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Full Length Research Paper

Analysis of awareness and adaptation to climate change among farmers in the Sahel savanna agro-ecological zone of Borno State, Nigeria

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This study examined the awareness and adaptation to climate change among farmers in the Sahel savanna agro-ecological zone of Borno State, Nigeria. Data for the study were collected from 225 respondents selected through multi-stage sampling technique. Socio-economic profile of the respondents indicated that 48.89% of them were above 45 years of age and majority (78.23%) had educational qualification below secondary school level. The study also revealed that more than half (67.56%) of them had less than 7 number of extension contact during the 2010 farming season. Analyses of the source of awareness about climate change revealed that majority (82.22%) of the respondents were aware of the phenomenon of climate change. The study showed that planting ahead of rains (97.78%) and planting of cover crops (80.00%), was the adaptation strategies most used by the farmers. It was also found that educational qualification and the number of extension contact were the most important factors that influenced the use of adaptation measures among the respondents. However, the main constraints to the use of climate change adaptation measures by farmers in the study area were poor financial resources (86.67%) and non availability of weather information (77.78%). The study concluded that majority of the farmers were aware of climate change and its consequences. It was therefore recommended that extension education should be strengthened in order to boost farmers' awareness of climate change and prepare them for adaptation measures.

Key words: Climate change, adaptation, extension agent, farmers.

INTRODUCTION

The growing problems of climate change are becoming more threatening to sustainable economic development and the totality of human existence (Adejuwon, 2004). Over time, farmers had adjusted agricultural systems and practices to the changing economic and physical conditions. This has been accomplished by adopting new technologies, changing crop mixtures and institutional arrangement. Such flexibility is suggestive of human potentials to adapt to climate change (CAST, 1992; Rosenberg, 1992). Changes in temperatures and rainfall patterns as well as increase in carbon dioxide (CO_2) level are expected to have effect on agriculture, especially in tropical regions. Such changes may manifest in the reduction in land quality and low agricultural yields.

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Oyekale (2009) asserted that the entire human conditions are likely to be affected by climate change due to decreased water availability especially in the arid regions. Moreover, Blaikie et al. (1994) is of the view that some social factors influence both the vulnerability and adaptation to climate change.

In the same vein, previous studies (Nhemachena, 2007; Adger and Kelly, 2001) highlighted the role of access to credit and extension services in the recovery from stress and disruption of livelihood. Oyekale (2009) postulated that through conditions of hazard exposure and vulnerability, poor countries suffer climate change disaster, disproportionately. The small-scale farmer still suffers most because of his dependence on rain-fed agriculture and lack of capacity to diversify. Carter (1997) pointed out that farmers react to climate change through adaptation. In an analysis of adaptation to climate change in the drought-prone areas of Bangladesh, Selvaraju et

al. (2006) found that the main adaptation strategies practiced by small-scale farmers were in the form of modification of agronomic practices and in the choice of crop varieties that tolerate the new regime. Desertification covers up to 35% of Nigeria's land mass and more than 60% of Borno State, where the study was conducted (Badi, 2010). This situation, coupled with ever decreasing rainfall regime is threatening the livelihood of the population, which depends largely on rain-fed agriculture. The arable land mass is seriously being threatened due to desertification and most of the local crop varieties are no longer appropriate due to changing climatic conditions.

Evidence abound (Katz and Brown, 1992) that farmer can adapt to climate change by changing their agricultural practices, which may include planting tolerable crop varieties or changing the husbandry practices. It may also involve blending scientific practices with local/traditional knowledge. UNEP (1996) reported found that global warming, which is fallout of climate change will add to worsening food insecurity. The report also added that reduced water availability will pose one of the greatest problems to agriculture, especially in developing countries. Adaptation to climate change refers to the adjustments in ecological, social and economic systems in response to climatic conditions and their effects (Tol, 1998). The capacity of farmers to adapt to climate change can be significantly influenced by the level of awareness about climate change in their communities. Tol (1998) is of the view that awareness about climate change has great capacity to drive farmers into improvising local technologies which can help in adaptation.

It is in view of the above that this study was designed to analyze the awareness and adaptation to climate change among small-scale farmers in the Sahel Savanna agro-ecological zone of Borno State, Nigeria. The specific objectives of the study were to:

(i) Identify the socio-economic characteristics of the respondents;
(ii) Examine the level of awareness about climate change among respondents in the study area;
(iii) Analyze the adaptive mechanisms to climate change being used by the respondents in the study area;
(iv) Identify the factors that influence adaptation to climate change by the respondents and
(v) Identify the constraints to adaptation to climate change by small-scale farmers in the study area.

METHODOLOGY

This study was conducted in the Sahel Savanna agro-ecological zone of Borno State, Nigeria. The area lies between longitude 13° 30'E and longitude 14° 0'E and latitude 12° 0'N and 13° 30'N (Agboola, 1987). It consists of six Local Government Areas, (LGAs), namely Abadam, Kukawa, Gubio, Monguno, Magumeri and Nganzai. Being a semi-arid zone, the mean annual rainfall in the area is 500 mm. The vegetation is mainly shrubs and seasonal grasses with few stunted trees, while the main crops grown are millet, cowpea and maize. The soil type in the study area is sandy, which is typical of most semi-arid region.

Respondents for the study were selected through multi-stage sampling procedure. In the first stage, three LGAs were randomly selected out of the six LGAs in the study area. From each of the selected three LGAs, three communities were randomly selected, giving a total of nine communities used for the study. In the third stage, twenty-five farming households were selected. The heads of the selected households were taken as the respondents. This gave a total of 225 respondents used for the study. The 225 respondents were administered interview schedules. Information sought from the respondents relate to their socio-economic characteristics, knowledge of climate change, adaptation practices undertaken as well as the constraints faced in adapting to climate change. Both descriptive and inferential statistics were used to analyze the data. Descriptive statistical tools (frequency counts and percentages) were used to categorize the respondents, while the inferential statistical tool (the Tobit regression Model) was used to establish the effects of some socio-economic characteristics on the use of climate change adaptation measures among farmers.

RESULTS AND DISCUSSION

Socio-economic profile of the respondents

The socio-economic profile of the respondents is presented in Table 1. The entries showed that 51.11% of the respondents were 45 years of age or younger, with close to half (48.89%) of the respondents above 45 years of age. This indicated that a large proportion of the respondents were with declining productivity. The aging population is less able to engage in modern agricultural practices. They are also less able to source and synthesize information. Younger farmers are more able to adopt improved ideas and innovations. The results in Table 1 also revealed that majority (78.23%) of the respondents had not gone beyond primary school level of education. This has serious implications for the level of awareness about climate change and also for the development of indigenous farm practices for adaptation. Education plays important role in creating awareness in farming communities as educated people are better equipped to source information compared to those that are not educated. Minimum threshold in terms of educational qualification is necessary for understanding the scientific and technical nature of modern agriculture. Education also helps farmers to understand where to access farm inputs as well as how to use them. Furthermore, earlier studies (Asfaw and Admassie, 2004; Bamire et al., 2002) reported that education affects agricultural productivity by increasing the ability of farmers to produce more output from given resources and by enhancing the capacity of farmers to obtain and analyze information. Education could also influence the ability of farmers to adjust quickly to disequilibria.

Table 1 further revealed that 79.12% of the respondents operated 1.5 hectares of land or less, indicating that majority of the respondents were small-

Table 1. Distribution of respondents based on their socio-economic characteristics.

Variable	Frequency	Percentage
Age(years):		
≤ 25	23	10.22
26 - 35	30	13.33
36 - 45	62	27.56
46 - 55	78	34.67
56 and above	32	14.22
Educational qualification:		
No formal education	26	11.56
Qur'anic education	108	48.00
Primary education	42	18.67
Junior secondary education	29	12.89
Senior secondary education	20	08.89
Farm size (ha):		
≤ 0.5	08	03.56
0.6 - 1.0	35	15.56
1.1 - 1.5	60	26.67
1.6 - 2.0	75	33.33
2.1 - 2.5	32	14.22
2.6 - 3.0	27	12.00
3.1 and above	06	02.67
Number of extension visit received:		
≤ 3	65	28.89
4 - 6	87	38.67
7 - 9	45	20.00
>9	28	12.44

Source: Field Survey (2010).

scale farmers. Small-scale farmers operate at subsistence level. This makes them vulnerable and less able to cope with the consequences of climate change, as indicated by Oyekale (2009). More than half (67.56%) of the respondents received not more than six (6) extension visits during the 2010 farming season. This implied that more than half of the respondents had very low extension contact. According to the Food and Agriculture Organization of the United Nations (FAO) recommendation, farmers are expected to receive at least one extension visit every week during a farming season. This will translate to a minimum of 15 extension contacts in a farming season. Extension contact determines the information that farmers obtain on production activities and the application of innovations through counselling and demonstrations by extension agents. The effect of exposure to extension programmes is enormous. For instance, Onu (2006) found that farmers who had access to extension contact adopted alley farming technologies 72% greater than farmers who had no access to extension contact. Nhemachena (2007) also opined that exposure to extension services influences the capacity of farmers to adapt to climate change.

Awareness about climate change

The study sought the level of awareness about climate change among the respondents. Results of the level of awareness of climate change among the respondents are presented in Table 2. The results revealed that majority (82.22%) of the respondents were aware of the changing climate. Out of that figure, 47.57% got their information about climate change from extension agents, 13.51% got the information from the media (mainly radio), 32.43% got the information from friends and neighbours, while a dismal (6.49) of them got the information from Non-Governmental Organizations (NGOs) and input sales agencies. This underscores the importance of interpersonal communication in creating awareness. The extension agents are the main source of technical information among farmers. As opined by Rogers and

Table 2. Source of awareness about climate change.

Source	Frequency (n = 185)	Percentage
Extension agents	88	39.11 (47.57)
Media (radio/television)	25	11.11 (13.51)
Friend/neighbours	60	26.67 (32.43)
NGOs and input sales agencies	12	05.33 (06.49)

Figures in parentheses are percentage of respondents that had awareness of climate change. Source: Field Survey (2010).

Table 3. Perceived causes of climate change by respondents.

Perceived cause	Frequency	Percentage*
Industrial activities (e.g. gas flaring CO_2 emission)	135	60.00
Domestic activities (e.g. burning of fire wood for cooking)	60	26.67
Deforestation, bush burning and overgrazing by livestock	205	91.11
Emission by vehicles	82	36.44
Emission of greenhouse gasses (e.g. CO_2, CH_4 and NO_2)	06	02.67
Natural process destined by God (drying up of natural water bodies such as river, ponds and lakes)	170	75.56

*Multiple responses existed, hence total percentage is greater than 100. Source: Field Survey (2010).

Table 4. Climate change adaptation measure practised by respondents.

Adaptation measure	Frequency	Percentage*
Irrigation to augment shortfall in rain	12	05.33
Mulching/cover cropping	180	80.00
Planting deeper than usual	85	37.78
Planting ahead of rains	220	97.78
Intensive manure application	150	66.67
Planting crops tolerant to climate change induced conditions	165	73.33

*Multiple responses existed, hence total percentage is greater than 100. Source: Field Survey (2010).

Shoemaker (1983), extension agents are not able to work closely with all farmers in a farming community. Rather, they work with few farmers (the contact farmers or the opinion leaders). These few farmers now form the agents of spreading the information in their own communities.

Perceived causes of climate change

Entries in Table 3 present the perception of the respondents as to the causes of climate change. The result showed that nearly all (91.11%) of the respondents perceived climate change as being caused by deforestation, bush burning and overgrazing by livestock. This was followed by natural processes destined by God (such as drying up of rivers and water bodies) as claimed by 75.56% of the respondents, while more than half (60.00%) of the respondents claimed that industrial activities are responsible for climate change. Other causes of climate change are emission by vehicles, domestic activities and emission of green house gasses as reported by 36.44, 26.67 and 02.67% of the respondents, respectively.

Adaptation to climate change

Table 4 presents the result of adaptation measures practised by the respondents against climate change. The result showed that majority (97.76%) of the respondents planted their crops ahead of rains. This is to give the crop the advantage of benefiting from the first flush of rains. Mulching and cover cropping were also practiced by 80% of the respondents. This was to reduce evaporation and also add to the organic matter content of the soil. About three-quarters (73.33%) of the respondents reported that they planted drought tolerant and early maturing crop varieties in order to cope with

Table 5. Tobit estimate of extent of factors influencing adaptation to climate change.

Adaptation to climate change	Coefficient	Standard error	Z	P> |z|	(95% Conf. Interval)	
Age	-0.5401261	0.2298583	-2.35	0.019**	0.9922079	0.0880444
Level of education	15.17621	2.017178	7.52	0.000***	11.20885	19.14356
Household size	1.65632	0.5433203	3.05	0.002**	2.724914	0.5877256
Extension visit	6.944238	1.86999	3.71**	0.000***	3.279124	10.60935
Constant	2.833213	1.028992	2.75	0.006	4.85	0.816427

**Significant at 5%; ***Significant at 1%.

Table 6. Constraints to adoption of climate change adaptation measures by respondents.

Constraints	Frequency	Percentage*
Inadequate financial resource	195	86.67
Inadequate access to extension service	72	32.00
Poor access to the technologies necessary for adaptation	130	57.78
Non availability of weather information	175	77.78

*Multiple responses existed, hence total percentage is greater than 100. Source: Field Survey (2010).

short rainfall regimes. Other adaptation measures used by the respondents include intensive manure application, planting deeper than usual and applying irrigation water to augment short fall in rains as reported by 66.67, 37.78 and 05.33% of the respondents, respectively. Earlier studies (Katz and Brown, 1992) found that farmers adapt to climate change by modifying their husbandry practices by changing crop mixes in order to cope with the new regime.

Factors influencing the use of adaptation measures to climate change

Table 5 presents the factors that influenced the use of adaptation measures among the respondents. Adaptation measure was measured in terms of the number of strategies used by a respondent. The strategies are listed in Table 4. The more the number of such strategies used by a respondent, the more he ranks in adaptation status. The results revealed that level of education of the respondents and extension visits were highly significant in influencing the use of adaptation measures among the respondents. Both variables were positive and significant at 0.01. This implies that as the level of education of the respondent increases, the capacity to use the adaptation strategies correspondingly increases. The same thing applies to extension visits. In a study of factors influencing the adoption of improved soybean seed among farmers in Borno State, Idrisa et al. (2010) found that extension visit was significant in influencing both the likelihood of adoption and the intensity of use of improved soybean seeds.

Age was also significant in influencing the use of adaptation measures among the respondents. The variable was significant at 0.05 and the sign of the coefficient of age was negative, implying that the younger respondents used more of the adaptation measures compared to their older counterparts. This is in line with Adesina and Zinnah (1993) who postulated that younger farmers have greater tendencies to improvise and adopt new technologies because they are relatively more knowledgeable, more open to risk taking and have longer planning horizons than their older counterparts. In addition, household size was also significant in influencing the use of adaptation measure among the respondents. Household size could be a measure of available labour for farming activities. Some of the adaptation measures to climate change such as mulching and manure application are labour-intensive. This may explain why the capacity of farmers to use these technologies depends on availability of labour and the main source of labour in subsistent agriculture is the family.

Constraints to adaptation

The result of constraints to adaptation to climate change among the respondents is presented in Table 6. The main constraining factor that hindered the adaptation to climate change among the respondents was poor financial resource base as reported by 86.67% of them. Non-availability of weather information was the second most important constraint, as reported by 77.78% of the respondents. Poor access to technology necessary for adaptation and poor access to extension services were among the constraints that militated against adaptation to climate change as reported by 57.78 and 32.00% of the respondents, respectively. As stated by Oyekale (2009),

the small-scale farmers, having low resource base are more vulnerable and less able to cope with the consequences of climate change. Such farmers also have less likelihood of accessing weather information or capacity to develop technologies on their own.

CONCLUSION AND RECOMMENDATIONS

In this study, awareness and adaptation to climate change among small-scale farmers in the Sahel Savannah agro-ecological zone of Borno State were analyzed. Results of the study indicated that a large proportion of the respondents were above 45 years of age, with the majority (78.23%) having no or very low level of formal education. Access to extension service was also very low in the study area even though extension service played the leading role in providing information about climate change to the respondents. The study showed that planting ahead of rains (97.78%) was the leading adaptation measure practised by the respondents followed by application of mulch/planting of cover crops. Important factors that influenced the use of adaptation practices among the respondents include level of education (P> |z| 0.01) and extension visit (P> |z| 0.01). Moreover, the major constraints that militated against the use of adaptation measures include inadequate financial resource and non-availability of weather information. Based on the findings of this study, the following recommendations are suggested:

(i) Extension services should be strengthened by organizing adult education programmes for farmers to expose them to climate change coping strategies.
(ii) Programmes should be put in place to attract young people, especially young school leavers and young graduates into farming. This can be done through strengthening programmes, such as the National Directorate of Employment (NDE) and the National Poverty Alleviation Programme (NAPEP).
(iii) Appropriate climate change adaptation technologies that require that require affordable should be developed for the resource-poor farmers to adopt.

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