agricultural zones namely:

1) Enugu North Zone, comprising Igbo-Etiti, Uzo Uwani, Nsukka, Udenu, Igbo-Eze North and Igbo-Eze South LGAs;
2) Enugu East Zone, comprising Nkanu West, Nkanu East, Enugu North, Enugu South, Enugu East and Isi Uzo LGAs;
3) Enugu West Zone comprising Udi, Ezeagu, Oji River, Awgu and Ani LGAs (ENADEP, 2007).

Farmers in the State constituted the population for the study. A multi-stage random sampling technique was used to select respondents, thus two agricultural zones (Enugu North and Enugu West) were randomly selected. Two LGAs were randomly selected from each of the two zones. For Enugu North Zone, Nsukka and Udenu LGAs were randomly selected while Udi and Oji River LGAs were selected from Enugu West Zone. Two town communities were also randomly selected from each LGA to give a total of eight town communities. They include Ibagwa-Ani and Okpuje (Nsukka), Obollo Eke and Amala (Udenu), Agbala-Enyi and Ugwuoba (Oji River), and Awhum and Nsude (Udi). Fifteen farmers with long years of farm experience were purposively selected from each of the town community. The preference for farmers with long years of farm experience (not less than 20 years) was made so as to gain the most useful information from them on their experiences of changes in climate as it affects their farming practices and production. This brought the total number of respondents that participated in the study to 120. Data for the study were collected through a semi-structured interview schedule that was validated by experts in agricultural extension and climatology.

A focus group discussion (FGD) was held in each zone to obtain more in-depth information from farmers on the subject matter. A pilot test was also conducted as part of the instrument validation and to test for reliability. Data were collected between June and October 2008. The interview schedule had three sections. Section A ascertained the different effects/impacts of climate change on agriculture in the area (Objective 1). A five-point Likert-type scale of 'to a very great extent, to a great extent, to some extent, to little extent and to no extent', with nominal values of 5, 4, 3, 2 and 1, respectively was used to determine the extent of effects/impacts of climate change on farmers' agricultural production. Relevant information on the possible effects/impacts of climate change on agriculture obtained from literature, observations and focus group discussions was utilized. The respondents' mean scores were obtained for each response option, such that items with $\overline{X} \geq 3.00$ were regarded as having significant effects/impacts on agriculture in the study area while items with $\overline{X} < 3.00$ were regarded as not having significant effect /impact on agriculture. Section B dealt with identification of the adaptive measures adopted by farmers in cushioning the effects of climate change (Objective 2). In order to obtain a quantitative measure of respondents' agreement on the use of each technique in cushioning the effects of climate change, a checklist of various adaptive measures which were obtained from literature, personal interviews, observations and the FGD was utilized. Respondents were requested to tick the measures used in adapting to the climate change effects/impacts. Any response option (adaptive measure) with score ≥ 50% was regarded as being useful and important while items with scores < 50% was regarded as not being useful and important in cushioning the effects of climate change by farmers.

Section C sought to ascertain the roles that agricultural extension could play in building adaptive/resilience capacities of vulnerable people to climate change effects/impacts (Objective 3). These roles were obtained from relevant literature, extension professionals and the FGD. A four-point Likert-type scale of strongly agree, agree, disagree and strongly disagree with nominal values of 4, 3, 2 and 1, respectively was used to obtain a quantitative measure of the extent to which the identified roles of extension were perceived by the respondents as effective. The respondents' mean scores were obtained for each response option such that items with $\overline{X} \geq 2.50$ were regarded as effective role of extension, while items with $\overline{X} < 2.50$ were regarded as not an effective role of extension in building adaptive capacities against climate change. Objectives 1 and 3 were analyzed using mean scores and standard deviations, while percentage scores were used to analyze Objective 2.

RESULTS AND DISCUSSION

Climate change effects/impacts experienced by farmers

Data in Table 1 shows that the most significant effects/ impacts of climate change experienced by farmers in the study area were intense weed growth ($\overline{X}$ = 4.52), incidence of pests and diseases ($\overline{X}$ = 4.28), soil erosion ($\overline{X}$ = 4.27), lack of portable water for human consumption and livestock use ($\overline{X}$ = 4.15), loss of vegetation/pastures ($\overline{X}$ = 4.10), distortion and destruction of wildlife ecosystems ($\overline{X}$ = 4.06), decrease in soil fertility ($\overline{X}$ = 4.06) and health related issues of climate change which can affect production for example hunger and famine, drudgery and stress from heat, etc ($\overline{X}$ = 4.01). Others include items 9 to 23 as shown in Table 1. On the other hand, respondents did not perceive items 24 to 27 as significant effects/impacts of climate change on agriculture. Data in Table 1 also shows that the standard deviations for all the issues considered were less than 1.5. This indicates that farmers' individual scores as regards their experience of climate change effects/ impacts on agriculture did not differ much from their mean scores. The high incidence of weeds in farmers' farms can be attributed to favourable climatic conditions that support weed growth in the area. This may include high moisture conditions experienced during the greater part of a farm year, poor agricultural practices and bad timing of weeding. Flooding and wind erosion may also contribute to intense weed growth because they help in weed dispersion especially to new areas where they have never existed before.

Farmers reported in all the FGDs conducted that they had to weed their farm plots more than three times if they were to obtain any meaningful harvest from the farm. This was against one or two times that they had previously weeded a typical farm plot some two decades

Table 1. Distribution of respondents based on effects of climate change on agriculture (n = 120).

Effects/impacts of climate change on agriculture	Mean scores	Std. deviation
Intense weed growth.	4.52*	0.85
Incidence of pests and diseases.	4.28*	1.17
Soil erosion.	4.27*	1.21
Lack of portable water supply for human consumption and livestock use.	4.15*	1.24
Loss of vegetation/pastures.	4.10*	1.36
Distortion and destruction of wildlife ecosystem.	4.06*	1.36
Decrease in soil fertility.	4.06*	1.30
Health related issues of climate change which can affect production for example hunger and famine, illness, drudgery and stress from heat, etc.	4.01*	1.35
Uncertainties in seasonal climate for example changes in rainfall pattern, temperature, etc.	3.97*	1.25
Decrease in yields of crops and animals.	3.96*	1.15
Storage losses in roots and tubers.	3.94*	1.20
Post harvest losses due to climate variability.	3.90*	1.38
Flooding..	3.83*	1.49
Premature ripening.	3.76*	1.39
High rainfall intensity.	3.58*	0.89
Heat from high temperature.	3.53*	1.24
Shortening of crop cycle.	3.52*	1.45
Drying of rivers, lakes and surface water bodies.	3.48*	1.43
Crop destruction in the field by rain and wind.	3.40*	1.12
Drought.	3.35*	1.42
Decrease in soil moistures.	3.32*	1.09
Loss of farm land/households to floods and erosion.	3.25*	1.35
Change in storage quality of fruits and vegetable..	3.16*	1.29
Changes in taste of fruits and vegetables.	2.83	1.27
Low rainfall intensity.	2.31	1.11
Increased salinity/water pollution due to climate variability.	2.29	1.33
Decrease in fish population due to salinity, water level, ocean currents, speed, etc.	1.87	1.49

Source: Field data 2008; *Significant effect/impacts; SD = Standard deviation; Cut off point = 3.00.

ago. They equally noted that there were new weed emergence in their farm plots that appeared to be recalcitrant. These symptoms really support the fact that climatic conditions have changed tremendously. It had been reported that heavier than normal rainfall will lead to increased growth of weeds, increase in erosion due to high rainfall and the indirect effect which include increase in pest and disease build up (MOE FRN, 2003). The implication of high incidence of weeds on farmlands is that it increases the cost of production through payments for labour or use of herbicides. Increased pest and disease infestation, which is also considered by farmers as significant in the area, was seen as an indirect effect of increased rainfall intensity, high humidity and warmer environment. Farmers noted in the FGDs that losses could be so high that nothing is harvested at times in a farm plot due to the incidence of pests and diseases. Efforts to control them could also be costly and frustrating, they observed. Research suggests that higher mean temperatures increase pest developmental rates and fecundity and frequency of outbreaks, and lead to expansion in the range of insect pests diseases and weed species (Spore, 2008). It was further noted that altered wind patterns are expected to change the spread of wind-borne pests and of bacteria and fungi that are crop disease agents. Climate change also has repercussions for human and livestock health, by shifting the distribution of certain disease vectors.

The World Health Organization established a clear link between heavy rainfalls over much of eastern Africa in 2008 and major outbreaks of malaria (Spore, 2008). These challenges will put serious strains on agricultural development and livelihood systems especially in the rural economy. High intensity of rainfall expectedly leads to flooding and causes serious soil erosion. In certain cases, farmers have lost their farmlands, crops, livestock, and even their homesteads to the devastating effects of flooding and erosion. In extreme cases, farmers have lost their lives to flooding and erosion. A farmer narrated how he lost all his property to flooding in one of the many

occasions of heavy rainstorm that swept his building in the night. Similar stories abound in many parts of Nigeria and Africa as a whole. In 2007, many parts of Africa suffered severe drought while floods on much of the continent destroyed roads and buildings and wiped out millions of hectares of farmlands (Spore, 2008). These effects will not only affect the rural agricultural economy but the entire nation, continent and the world as a whole. Urgent action is therefore needed to mitigate and build resilience capacities of vulnerable people especially farmers so as to save the developing world from imminent danger. With increasing consequences of climate change, the availability of water for both human consumption and livestock use is put at great risk. This is because climate change sometimes leads to the drying up of rivers and streams, which human beings and livestock depend upon. The case could be worse in many African countries where the systems of portable water supply by governments have failed.

According to Ozor (2009), the drying up of streams and rivers in some communities due to climate change ultimately lead to their search for water in neighbouring communities with its attendant man hour losses, and the propensity to trigger conflicts and hardships on the people. Prolonged incidence of drought, urbanization, overgrazing and crop production lead to loss of vegetation/pasture that enhances carbon sequestration. This invariably distorts the wildlife and endangers some species. Again, global warming causes soil degradation and erosion as a result of increased precipitation in the areas thereby leading to decline in soil fertility. The aspects of health that will be exacerbated by climate change include: increased cases of cataracts (eye disease) especially in the northern parts of Nigeria due to low cloud cover and greater intensity of solar radiation; increased cases of malaria and typhoid due to increased rainfall and temperature in certain parts of the country; and increased cases of water-borne diseases such as cholera and dysentery due to urban flooding and improper disposal of wastes (Anyadike, 2009).

Adaptive measures adopted by respondents in cushioning the effects of climate change

The most significant adaptive measures adopted by farmers in coping with climate change effects in the study area are presented in Table 2. These include; use of resistant crop and animal varieties/species (95.43%), use of organic manure (94.16%), mixed farming (93.09%) and diversification in crop enterprise (91.81%). Other useful adaptive measures adopted include items 5 to 26. On the other hand, items 27 to 33 were not considered as significant adaptive measures in the area. The use of resistant crop and animal varieties/species provides useful adaptations and resilience to the effects of climate change. Such crops or animals are known to survive and complete their life cycles normally even when the environment will not allow others to thrive. The increased adoption of resistant varieties/species may not be unconnected with the fact that farmers encounter serious pest and disease infestations and weed growth, which have been recognized as the most significant effects of climate change in the area. It has already been reported that one of the many adaptations to climate change involves the use of resistant varieties such as early maturing varieties or drought resistant ones (Maddison, 2006). However, farmers noted that the issue of availability of the resistant varieties at the appropriate time is a problem. This has led them to once in a while fall back to local species that might fall victim of the environmental changes. It was reported also that the non-availability of seeds may be a significant impediment to adaptation (Maddison, 2006). This underpins the need for sustainable research and innovation in agriculture.

Increased application of organic manure was adopted by farmers not only to increase the fertility of the soil in the most sustainable way but also to increase the moisture content of the soil. Farmers noted that with the increase in temperature and evapo-transpiration resulting from climate change, measures to conserve moisture for crop use is necessary hence they preferred the use of organic manure. They equally pointed out that it is cheaper for them and most readily available unlike inorganic fertilizers. Mixed farming practice is adopted by farmers for many reasons such as to ensure food security, increased income, reduced incidence of pests and diseases, among others. In the FGDs conducted, almost all farmers confirmed that they engaged in mixed farming practice. In response to higher temperatures, farmers have resorted to using heat tolerant crop varieties, crop varieties with high water use efficiency, early maturing crop varieties, and increased crop and livestock farming, (mixed farming) (Benhin, 2006). Diversification in crop production is aimed to achieve similar objectives like mixed farming. The only difference is that it concentrates on diversifying crop production alone. It is worrying to note that some modern and scientific coping strategies such as irrigation schemes, increased mechanization of agricultural production and use of weather forecasts were not significant in the study area. Farmers noted that they do not know how to use the modern technologies and besides, most of them were not aware of the facilities.

Few farmers that reported that they were aware of the modern technologies observed that they are expensive and not accessible. This circumstance poses great challenge for agricultural extension.

The role of extension in agricultural adaptation to climate change

Data in Table 3 shows that farmers perceived most of the

Table 2. Distribution of respondents based on the adaptive measures adopted by respondents in cushioning the effects of climate change (n = 120).

Adaptive measures	Percentage score*
Use of resistant crop and animal varieties/species.	95.43
Use of organic manure.	94.16
Mixed farming.	93.09
Diversification in crop enterprise.	91.81
Changes in planting dates.	87.92
Changes in harvesting dates.	87.94
Processing of crops to reduce post harvest losses and enhance shelf life of crops.	87.25
Mulching/ use of cover crops.	86.81
Changes in the timing of land preparation activities.	86.30
Prompt weeding.	85.72
Water storage in ponds.	85.74
Construction of shelter for animals and human using palms, grasses and other non-conductors of heat.	83.51
Contour cropping across hill slopes.	81.32
Changes in planting depth of seeds and seedlings.	79.16
Afforestation/ reforestation initiatives.	76.94
Construction of drainage/dams.	74.45
Increased range land.	73.65
Contour and cut-off ditches.	73.61
Expansion of cultivated areas.	69.70
Adoption of zero or minimum tillage.	71.19
Road catchments.	68.17
Contour bund.	67.83
Flexibility in the location of watering points.	64.41
Cultivation of marginal lands.	63.37
Culling of infected animals.	62.23
Decrease in stocking rate of animals.	56.56
Half moon catchments.	51.62
Laws against deforestation activities.	49.81
Changing from production to marketing of agricultural products.	48.90
Abandonment of crop land or destruction of infected animals.	31.96
Lengthened fallow.	31.03
Use of weather forecasts.	28.67
Increased mechanization of agricultural production.	27.99
Irrigation schemes.	25.69

Source: Field data 2008; *Multiple responses; Cut off mark = 50%.

roles of extension identified in the study as effective in cushioning the effects of climate change. They include in order of importance the re-training of extension staff to acquire new knowledge and skills in climate risk management ($\bar{x}$= 3.93), setting up of emergency management units by extension agencies that will attend to victims of climate risks ($\bar{x}$= 3.91), dissemination of innovations on best practices and building resilience capacities of vulnerable people in climate risk management ($\bar{x}$= 3.90), and providing feedbacks to governments and interested agencies with situation reports on the causes of climate change, its effects, and the local knowledge and practices of the rural people ($\bar{x}$= 3.90). Other effective roles of extension include items 5 to 10. On the other hand, items 11 and 12 were not considered as effective roles of extension in agricultural adaptation to climate change. The standard deviations from the mean for all the perceived roles were less than 1.0, indicating that farmers' individual responses were not far apart from the mean. Climate change presents new challenges and threats to food security in most countries especially the developing ones. This demands that extension service brace up to the development by re-training its staff to acquire the capability (knowledge and skills) in

Table 3. Mean distribution of respondents' perception of the roles of extension in agricultural adaptation to climate change (n = 120).

Role of Extension	Mean score	Std. deviation
Re-training of extension staff to acquire the new knowledge and skills (capacity) in climate risk management.	3.93*	0.36
Setting up of emergency management unit by extension agencies that will attend to victims of climate risks.	3.91*	0.29
Dissemination of innovations on best practices and building resilience capacities of vulnerable people in climate risk management.	3.90*	0.40
Providing feedbacks to governments and interested agencies with situation reports on various causes of climate change, its effects, and the local knowledge and practices of the rural people.	3.90*	0.42
Use of demonstration methods in teaching farmers the measures used to mitigate or adapt to the effects of climate change.	3.84*	0.50
Organizing seminars, workshops, and field days to sensitize farmers and the public on climate risk management.	3.82*	0.49
Use of farmer-to-farmer extension strategy to promote awareness and adoption of best practices in climate risk management.	3.80*	0.48
Use of information communication technologies (ICTs) such as the internet, radio, television, media vans, leaflet, and posters etc, to create awareness on the climate change issues.	3.77*	0.45
Formation of Young Farmers Club (YFC) in schools to educate and encourage young farmers in learning about climate change issues with a view to reducing human causes and improving adaptation options.	3.70*	0.69
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.	3.37*	0.71
Denying farmers who indulge in poor agricultural practices that contribute to climate change such as bush burning access to extension services.	2.38	0.67
Use of law enforcement agents against persons that deliberately indulge in practices that contribute to climate change such as bush burning.	1.56	0.45

Source: Field data 2008; *Significant roles of extension; Cut off point = 2.5.

managing the risks that climate change poses especially in rural areas where the greater part of agricultural activities take place. The retraining program will mostly involve staff who are directly in contact with farmers and those that supervise and manage them. They will include extension agents, block extension agents, block extension supervisors, subject matter specialists, zonal extension officers, zonal managers, directors of extension services, directors of rural institutions development, and the programme managers of agricultural extension agencies such as the agricultural development programmes (ADPs).

According to Ozor (2009), there is need for change in roles and capacity in the extension system so as to

accommodate the new dimensions brought about by climate change. In order to provide practical solutions to hazards and sudden uncertainties in agricultural production, there is need to establish emergency management units within every extension agency that will be trained to take charge of victims of disasters emanating from climate change risks such as flooding, erosion, acid rains, drought, submergence and poisoning from agricultural chemicals (insecticides, pesticides, herbicides, fertilizers, etc). The role of extension in emergency management is advocated because they work very closely and live with the rural farmers and can provide at least the best first aid assistance before the arrival of experts. It therefore makes it important for extension to be linked to the state emergency services, health workers, and the police. The primary role of extension is in the dissemination of innovations to targeted clientele ranging from farmers, pastoralists, fisher-folks, hunters, foresters, wine-tappers and other rural residents who depend on agriculture in one way or the other. Therefore, it behoves on extension to disseminate the best practices and innovations currently being developed by numerous research efforts across the globe on how to boost the adaptive capacity and resilience of vulnerable people to the effects of climate change. This is the only way to save the agricultural system that employs over 70% of Nigeria's population and contributes about 40% to the nations GDP.

Another significant role of extension in agricultural adaptation to climate change is its feedback role to government and other interested agencies on climate change issues. Extension agents live and work with the people in rural areas. This affords them the opportunity to be knowledgeable on issues that border on climate change in their areas of coverage. During the fortnightly meetings (FNTs) and block meetings (BMs), extension agents are expected to give situation reports on their duty stations. From this, government and non-governmental bodies can become aware of climate risk situations in the rural areas and then be able to render assistance, make policies, or execute programmes to manage the challenges identified by agents. In this circumstance, challenges such as flooding, drought, pest and diseases infestation, submergence by water and other catastrophic effects of climate change can be reported promptly. Similarly, local practices which have helped a particular individual or community to adapt to the effects of climate change can also be reported and advertised thereby creating the avenue for such practice(s) to be replicated and up scaled in other vulnerable areas. In a related study conducted in Australia, Cotching et al. (2009) recommended effective communication and feedback mechanisms in addressing systemic environmental impacts. Again, farmers perceive the use of demonstration methods as a significant role of extension in disseminating the coping and adaptive measures that could reduce climate change risks among vulnerable communities. It is common parlance that 'seeing is believing'.

Based on this, extension agents can use various extension teaching approaches including method demonstration, result demonstration, print media (for example, posters, leaflets, etc) and computer/ telecommunication media (for example internet, television, cinema, radio, computer, etc) to further inform and educate farmers on various issues of climate change. Farmers learn by doing and practices learnt during a demonstration session could lead to adoption of the technology. Other significant roles of extension in agricultural adaptation to climate change as perceived by farmers in the study area, border on the use of groups to achieve wide scale adoption of innovations. Areas identified include organizing seminars, conferences, field days and workshops; use of farmer field schools, use of farmer to farmer extension strategy; and the use of young farmers club. All these strategies centre on maximizing mass adoption of innovations through group approaches. According to Garforth (2005), the five common sets of arguments for focusing extension efforts on groups rather than individuals are for efficiency, effectiveness for learning and action, equity, demand-orientation and empowerment. Junge et al. (2009) emphasized the need for farmer education and training through capacity building. Using group efforts in communicating adaptive/resilience measures to climate change boosts understanding and knowledge on the issue as it achieves multiplier effects.

CONCLUSION AND RECOMMENDATIONS

The study sought to ascertain the roles of extension in agricultural adaptation to climate change in Enugu State, Nigeria. Specifically it examined the effects/impacts, adaptive measures and roles of extension in climate change adaptation. Results show that the most significant effect/impact of climate change in the area was intense weed growth, while the most significant adaptive measure adopted by respondents was the use of resistant crop and animal varieties/species. The key role of extension in agricultural adaptation to climate change was in retraining of extension staff to acquire the new knowledge and skills (capacity) in climate risk management. It is therefore recommended that extension should brace up to the new challenges posed by climate change by retraining its staff, mounting awareness programmes, and disseminating proven measures to boost the adaptive/resilience capacities of various stakeholders including farmers, foresters, pastoralists, hunters, etc to climate change in the area. These will of course reduce the anthropogenic causes and hence the effects/impacts of climate change. Also, there is need for increased

research and innovation in agriculture to find out more sustainable ways of adaptation to climate change.

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