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ASSESSMENT OF FARMERS' AWARENESS OF CLIMATE CHANGE AND ADAPTATION MEASURES IN THE NORTHERN ZONE OF SOKOTO STATE AGRICULTURAL DEVELOPMENT PROJECT

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ABSTRACT

The study assessed the awareness of climate change and adaptation measures among arable crop farmers in the northern zone of Sokoto State Agricultural Development Project. Five out of the 12 Local Government Areas in the zone were purposively selected using multistage random sampling techniques. Two hundred and forty farmers were randomly selected for the study from the list of registered farmers in Sokoto State Agricultural Development Project (SADP). Primary data were collected with the aid of a structured questionnaire. Data obtained was analyzed using descriptive statistics and Chi-square analysis. The results revealed that the causes of climate change in the study area were attributed to overgrazing (99.3%), deforestation (90.0%) and other agricultural activities (88.3%). The effects of climate change, according to the respondents, include: altering crop growing season, reduced crop yield, altering crop planting dates and altering crop harvesting dates. The adaptation measures adopted by the farmers were early sowing (100%), planting more than one crop (100%), use of cover crops (92.9%) and using early maturing crops (35.4%). The study revealed that the farmers were fully aware of climate change in the area with a mean of 17 years in witnessing the occurrence. Chi-square test of association indicated a significant association between awareness and the adaptation measures adopted by the farmers. The constraints to adaptation measures includes: inadequate operating capital, illiteracy and inadequate markets. Farmers should endeavor to obtain formal education through literacy programme. Improved education and disseminating information from agricultural research institutes are important policy measures for stimulating awareness and local participation in various development and natural resource management initiatives.

Keywords: Farmers; Climate change; Adaptation measures; Awareness

INTRODUCTION

According to Enete *et al.*, (2011) most of the agricultural research institutes like the International Institute of Tropical Agriculture (IITA) and National Cereals Research Institute (NCRI) have tended to concentrate attention on assessing the sensitivity of various attributes of crop systems (e.g. crop yields, pests, diseases and weeds) the bio-physical

aspects of food production, with little or no regard to the socioeconomic aspects. These partial assessments, most often consider climate change effects in isolation, providing little insights into the level of awareness of the farmers on the issue of how they are coping with climate change. However, to better address the food security concerns that are central to the economic and sustainable development agenda, it is desirable to also address these aspects of climate change and agriculture. Wisner *et al*. (2004) reported that the vulnerability of agriculture is not determined by the nature and magnitude of environmental stress like climate change per se, but by the combination of the societal capacity to cope with and/or recover from environmental change. While the coping capacity and degree of exposure is related to environmental changes, they are both related to changes in societal aspects such as land use patterns and cultural practices.

In addition, there is need for increased awareness, teaching, learning and research by Universities and Research Institutes purposely to develop a multi-pronged capacity to tackle the imminent danger posed by climate change which is slowly eroding the benefits of the fight against starvation, hunger and poverty among farming communities in Africa (Anselm *et al.*, 2011).

In today's constantly changing environment, farmers need accessible as well as usable climate services for managing climate risks and exploiting climate resources. It has been argued that the world's climate is changing and it will continue to change at rates unprecedented in human history and that all communities need to enhance their adaptive capacity to face both present and future challenges of climate change.

Also, the awareness of climate problems and the potential benefits of its mitigation is important determinant of adaptation measures to climate change (Hassan and Nhemachena, 2008). Maddison (2006) argued that farmers' awareness of change in climate attributes (temperature and precipitation) is important to adaptation decision making. Based on Araya and Adjaye (2001) farmers awareness and perceptions of soil erosion problem as a result of changes in climate will positively and significantly affect their decisions to adopt soil conservation measures. It is expected that improved knowledge and farming experience will positively influence farmers' awareness and decision to employ adaptation measures. Improved education and disseminating knowledge are important policy measures for stimulating awareness and local participation in various development and national resource management initiatives. Farming experience improves awareness of change in climate, the potential benefits and willingness to participate in local natural resource management activities. In view of the background, the study had assessed the level of awareness and identified the different climate change adaptation measures adopted by the farmers.

MATERIALS AND METHODS

Study Area

The study was carried out in the Northern zone of state Agricultural Development Project, Sokoto State. The State falls within the Sudan Savannah ecological zone and is located between latitude 13^{o}05' N and longitude to 05^{o}15' E. The study area is bordered to the north with Niger Republic, and Zamfara State to the east with a total land mass of 28,232,375 square kilometers (Sokoto State Desk Diary, 2013). The state has a population of 3.6 million people (NPC, 2006).

The effects of climate change will be more pronounced in communities in the zone because of its poor climatic conditions, drought and subsequent long period of dry spells in the raining season compared to the western zone of the State (Illiya *et al*., 2009). The area experiences a long dry from October to May and short raining from June to September seasons. The dry season consists of a cold dry spell harmattan (Singh and Babaji, 1989). The rainfall in the area is erratic in nature and small in quantity with an annual falls ranging between 500 to 1,300mm. The average annual temperatures of 28.3^{o}C (87.9^{o}F) was recorded (Rode, 2009). However, the highest monthly temperature is about 43^{o}C in April while the lowest mean monthly temperature occurs during the harmattan period when the temperature could be as low as 15^{o}C. In terms of vegetation, the area falls within Sudan savannah zone and the climate is semi-arid. This is open tsetse fly free grassland suitable for the cultivation of grain crops and animal husbandry.

Sample Population/Sampling Frame

The arable crop farmers in the Northern operational zone of the State Agricultural Development Project purposively constituted the sample frame for the study. A list of registered farmers (400 farmers) was obtained from the village extension agents.

Sampling procedure and sample size

A multistage sampling technique was used to select 240 farmers to arrive at the sample size for the study. In the first stage, the five frontline Local Government Areas namely: Gada, Illela, Isa, Sabon-birni and Tangaza in the zone were purposively selected to constitute the blocks. The purpose was to determine the magnitude of the occurrence of climate in those selected local government areas. Because it was assumed that the effects of climate change were more pronounced in those communities in the zone due to poor climatic conditions, drought, subsequent long period of dry spells in the raining season and closeness to the boundary with Niger and Cameroon republics respectively; known for their harsh environmental conditions. In the second stage, eight circles were selected from each of the selected blocks to make a total of forty circles for the study. In the final stage, six farmers were selected randomly from each of the selected circles to make a total of 240 farmers for the study.

Data Collection

Both primary and secondary data were used for the study. Primary data were collected using a structured questionnaire administered by the researcher and secondary information were obtained from textbooks, journals, internet, magazines and other literatures relevant to the study.

Data Analysis

Descriptive (Frequency, Percentage and Mean) and inferential (Chi-square) statistics were used to analyze the data. Chi-square analysis was used to determine the association between the awareness of climate change and the adaptation measures adopted.

RESULTS AND DISCUSSION

Respondents Socio-economic Characteristics

Results in Table 1 show the distribution of farmers according to their socio-economic characteristics. The results show that the farmers were within the age range of 25, 35 and 42 years respectively with a mean of 34 years and standard deviation of 6.58. This further shows that the farmers were at the middle or active productive age group. At this age, they tend to withstand stress and harsh climatic condition in various farming activities. Musa (2010) asserted that physical labour productivities of farmers depend on their socio-economic characteristics namely: age, sex and their health status.

The entire farmers were male. Farming is a laborious activity that could be handled more effectively by men. Generally, farming requires much energy in order to meet up with various farm activities. This implies that men dominate women in terms of farming activities in the study area. This is in line with findings of FAO (2009), which reported that men participated fully in farming activities whereas women engaged mostly in processing and selling of farm products.

As indicated in Table 1, 100% of the farmers were married. This connotes that marriage is highly valued in the study area. This will ensures a steady increase in the size of the family which in turn provides more hands in the farming activities. Married people are more involved in farming activities and more aware about climate change in order to adopt adaptation measures. These findings supported the view of Olorunfemi (2009), that most of the arable crop farmers are married.

Findings in Table 1 further revealed that 30.0% of the farmers had a household size in range of 5-7 persons while 25.8% had 8-10 persons respectively. It was also found out that mean household size in the study area was 6 persons. Given the poor economic condition of small farmer the use of household members as farm labour is an ideal option. Ogunbameru, et al.,(2008) found a significant relationship between household size and farm labour.

Table 1 further indicated that 56% of the farmers had no formal education, 12.0% acquired primary education, 13.8% acquired secondary education and 12.0% acquired tertiary education. Climate change is a natural occurrence and can be easily identified even without being informed or heard but the adoption of right and suitable adaptation measures requires a formal education. The educated farmers adapt modern agricultural practices than the uneducated farmers. Ogunbameru et al., _ (2008) stated that the level of education attained is one of the important socio-economic factors in the overall capital accumulation and investment in agricultural enterprises.

Table 1 expressed that (69.2%) of the farmers are full-time, while 30.8% are part-time farmers. This shows that farming as an occupation accounts for a greater percentage of the total employment. With the knowledge of climate change awareness occurring naturally year by year and considering farming as a full-time occupation, the adoption of suitable and right climate change adaptation measures will be possible. In line with this finding, Lawal (2002) noted that farming is still an important sector of the nation's economy that can provide employment.

Table 1: Distribution of respondents based on their socioeconomic characteristics (n=240)

Variable	Frequency	Percentage	Mean and SD
Age(years)			
<25	14	5.8	
25-30	71	29.6	
31-36	125	52.1	34, 6.58
37-42	29	12.1	
>42	1	0.4	
Sex			
Male	240	100.0	
Marital status			
Married	240	100.0	
Household size(persons)			
<2	7	2.9	
2-4	49	20.4	
5-7	72	30.0	6 persons
8-10	62	25.8	
>10	50	20.8	
Educational status			
No formal education	156	56.0	
Primary education	29	12.0	
Secondary education	33	13.8	
Tertiary education	22	9.2	
Occupation			
Part-time farming	74	30.8	
Full-time farming	166	69.2	
Farm size(hectares)			
< 1.00	90	37.5	
1.00-1.50	89	37.1	
2.00-2.50	26	10.8	
3.00-3.50	10	4.2	2.7 hectares
4.00-4.50	3	1.3	
>4.50	22	9.2	
Farm ownership			
Inherited	235	97.9	
Purchased	5	2.1	
Farming experience(years)			
<5	20	8.3	
5-10	61	25.4	14 years
11-16	63	26.3	
17-22	66	27.5	
>22	30	12.5	
Level of income(N)			
<10,000	136	56.7	
10,000-15,000	47	19.6	
16,000-21,000	31	12.9	
22,000-27,000	14	5.8	N21,500
28,000-33,000	9	3.8	
>33,000	3	1.3	

Source: Field survey, 2013.

Table 1 further expressed that 37.5% cultivates <1.00ha, 37.1% cultivates 1.00-1.50ha and 10.8% cultivates about 2.00-2.50ha with a mean farm size of 2.7 ha in the study area. The awareness of climate change is obvious since it occurs naturally and the vulnerable are the farmers. The limiting factor to the adoption of adaptation measures to climate change in the area was largely attributed to the fragmentation of the farmlands. The implication of this was that the farmers would not be able to engage in a large scale production or to have access to bigger credit facilities to improve on their level of output. This is in line with the findings of Musa (2010) that most farmers in Nigeria still produce at a subsistence level.

Results in Table 1 shows that majority of the farmers (97.9%) acquired the farmland by virtue of inheritance while 2.1% by purchased. Farmlands were continuously fragmented and transferred from generations to generations. Farm size is an important factor in farming as it affects not only the crop output but also the level and type of input to use. The implication of this was that there will be no improvements on agricultural output since the farmlands were fragmented continuously; production will remain at subsistence level. According to Musa (2010), farm size is an important determinant in the allocation of resources like basic inputs and labour which will eventually impact on the final output and returns.

Results in Table 1 further shows that the farmers (27.5%) had farming experience between 17-22 years, (26.3%) had farming experience between 11-16 years and 12.5% of the farmers had more than 22 years farming experience. The mean years of farming experience in the study area was 14 years. Farming experience improves awareness of climate change, the potential benefit and willingness to participate in local resource management activities. According to Lawal (2002), experiences acquired so far in farming by the farmers have been of tremendous contributions to the sustainability of their farming occupation in view of the prevailing agro ecological conditions.

The Findings in Table 1 revealed that the farmers (56.7%) earned less than N10, 000, (19.6%) earned between N10, 000 - N15, 000 and (12.9%) earned between N16,000-21,000. The annual income of N21, 500 was recorded as the mean in the study area. This could be attributed to the fact that the production is subsistence and mainly for family food security. The sale of farm products is a taboo in the rural areas. The implication of this was that the farmers will find it difficult to cope with the farm expenses. Also, adoption of adaptation measures would be difficult especially those that require finance and technical know-how. This in a long run will not allow the farmers to invest in agriculture in order to increase on their outputs. This is in line with the findings of Musa (2010) that most farmers in Nigeria still produce at a subsistence level.

Awareness, Evidence and Duration of Climate Change as Observed by the Farmers

This section provides information on the level of awareness, evidence and the duration of climate change in the study area as observed by the farmers.

Awareness of Climate Change

Table 2 shows that all (100.0 %) of the farmers were aware of climate change. Climate change is a natural occurrence and can easily be identified even without being informed or heard. The knowledge of the presence of climate change year by year prompted

the farmers most likely to find ways of adaptation to climate change in their area in order to be successful in their farming activities. Hassan andNhemachena (2008) are of the view that the awareness of climate problems and the potential benefits of taking action is important determinant of adoption of adaptation measures. Also, Ani, (2007) and Yakubu (2011), recognized awareness as the first stage in the adoption process.

Evidence of Climate Change

Results in Table 2 revealed information on the evidence of climate change in the study area. The results showed that majority (97.9 %) farmers were aware of the late commencement of rainfall while (95.8 %) early cessation of rainfall, (94.6 %) poor yield and(93.8 %) drought. This implies that the farmers were conversant with their environment and its ecological conditions. Also, the farmers knew exactly when to commence their farming activities in their area. These findings supported the idea of Iliya *et al.* (2009) that farmers being good observers have in their traditional societies been watching changes in plants, trees and crop phrenology in relation to climate.

Duration of Climate Change

Table 2: Awareness, evidence and duration of climate change as observed by the respondents (n=240)

Variables	Frequency	Percentage	Mean
Awareness of climate change	240	100.0	
Evidence of climate change			
Late commencement of rainfall	235	97.9	
Early cessation of rainfall	230	95.8	
Poor yield	227	94.6	
Drought	225	93.8	
Heavy wind	217	90.4	
Desertification	209	87.1	
Early drying of streams	204	85.0	
Erosion	149	62.1	
Flood	145	60.4	
Heat stress	135	56.3	
Duration of climate change(years)			
<6	54	22.5	
6-10	70	29.2	
11-20	65	27.1	17 years
16-20	33	13.3	
21-30	15	6.3	
>30	3	1.3	

Source: Field survey, 2013.

Results in Table 2 further revealed the farmers duration of witnessing the occurrence of climate change in the study area. Results shows (70%) farmers had 6-10 years of climate change occurrence while (65%) had 11-15 years and (33%) had 16-20 years with average of 17 years in witnessing the occurrence of climate change in the study area. The

implication was that the number of years acquired by the faarmers in witnessing the occurrence of climate change in the study area would enable them to know the adaptation measures to adopt. Araya *et al*. (2001) stated that improved knowledge and farming experience will positively influence farmers' awareness and decision to take up adaptation measures (Araya and Adjaye, 2001). These findings were in line with Iliya *et al.* (2009), that farmers' good knowledge of their physical environment and their cultural peculiarities most probably explain their success.

Causes and effects of climate change on crop production

The results (Table 3) shows that the causes of climate change in the study area were: overgrazing (99.2%), deforestation (90.0%) and agricultural activities (88.3%). This implies implies a reduction in yield as a result of depletion of soil nutrients due to activities of human and livestock. Application of fertilizers, rearing of livestock and land clearing are some of the agricultural activities that influence the levels of green house gases in the atmosphere and the potential for carbon emission. These findings supported the view of Noma *et al*. (2009) that climate change is the result of the influence of many factors and more recently by human activities. According to World Bank (2008), agriculture contributes about half of the global emissions of two of the most potent non-carbon dioxide green-house gases such as: nitrous oxide and methane.

Almost the entire farmers (98.8%) perceived that the effects of climate change were attributed to altering crops growing season (98.8%), reduced crop yield (97.5%), altering crops planting dates (94.2%) and altering harvesting dates(85.4%). The implication of this was that the crop cultivation and other related farm operations will be done late. These findings supported the idea of Mark *et al*.(2008) that some of the direct effects of climate change on agricultural systems are seasonal changes in rainfall and temperature which could affect agro-climatic conditions, altering growing seasons, planting and harvesting dates, water availability and pests.

Table 3: Perceived causes and effects of climate change (n=240)

Variables	Frequency	Percentage
Causes of climate change		
Overgrazing	238	99.2
Deforestation	216	90.0
Agricultural activities	212	88.3
Bush burning	68	28.3
Burning of crop residues	18	7.5
Burning of fossil fuel	8	3.3
Effects of climate change		
Altering crop growing season	237	98.8
Reduced crop yield	234	97.5
Altering planting date	226	94.2
Infestation of pests, weeds and diseases	217	90.4
Altering crop harvesting dates	205	85.4

Source: Field survey, 2013

Adaptation measures to climate change adopted.

Results in Table 4 provided information on the type of climate change adaptation measures adopted by the farmers in the study area. The Table shows that all (100%) the farmers adopted the use of early planting and planting more than one crop respectively. Using cover crops (92.9%) and using early maturing crops (35.4%). Growing different type of crops on the same plots or on different plots reduces the risk of complete crop failure since different crops are affected differently by climate change. The findings supported the view of Hassan (2008) who reported that the adaptation measures farmers perceived as appropriate include: crop diversification, using different crop varieties, varying the planting dates, harvesting dates, use of irrigation, soil conservation techniques and diversifying from farming to non farming activities

Table 4: Adaptation measures adopted (n=240)

Variables	Frequency	Percentage
Early planting	240	100.0
Planting more than one crop	240	100.0
Using cover crops	223	92.9
Using soil conservation techniques	100	41.7
Using early maturing crop	85	35.4
Using irrigation	74	30.8
Migration	35	14.6
Using resistance crop varieties	22	9.2
Varying the sowing/planting dates	20	8.3
Change crop intensity	15	6.3
Reduced tillage practices	12	5.0
Adjusting the timing of farm operations	11	4.6
Diversifying from farming to non-farming activities	7	2.9
Using crop rotation	6	2.5
Crop diversification	3	1.3

Source: Field survey, 2013

Constraints to Adoption of Climate Change Adaptation Measures

Results in Table 5 provided information on the constraints to adoption of adaptation measures faced by the farmers. The table shows that majority (97.9%) lack of finance, lack of farm size (96.7%), access to extension services (62.5%) and lack of information on climate change adaptation measures (61.7%). Adoption of adaptation measures would be difficult especially those that require finance and technical knowhow. Therefore, the farmers kept on operating and producing at subsistence level from generations to generations. These research findings supported the result of study conducted by Centre for Environmental Economics and Policy in Africa (CEEPA) that finance, labour, farm size, tenure status, level of education, adequate information on climate change and access to extension services are the major determinants of speed of adoption of adaptation measures to climate change (Maddison, 2006).

Table 5: Constraints to adoption of adaptation measures (n=240)

Variables	Frequency	Percentage
Lack of finance	235	97.9
Farm size	232	96.7
Shortage of labour	226	94.2
Lack of access to extension service	150	62.5
Lack of information on climate change adaptation measures	148	61.7
Lack of education	126	52.5
Lack of market	22	9.2

Source: Field survey, 2013

Chi-square Test of Association

Table 6 indicates a test of association between awareness of climate change adaptation measures and adoption of adaptation measures. The result indicates a significant association between awareness and adoption. This implies that farmers in the study area depend on awareness of adaptation measures to determine the adoption of adaptation measures. The more the farmers' awareness of the adaptation measures, the more the adoption. Ani (2007) and Yakubu (2011) recognized awareness as the first stage in adoption process.

Table 6: Chi-square test of association between awareness and adoption of adaptation measures

Variables	X^2tab.(0.05)	Df	X^2 cal.	Decision
Awareness / Adoption of Adaptation measures	5.99	2	12.69	Reject

Source: Field survey, 2013

CONCLUSION

The findings from the study revealed that the farmers were at active productive age group and all married with mean household size of 6 persons. The farmers' level of education was very low. The mean farming experience was 14 years. The findings further revealed that the farmers were fully aware of climate change with a mean of 17 years in witnessing the occurrence. The main climate change adaptation measures adopted were: early planting and planting more than one crop. The association between awareness of climate change and adoption was found to be significantly related. The more the farmers are aware of adaptation measures the more the adoption. However, the constraints to the adoption of adaptation measures include: inadequate operating capital, poor access to extension services and lack of information on climate change adaptation measures.

Farmers should form themselves into co-operatives to enhance their accessibility to credit facilities to invest in their agricultural activities.Government should provide adequate extension support services with a view to educate farmers on better ways of adoption to climate change during crop production. Improved education and disseminating knowledge are important policy measures for stimulating awareness.

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