I.J.A.B.R., VOL. 2(2) 2012: 220-227 ISSN 2250 - 3579

INTERNATIONAL JOURNAL OF ADVANCED BIOLOGICAL RESEARCH

DETERMINANTS OF ADAPTATION TO CLIMATE CHANGE AMONG ARABLE CROP FARMERS IN EDO STATE, NIGERIA AND ITS IMPLICATIONS FOR EXTENSION SERVICE

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ABSTRACT
This study identified the major adaptation measures to climate change among arable crop farmers in Edo State, Nigeria, the factors that influenced their adaptation to climate change, and the barriers to climate change adaptation. One hundred and twenty respondents were randomly selected for the study. Data were collected with the use of structured interview schedule. And the data were analyzed using descriptive statistics and multiple regression model. .The adaptation measures taught to and used by farmers included irrigation, vermin composting, increased use of animal manure, changing of planting dates, mulching, tree planting, use of different crop varieties and zero tillage. However, adoption of the adaptation measure to climate change was generally low (adoption index = 0.168). The major barriers to adaptation include lack of information (77%) on adaptation measures and financial challenges (42%).Results of the linear regression model indicate that the level of education of the household head (t-stat = 3.65081), household size (t-stat = 3.23023),extension visit (t-stat = 6.87084), visit to other farmers (t-stat = 3.6084001) and attendance to meetings (t-stat = 5.37596) significantly and positively impacted on adaptation to climate change. These imply that increase in these variables would lead to increase in the application of adaptation measures to climate change. Extension service needs to organize the farmers and other stakeholders into an information network. It was recommended that farmers should be given access to credit, effective policy must be put in place to address imperfections in the agricultural knowledge and information system in promoting adaptation to climate.

KEYWORDS: Determinants, adaptation, climate change, arable crop farmers, extension service, implications, adoption

INTRODUCTION

Every nation has the need for self-sufficiency in food production. It is well known that agricultural production depends on climatic condition being conducive to the growth and development of the crops and livestock. According to Low External Input Sustainable Agriculture (LEISA, 2008), the rains are unpredictable, in that one year they start in November, and another year in December, and there we have dry spells at the critical stages of crop growth and development. There is a 0.76^0 C increase in the world's average temperature in the last century, and temperature did rise by 2^0 C in 2005 (Intergovernmental Panel on Climate Change; IPCC, 2008). This has led to rising sea levels, flood and drastic changes in rainfall patterns, affecting the production potentials of rural areas.

Most rural areas have always experienced climate variability and arable crop farmers have always had to cope with a degree of uncertainty in relation to the local weather. Observations have shown that many of the effects that are attributed to climate change are the result of deforestation.

While climate change is a global phenomenon, those in rural areas in the tropics face greater risks (LEISA, 2008). The vulnerability of rural dwellers depends on intrinsic factors such as the local topography and geology. But many other factors are involved, the combination of which determines a farm family's capacity to cope with stress and drastic change.

In Nigeria, the Agricultural Development Project (ADP) was designed to give energetic life to rural agriculture (Eze *et al.,* 2006). According to Akinbode (1982), rather than engage in direct production, the ADP was designed to stimulate and motivate small scale farmers. One of the objectives was to communicate current information and modern farm management techniques to farmers. The actual assessment of ADP is in the farmers' utilization of these information and techniques.The knowledge a farmer has of climate issue, or how regularly and easily he/she can get information, such as weather forecast, play an important role (LEISA, 2008). Armed with such information, farmers can adapt their farming systems to suit climate change. Adaptation to climate change means a pro-active approach such as preparing in advance for what might come. Adaptation can also be regarded as adoption of new farm practices such as "vermin-composting" to improve soil organic matter content. Management skills are needed when opting for associated crops, mulching, intercropping, or mixed cropping, green manuring, "verm-composting" crop diversification and seed banks, complementing traditional practices with new ideas (Shehand and Ameta, 2008).

A change in the farmers' behavior towards situation like climate change is very necessary, as it will impact positively on their productivity. This means that the steps taken by arable farmers count and are very important in helping the farmer prepare for climate change.

Rural communities are already experiencing the impact of climate change, and most are trying their best to adapt (Gurung and Bhanderi, 2008). Farmers have been exposed to different coping approaches to climate change (Shah and Ameta, 2008). In spite of the aforementioned, the effects of the approaches on arable crop production are still minimal. According to Deressa *et al*., (2009), the studies on agriculture analyzed the monetary or yield impact of climate change and suggested adaptation measures but failed to indicate the factors affecting the choice of the suggested adaptation methods. This presents an important limitation as farmers' responses to climate change or their choice of adaptation measures depends on some socio-economic and environmental factors (Deressa, 2009).

Despite the high contribution of agriculture to the overall economy, it is challenged by many factors that are climate-related disasters such as flood and draught which cause a lot of problems to farmers (Deressa, 2007). The knowledge of the adaptation measures taken by farmers and the factors influencing their choice of such adaptation measures will contributes to deriving policies aimed at solving the problems that climate change has put up against farmers in Edo State.

The result of the study will be supplied to the Edo State Agricultural Development Project, the major extension agency of the state, Ministry of Agriculture and Non-government Organizations related to agricultural and rural development. The result will be a useful guide to the programme planners of the above mentioned organizations. The major objective of this study was to ascertain the determinants of adaptation to climate change among arable crop farmers in Edo State. Specifically the study aimed to ascertain the arable farmers socio-economic characteristics and identify the climate change adaptive techniques taught or recommended to the farmers by extension agents, ascertain the number of adaptive techniques adopted and determine the level of adoption of the climate change adaptive techniques.

METHODOLOGY

The study area

The study area is Edo State of Nigeria. It was created in 1991 out of the former Bendel State. Edo state lies roughly between longitude 6^0 04^1 N and 6^0 43^1 N and latitude 5^0 44^1 E and 7^0 34^1 E. It is bounded in the south by Delta State, in the north by Kogi state and in the east by Kogi and Anambra states. It occupies a land area of about 17, 802 sq kilometer (km^2) (Edo State Government, 2001). The state has a population of 3,218,332 with 1,640,461 and 1,577,871 male and female respectively (NPC, 2006).

The state is located in the rainforest vegetation belt, with mainly derived savannah vegetation in the north. The riverine communities in the south have mainly mangrove swamp vegetation. The main soil types range from low productive sand in the southeast to fertile clayer soil in the northwest. The soil types in the state are reddish-yellow kind of "ferrosols", "dish clay", "lathyritic clay" and "fine hydromorphic" soils. Edo state has a tropical climate characterized by two distinct seasons: the wet and the dry. It has an average rainfall ranging from 1500mm in the north to 2500mm in the south. The temperature averages about 25^0 C (77^0F) in the rainy season and 28^0 C (82^0 F) in the dry season (Edo State Government, 2006).

The main crops cultivated are rubber, oil palm, cocoa, yam, cassava and maize. Others are rice, plantain sugarcane, groundnuts etcetera. There is a significant animal husbandry practice, with cattle, goats, pigs, rabbits and sheep as the main products. Most of the farmers are small scale farmers.

Sampling technique and sample size

Arable crop farmers in Edo State formed the population of this study. Three extension blocks were randomly selected from each Agricultural zone in the state to get nine (9) blocks. Fifteen ADP registered small scale arable crop farmers were randomly selected from each block to get a sample size of 135 respondents. At the end, 120 respondents gave their responses as 15 of them did not cooperate.

Data collection

Data for the study were collected with the use of structured interview schedule because it is envisaged that most of the small scale farmers might not have formal education and so may not be able to read and write. Enumerators were hired and trained to administer the instrument.

Data Analysis

Data for the study were subjected to statistical analysis using descriptive statistics such as frequency counts, and percentages. The hypotheses were tested with the use of multiple regression analysis. The adopters were categorized into low, medium and high and assigned < 4 adaptive measures, 4-6 adaptive measures and > 6 adaptive measures respectively. The level of adoption of adaptive measures or techniques which is the dependent variable were determined by counting the number of adaptive technologies adopted by the farmers in the study area. Adoption index were computed by dividing the grand mean (overall), adoption score by the number of adoption stages. The multiple regression models are implicitly specified as follows:

$$Y = F (X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, U).$$

Where

Y = Level of adoption of climate change adaptation technology
(number of technologies)

X_1 = Level of education (years)

X_2 = Age of farmers (years)

X_3 = Farm size (hectare)

X_4 = Household size (number of persons in the household)

X_5 = Farm income (N)

X_6 = Number of visits by extension agents

X_7 = Neighbours visits (number of visit by and to neighbours and other farmers)

X_8 = Meeting attendance (actual number of times farmers attend association/cooperative meetings in a year)

μ = Error term

Four functional forms of the model; linear, double log semi log and exponential were used to determine the function which best fits. The levels of significance adopted were 5%.

RESULTS AND DISCUSSION

Socio-economic characteristics of respondents

Table 1 shows that most (58.3%) of the respondents were women while 41.7% were men. This finding is congruent with World Bank (1989), Olawoye (2001), Prakash (2003), Ofuoku and Emuh (2006) who asserted that women account for more than half of the labour required to produce food and most farmers are women.

Majority (73.3%) of the farmers were in the age range of 20-49 years. Farmers in this age range are youthful and energetic, thus strong enough to carry out farm operations efficiently. Most (96.7%) of them were married. This means much of responsibilities on their shoulders.

As far as education is concerned, most (71.7%) of the respondents had one form of formal education or the other, but most (40%) of them had primary education. Formal education is known to enhance adoption of innovations among farmers. According to Okoye (1971), Lemchi *et al* (2003) and Eze *et al* (2006), technological change is achieved through formal education. Most (30%) of the respondents had average annual income of between N501,000 – 600,000. Most (38.8%) of them also had a household size of 5-6 household members. Majority (59.2%) of them, had farms of the sizes of between ½ - 3 hectares. This implies small-holdership among most of the respondents.

Most (45.8%) of them were not visited by extension agents; while 30.8% were visited once monthly. Most (73.3%) of them were visited by neighboring farmers 1-4 times monthly. Farmers ought to get information from extension agents and other farmers. Farmers exchange information with neighboring farmers from time to time. Most (60%) of the respondents also subscribe to various farmers' associations. Most (71.7%) of them attended such associations' meetings 7-12 times yearly.

Farmers' cooperative societies and other farmers' associations formed the sources of information for most (70.0%) of the respondents. While neighbouring farmers were a source of information for 20% of them, extension agents served as sources of information on weather for 10% of them. Farmers' associations serve as a clearing house for information for farmers generally

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TABLE 1: Socio-economic characteristics of respondents

Variables(X)	Frequency	Percentage (%)	
Gender			
Male	50	41.7	
Female	70	58.3	
Age (years):			
20-29	34	28.3	
30-39	29	24.2	
40-49	25	20.8	49 years
50-59	21	17.5	
60 - above	11	9.2	
Marital status			
Married	116	96.7	
Single	4	3.3	
Level of education:			
No. formal education	34	28.3	
Primary education	48	40.0	
Secondary education	24	20.0	
Tertiary education	14	11.7	
Average annual income (N):			
50,000 – 100,000	5	4.2	
101,000 – 200,000	13	10.8	
201,000 – 300,000	22	18.3	₦55,062.96(PA)
301,000 – 400,000	18	15.0	
401,000 – 500,000	26	21.7	
501,000 – 600,000	36	30.0	
601,000 – 700,000	0	0	
701,000 and above	0	0	
Household size (persons)			
1 – 2	13	10.8	
3 – 4	30	25.0	
5 – 6	46	38.3	6 persons
7 – 8	19	15.9	
9 – 10	12	10.0	
Farm Size (Hectares)			
½ - 2	47	39.2	
2 ½ - 3	24	20.0	

3 ½ - 4	8	6.7	
4 ½ - 5	16	13.3	5..8ha
5 ½ - 6	9	7.5	
6 ½ - 7	3	2.5	
7 ½ - 8	7	5.8	
8 ½ and above	6	5.0	
Frequency of extension agent visit (times monthly)			
No visit			
1	55	45.8	
2	37	30.8	2 times
3	18	15.0	
4	10	2.5	
Frequency of visit by neighbours (times monthly)			
1 – 2	52	43.3	
3 – 4	36	30.0	
5 – 6	22	18.3	6 times
7 – 8	8	6.7	
9 – 10	2	1.7	
Membership of farmers' association			
Yes	72	60.0	
No	48	40.0	
Frequency of associations' meeting attendance (time annually):			
1 – 3	14	11.7	
4 – 6	19	15.8	8 times
7 – 9	41	34.2	
10 – 12	45	37.5	
Source of information:	12	10.0	
Extension agent			
Other farmers	24	20.0	
Farmers' association	32	26.7	
Farmers' cooperative society	52	43.3	

Source: Field Survey, 2009

Farmers' perception of climate change

Table 2 indicates that most of the respondents stated that there is climate change as according to them, that temperature increased (96.7%), precipitation decreased (96.7%), on set of rainy season changed (93.3%), onset of the dry season changed (90%) and dry season now longer (92.5%). However, 3.3% stated that they had not observed Climate change. These findings agree with Bryan *et al* (2008) and Gurung and Bhandri (2008) who stated that climate change is already being felt and the effects are seen in many ways. This implies that climate change is real and it is affecting the major source of livelihood of farmers as agricultural production is naturally tied to climatic conditions.

TABLE 2: Farmers' perception of climate change

Perceptual statements	Frequency	Percentage (%)
There is increase in temperature	116	96.7
There is decrease in rainfall	116	96.7
There is change in onset of rainy season	112	93.3
There is change in onset of dry season	108	90.0
Dry season is now longer	111	92.5
There is no change in climate	4	3.3

Source: Field Survey, 2009

Climate change adaptation measures taught to respondents

Most (29.2%) of the respondents were taught to adapt to climate change by changing planting dates (Table 3). Other adaptation measures taught to farmers included irrigation (5.8%), vermin –compositing (11.7%), increased use of animal manure (15%) , mulching (16.7%), planting of trees (5.8%), use of different crop varieties (10.8%) and zero tillage (5%). This means that apart from the use of various crop varieties, they were taught soil conservation measures as adaptation measures to climate change. This is congruent with Bryan et al (2008) in their study in Ethiopia and South Africa were taught the use of irrigation, use of different crop varieties tree planting and soil co0nservation for adaptation to climate change.

TABLE 3: Climate change adaptation measures taught to farmers

Adaptation measures	Frequency	Percentage (%)
Irrigation	7	5.8
Vermicomposting	14	11.7
Increased use of animal manure	18	15.0
Changing planting dates	35	29.2
Mulching	20	16.7
Planting of trees	7	5.8
Planting of different crop varieties	13	10.8
Zero tillage	6	5.0
Source: Field Survey, 2009		

Climate change adaptation scores of farmers

Table 4 indicates that most (75%) of the farmers adopted 0-3 climate change adaptation technologies, 20% used between 4-6 adaptation technologies, while 5% used more than 6 adaptation technologies. This study area was generally low as 75% of the respondents fell under the low categories.

TABLE 4: Farmers' climate change adaptation scores

Adaptation scores	Frequency	Percentage (%)
Low (0 – 3)	90	75
Medium (4 – 6)	24	20
High (> 6)	6	5

Source: Field Survey, 2009

On further analysis of the farmers' adoption decision stages and climate change adaptation technologies adopted by them (table5), it was discovered that 26.66% had adopted the use of irrigation, 10.83% - vermin-compositing, 10% increased the use of animal manure, 20% adapted to climate change by changing their planting dates, 25% by applying mulch, 35.83% through the use of different crop varieties, 45% by zero tillage while 20% adapted to it by tree planting.

Tables 4 and 5 indicate that farmers are yet to fully adopt most of the climate change adaptation measures. The low levels of adoption of adaptation measures were as a result of the high cost of technologies to farmers. Another reason is inaccessibility to information like weather forecast in case of changing of planting date. About 45.8% of them reported the reason to be inaccessibility to extension agents to teach, demonstrate or even introduce the adaptation technologies to them. Heidhmes (1994), however opined that an agricultural innovation could be adopted if among other factors, the input and output relationship is more favourable, procurement cost is low, risk of adoption – low, success of innovation is more visible, sooner or later and the innovation is simple to use.

TABLE 5: Adoption – decision process of farmers

Adoption stages	Irrigation	Vermi-composting	Increased use of animal manure	Changing of planting dates	Mulching	Use of different crop varieties	Zero tillage	Tree planting
Awareness	16.66	26.66	50.0	20.83	33.33	29.17	20.83	11.67
Interest	40.0	41.66	16.66	16.66	18.0	10.0	25.0	15.0
Evaluation	6.66	15.0	8.33	37.5	3.33	5.0	4.17	20.83
Trial	10.0	5,83	15.0	5.0	23.33	20.83	5.0	32.50
Adoption	26.66	10,83	10	20.0	25.0	35.83	45.0	20.0
Total	99.98	99.98	99.99	99.99	102.99	100.83	99.97	100
Mean adoption score	0.83	0.83	0.83	0.83	0.86	0.84	0.83	0.83

The mean of means (grand mean) adoption score = 0.84, Adoption index = 0.168

Source: Field Survey, 2009

Barriers to adaptation

The farmers (Fig.1) however, stressed that their low level of adoption of adaptation measures is attributable to lack of money (42%), lack of information (77%), inadequate labour (46%), inadequate land (28%) and poor potential for irrigation (5%). This is congruent with the finding of Deressa *et al* (2009) as they discovered similar barriers prevented farmers from adopting various adaptation measures to climate change.

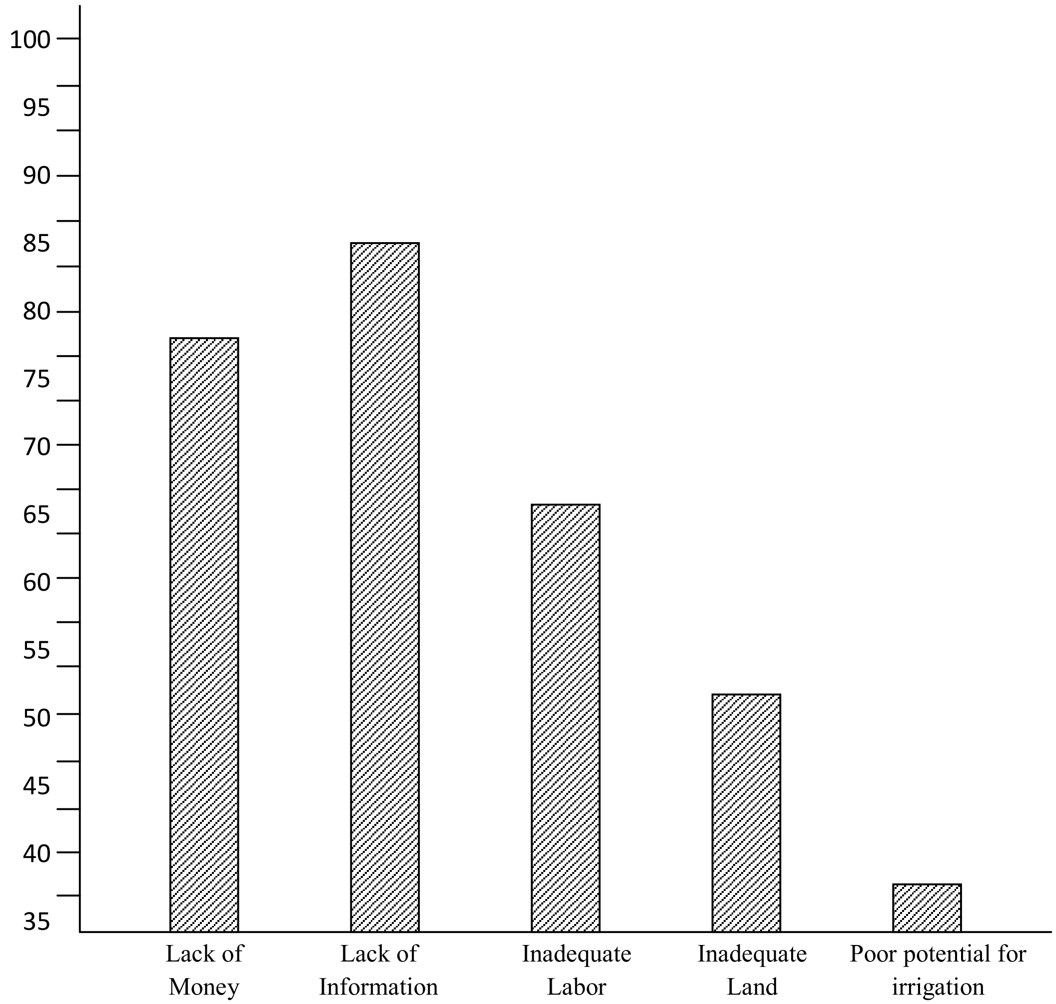

FIGURE 1: Barriers to adaptation

TABLE 6: Linear regression estimate of the relationship between socio-economic characteristics of farmers and adaptation to climate change

	Coefficients	Standard Error	t-stat	p-value
Intercepts	-1.1556736	0.318865672	-3.6243*	0.00043873
X_1 – Level of education	0.06500839	0.017806559	3.65081*	0.000400262
X_2 – Age	0.00267997	0.004023272	0.66612	0.506717717
X_3 – Farm size	0.2125744	0.035981552	5.90787	3.86629-08
X_4 – Household size (HH)	0.1478175	0.015760749	3.23023*	0.001627667
X_5 – Farm income	9.2804E-08	1.00421E-07	0.92415	0.357414993
X_6 – Ext. Visit	0.69362037	0.100951248	6.87084*	3.89456E-10
X_7 – Visit to other farmers	0.07508128	0.02080736	3.6084001*	0.544165109
X_8 – Meeting attendance	0.13500739	0.025113171	5.37596*	4.26029E-07
R^2	0.95595562			
Adjusted R^2	0.95278125			
F - Ratio	301.1481931			

* Significant at 5% level of significance

Educational level (X_1) of the household lead is significantly and positively related with adaptation to climate change. Higher level of education is believed to be associated with access to information on improved technologies and higher productivity (Norris and Batic, 1987). Igoden *et al* (1990); Lin (1991) argue that evidence from various sources indicate that there is a positive relationship between the educational level of the household head and the adoption of improved technologies and according to Maddison (2006), adaptation to climate change. The implication is that with higher levels of education, household heads and informed families are more likely to adapt better to climate change. Deressa *et al* (2009) opined that a unit increase in number of years of schooling would result in a 1% increase in the probability of soil conservation and a 0.6% increase in change in planting dates to adapt to climate change.

The age (X_2) of household heads which can also be used to capture farming experience did not have a significant relationship with adaptation to climate change. This is contrary to *a priori* expectation. This is at variance with Deressa *et al* (2009) who discovered in their study that age of household head affected adaptation to climate change. Other studies in Ethiopia have also shown a positive relationship between number of years of experience in agriculture and the adoption of improved agricultural technologies (Vebede *et al*, 1990). However, a study by Shiferaw and Holden (1998) indicates a negative relationship between age and adoption of improved soil conservation practices.

Farm size (X_3) of the farming households has no relationship with adaptation to climate chance, if it had, this would have meant that increasing farm size significantly increase the probability of adaptation. Even when there was no relationship, it can be inferred that the larger the farm size, the better the chance of adapting the climate change.

Household size (X_4) is positively related to adaptation to climate change. Increasing household size increased the probability of adaptation to climate change. This is at variance with the findings of Deressa *et al* (2009) who discovered that increasing household size did not significantly increase the probability of adaptation. This study supports Croppenstedt *et al* (2003) who argue that households with a larger pool of labour are more likely to adopt agricultural technology and use it more intensively because they have fewer labour shortages at peak times. It is expected that large households are more likely to adapt to climate chance (Deressa *et al,* 2009). It can therefore be hypothesized that the larger the household size, the better the change of adapting to climate change.

Farm income (X_5) did not have a positive relationship with adaptation to climate change. This is contrary to *a priori* expectation. It is regularly inferred that the adoption of agricultural technologies requires sufficient finance (Knowder and Bradshow, 2007). Franzel (1999) in his investigation of the impact of income on adoption discovered a positive correlation.

Extension visit (X_6) has a positive correlation with adaptation to climate change. This is in consonance with *a priori* expectation. Deressa *et al* (2009) argue that extension on crop and livestock production and information on climate represent access to the information required to make the decision to adapt to climate change. As expected, the reformed, access to crop extension has a positive and significant effect on climate change adaptation.

Extension is also the source of information on climate change to farmers. The information on climate change is expected to have a significant positive impact on the likelihood of adopting various climate change adaptation measures.

Visit to other farmers (X_7) has a positive correlation with adaptation to climate change, congruent with *a priori* expectation. Visit to other farmers is here referred to as farmer-to-farmer extension. Farmers' access to 'farmer-to-farmer' extension increases the likelihood of adaptation to climate change. This is congruent with Deressa *et al* (2009) who suggest that having access to 'farmer-to-farmer' extension increases the likelihood of using different crop varieties by 11.3% and planting trees by 12%.

Meeting attendance (X_8) has impact on adaptation to climate change. This again is at variance with *a priori* expectation. Farmers' association meetings are known to be clearing houses of knowledge and information among farmers. Through these meetings the farmers exchange ideas, knowledge and information (Ofuoku *et al*, 2008). This implies that an increase in meeting attendance would mean an increased likelihood to adapt to climate change will use more climate change adaptation measures.

Implication for Extension Service

Climate is a very crucial variable in agriculture as agricultural productivity is partly and crucially influenced by climate. A change in climate which upsets a lot of anomalies in agricultural production is already affecting agricultural production. Rural communities are already experiencing the impact of climate change, and most are trying their best to adapt (Gurung and Bhanderi, 2008).

It has been discovered in this study that the greatest barrier to climate change adaptation is lack of information. The Edo State agricultural extension agency has to increase farmers' access to information on climate change adaptation. Extension service needs to organize the farmers and other stakeholders into an information network. This will enhance the flow of information among farmers and between farmers and other stakeholders within and outside the extension service. When this is done, the issue of the dearth of information would have been solved to a great extent.

CONCLUSION

The determinants of adaptation to climate change are those factors that impact positively on adaptation to climate change. These factors include socio-economic factors such as educational background. The higher the farmers' level of education the higher his/her likelihood to adapt to climate change.

Household size also positively influences adaptation to climate change. This is as a result of the fact that the larger the household size, the higher the probability of adaptation to climate change.

Extension visit, visit to other farmers and attendance at meetings have positive influence on adaptation to climate change. These are information sources to farmers. Information are a great resource to farmers as their farm operations rely very much on them.

RECOMMENDATIONS

Considering the results of this study, it is recommended that:

i. Farmers should be given access to credit through micro-credit or state empowerment scheme. This will help them access irrigation facilities.
ii. Effective policies must also address imperfections such as access to information and linking farmers with

extension services and farmers group in order to reach small-holder subsistence farmers. The social network through farmer-to-farmer extension should be promoted and strengthened.

iii. Public and private sectors, non-governmental organizations (NGOs) and the media should be more involved in promoting adaptation to climate change in ways that will motivate farmers to adopt adaptation technologies.

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