

Assessment of climate change adaptation strategies among sorghum farmers in Kwara State, Nigeria

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Abstract

Sorghum is a major cereal crop among farmers and has a lot of food security importance in Kwara State. There has been paucity of empirical information in the area of adaptation strategies to climate change in relation to sorghum production in Kwara State, and to sustain the yields of sorghum in Nigeria, there is need for assessing climate change adaptation strategies among sorghum farmers in the State. This study was therefore designed to: 1) identify adaptation strategies to climate change used in sorghum production; 2) identify the constraints to climate change adaptation strategies; 3) estimate the costs implication of adaptation strategies to sorghum yield in the study area; 4) examine the determinants of sorghum farmer's choice to the usage of climate change adaptation strategies and 5) determine the determinants of investment on adaptation strategies. Structured questionnaire was used to elicit information from 145 sorghum farmers that were randomly selected from the 5 LGAs in Zone C of the KWADP. A three-stage random sampling technique was used to select the sampled sorghum farming households used for the study. Major tools of analysis for the study included descriptive statistics, 5 points likert-type scale, correlation analysis and multinomial logistic regression and ordinary least square regression for the respective objectives. Findings from the study showed that the costs of using more adaptation strategies have positive relationship with the sorghum yield. The multinomial logistic regression indicated that household size significantly affects the use of adaptation strategies among sorghum farmers in the study area and the reference category is high level of usage of adaptation strategies. It was discovered with the aid of ordinary least square regression that the number of strategies used, farming as source of income, farm income and farm size have positive relationship with the costs incurred by farmers. The implication of the findings of the study is that all adaptation strategies to climate change, in sorghum production are necessary while the farmers use more of the strategies common to them and less of others. The larger the household size and farm size, the better the yield, because these ensure high number of usage of adaptation strategies. The study recommended that farmers should be trained and supported on the use of more adaptation strategies. Policies that will increase development and farmers' access to improved sorghum varieties should be encouraged.

Keywords: Sorghum, Adaptation, Climate Change, Nigeria

Introduction

Background to the study

Approximately, sixty five percent of Africans rely on agriculture as their primary source of livelihood. Small scale farmers are responsible for more than ninety percent of African's agricultural production (IFPRI, 2009). Nigeria is the most populous country in Africa with estimated population of about 174, 507, 539 (CIA World Fact Book, 2015). Currently, Nigeria is the 8th most populous nation on

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the planet earth, with an estimated population of 177 million. This is expected to rise to 264 million by the year 2050 (CIA, 2015). Approximately, 75% of this population consists of women and children with over 70% residing and securing their livelihood in the rural area (Maziya-Dixton *et al*; 2004). Nigeria agriculture is one of the important sectors of the notable relevance in economic development and growth. It contributes more than 30% of the labour force, accounts for over 70% of non-oil exports and provide over 80% of the food needs of the country (Adegboye, 2004). Sorghum production refers to the cultivation and commercial exploitation of species of grasses within the genus sorghum (often *S. bicolor*). These plants are used for grain fibre and fodder; the plants are cultivated in warmer climates worldwide. Sorghum species are native to tropical and subtropical regions of African and Asia. Sorghum (*Sorghum bicolor*) occupies about 45-50 percent (%) of the total land area under cultivation in Nigeria and most of it is in Savannah zone where it contributes the major food grain and occupies about a third of the cultivated land. The total world production in 2002 was put at 5.5 million tonnes with average yield of 1,280kg/ha. In Africa, production was estimated at 2.0 Million tonnes with a yield of 861kg/ha while in Nigeria, production was at 0.8 Million tonnes with an average yield of 1,090kg/ha (FAO, 2003). Sorghum is one of the most important tolerant crops which has been globally cultivated due to its tolerance to water logging, high temperature and harsh environmental condition among cereals (Mwadalu & Mwangi, 2013). It is reported to be one of the viable staple food crops for the world's poorest and food insecure people; grown predominantly in arid and semi-arid areas of Africa.

Climate change is one of the serious environmental threats facing mankind worldwide. Climate change is rapidly emerging as one of the most global problems affecting many sectors in the world and is considered to be the one of the most serious threat to sustainable development with adverse impact on environment, woman health, food security, economic activities, natural resources and physical infrastructure (IPCC, 2007, Huq *et al*, 2006). African is one of the most vulnerable regions to climate change in the world. Previous assessments (IPCC, 1998; Hulme, 1996) concluded that Africa is particularly vulnerable to the impact of climate change because of factors such as widespread poverty, recurrent droughts, and inequitable land distribution and over dependence on rain-fed agriculture. Giving the over dependence on rain-fed agriculture by the majority of people living in rural areas, climate change has been one of the major limiting factors in agriculture production thus resulting in food insecurity and low income generation. The resultant effect of climate change among others include changes in the length of growing seasons, drought, erosion, flooding, pest infestations, disease outbreak, delay harvesting and excessive temperature which will cause failure and damage to crop production.

In recent times, vulnerability and adaptation to climate change are urgent issues in the current food security discourse among many developing countries (Westengen & Brysting, 2014). Vulnerability to climate change has been linked to social, economic, and environmental conditions which amplify susceptibility to negative impacts and contribute to a low capacity to cope with and adapt to climate hazards. Nigeria, like all the countries of sub-Saharan Africa, is highly vulnerable to the impacts of climate change due to the dependence of the Nigerian Agriculture on weather. The sorghum production in the country is weather dependent and it is especially sensitive to erratic rainfall and temperature which makes the crop more susceptible to changes in weather. A study conducted in Nigeria was modeled worst case in climate change scenarios for maize, sorghum, rice, millet and cassava in the 21st century (Enete and Amusa, 2010). The decreases in yield could be explained in terms of the very high tempera-

tures which lie beyond the range of tolerance for the current crop varieties and cultivars. Iorliam, *et al.* (2014) also found a positive future climate change shown an adverse effect on sorghum in a study carried out in North Central zone of Nigeria.

Most studies on climate change and agriculture in Africa have tended to concentrate on actual and projected impact as well as farmer's coping/ adaptation strategies (Adejuwon, 2006, Apata *et al.*, 2010, Mendelsohn *et al.*, 2000). Responding to climate change through mitigation will take time and therefore adaptation becomes critical particularly where the ability to adapt is low. Thus, without adaptation, climate change is generally detrimental to the agriculture sector (Gbetibouo, 2009). Therefore, to sustain the yields of sorghum and boost agricultural production in the country, there is need for effective adaptation strategies for combating climate change in crop production particularly sorghum which has a lot of food security importance for the country. There has been paucity of empirical information in the area of adaptation strategies to climate change in relation to sorghum production in Kwara State, Nigeria and also to sustain the yields of sorghum in Nigeria, there is need for effective adaptation strategies for combating climate change. This research work, therefore, explored indigenous knowledge on mitigation and coping strategies to prevailing climatic regime in the area of study for sorghum production. The information accrued from the study is expected to provide empirical information to the farmers, government, stakeholders, non-governmental organizations (NGOs) and policy makers to address issues related to climate change (CC) in similar agro-climatic condition—Guinea savannah. It will also serve as a guide and innovative tools for policy formulation and future predictions in climate change related issues. It is expected to build on the existing studies and the advancement of past research studies is not left out as well. Climate change is perhaps the most serious environmental threat to the fight against hunger, malnutrition, disease and poverty in Africa, mainly through its impact on agricultural productivity. Small-holder farmers, majority of which engaged in rain-fed agriculture, in Nigeria, are facing several climate related hazards, in particular highly variable rainfall with several droughts which can have devastating effects on their livelihood. Thus, climate change manifests negative effects on sorghum production such as increase in the frequency of droughts and severity of floods, induces the pests and diseases outbreak and enhances the likelihood of poor yield.

Also, most of the studies on climate change focused on climate trends, vulnerability, perception, mitigation and also adaptation. Based on researcher's knowledge, there is little research on the assessment of climate change adaptation strategies required for appropriate public policy and action for eliminating poverty, ensuring food security and endemic malnutrition. However, the little empirical information available failed to consider the experience of sorghum farming household data in Kwara State, Nigeria especially in the area of determinants of sorghum farmers' decision and investment on adaptation strategies to climate change in the study area. Also, there is a scantiness of information on the degree of using climate change adaptive measures on sorghum production for combating climate change effects. Hence, the study intends to identify adaptation strategies to climate change among sorghum farmers, identify the constraints to the usage of adaptation strategies against climate change in sorghum production; estimate the costs implication of adaptation strategies to sorghum yield, examine the determinants of sorghum farmers' decision to the usage of adaptation strategies to climate change and determine the determinants of investment on adaptation strategies.

Research Methodology

Study area

The study was carried out in Kwara State, Nigeria. The state is situated in the North Central geopolitical zone and Guinea Savannah of Nigeria which is suitable for sorghum production. The climate of the state is characterized by the wet (double rainfall maxima) and dry seasons, each last for six months. The rainy season begins at about the end of March and lasts till October, while the dry season begins in November and ends in early March. The vegetation is derived Guinea Savanna with large expanse of arable land and rich fertile land that is suitable for cereal production (for example sorghum). It lies between parallels 8° and 10° North latitudes and 3° and 6° East longitudes. It has a land area of about 36,825 square kilometers (14,218 Sq mi). According to the 2006 National Population Census figure, Kwara State has a total population of 2,591,555. This is made up of 1,330,814 males and 1,260,741 females. The state is bounded in the North by Niger state, in the South by Osun and Ondo states, in the East by Kogi State and in the West by Oyo State. Kwara State shares an international boundary with the Republic of Benin. Kwara State is located between latitudes 7° 45'N and 9° 30'N and longitudes 2° 03'E and 6° 25'E. The topography is mainly plain lands to slight and 1500mm. Average temperature ranges between 30 and 35°C (KWADP, 1996). The North Central Zone including Kwara State produces about 19% of the country's sorghum output (Gourichon, 2013).

There are a total of one thousand, two hundred and fifty eight rural communities in Kwara State (National Population Commission, 1991). It has about 260,528 farm families (KWADP, 2006) and about 36,820 hectares of farmland (FOS, 1995). The state is made up of the citizens of the Fulani, Hausa, Nupe, Baruba, and small population of Yoruba and Kanuri but all speaks Yoruba language fluently. More than 90% of the rural populations who constitute about 80% of the total population are engaged in farming (Yusuf, 2000). Kwara State has 16 Local Government Areas which are as follows: Baruten, Kaiama, Edu, Patigi, Asa, Ilorin East, Ilorin South, Ilorin West, Moro, Ekiti, Ifelodun, Irepodun, Isin, Offa, Oke-Ero and Oyun LGAs. The State is divided into four zones by Kwara State Agricultural Development Project (KWADP) in consonance with ecological characteristics, cultural practices and project's administrative conveniences. The zones are as follows: Zone A: Baruten and Kaiama LGAs; Zone B: Edu and Patigi LGAs; Zone C: Asa, Ilorin East, Ilorin South, Ilorin West and Moro LGAs; and Zone D: Ekiti, Ifelodun, Irepodun, Isin, Offa, Oke-Ero and Oyun LGAs (23 blocks and 184 cells). Sorghum production is significant in all the 4 zones.

Agricultural production is largely peasant and small scale relying on the use of manual labour, and crude implements, while fertilizers, mechanical implement, improved seeds and agrochemicals are used to some extent. Maize, rice, and guinea corn among other crops, forms a staple crop in the state and its production is widely practiced. The agro-based industrial materials in the state include castor oil, shea butter, kenaf, plantain, maize, rice, sorghum, banana, cassava, ground nut, yam, soya beans and cowpea etc.

Methods of data collection

Primary and secondary data were used for this study to satisfy the ideal of this work. Primary data were collected from field survey through properly structured questionnaires which were administered

randomly to the sorghum farmers in the study area while the researcher monitor to the details. Information were also obtained through informal discussion and interview. Secondary data were sourced from organization like IPCC, UFPCCC, FAO, FOS, textbooks, journals, magazines, bulletins international network information (i.e. Internet) services and other literature materials (published and unpublished works), annual reports and a host of others. Thus, the instrument for data collection was a structured interview scheduled to collect information on and socio-economic and demographic characteristics from sampled farmers, that were consisting of the adaptation strategies on climate change, the constraints to effective use of adaptation strategies against climate change in sorghum production, costs of each strategies and yields and categories of level of usage of adaptation strategies to climate changes. The quantitative data were collected through personal interviewing of the respondents, with the aid of well-structured interview schedule while qualitative data were collected through Focus Group Discussion (FGD) with the sorghum farmers.

Climatic data were collected from Nigerian Meteorological Agency, Ilorin International Airport, Ilorin which covers the period between the year 1996 and 2014 to ascertain that the climate is changing. This was done to justify the implication of climate change from the variation of climatic conditions in the study area.

Pre-test: The instrument was administered to about 10 sorghum farmers different from the sampled size and the results were collated. Two weeks later, the same instrument was administered to the same respondents and the results were correlated with the first one. The instrument was reliable by the coefficient of correlation found. Thus, it was considered reliable and finally used for the sample selected for the study.

Sampling procedure.

The target population for the study is the sorghum farmers in Kwara State. The primary data were obtained from sorghum farmers' survey that was conducted in the study area. A three-stage sampling techniques was employed in selecting the sampled sorghum farming households for this study. The first stage involved a random selection of Zone C (25%) out of the four agricultural Zones in Kwara State because sorghum production is significant in all the 4 Zones. The second stage involved a random selection of 2 communities in each of the five Local Government Areas that make up the Zone selected. The third stage involved a random selection of sorghum farmers (29 respondents) in each of the selected communities. A total of 145 sorghum farmers were selected and interviewed for the study. Therefore, the 145 sorghum farmers constitute the population.

The data that were collected covered issues on constraints, effects and the determinants of adaptation strategies to climate change among sorghum farmers in Kwara State. The sample outlay for the study is as presented in Table 1.

Analytical techniques.

Data gathered for the study were analyzed using both descriptive and inferential statistics. The descriptive statistics used are tables of frequencies, cumulative frequencies, percentages, bar chart, mean, and mode, likert scale techniques (measuring scale), while correlation analysis and multinomial logistic regression are the inferential statistics used. The analytical tools employed in analyzing the

Table 1. Study sample design outlay

Agricultural Zone: Zone C.			
ADP Zone	LGA in Zone C	No of Communities	No/Proportional Sorghum Farmers Selected
Zone C	Asa	2	29
	Ilorin East	2	29
	Ilorin South	2	29
	Ilorin West	2	29
	Moro	2	29
Total		10	145

Source: Field Survey (2015).

Population: Sorghum Farmers

Target Population: Sorghum Farmers in Kwara State.

Sample Population: 145 Sorghum Farmers selected in Kwara State (Unit of Analysis).

data include the following:

- Descriptive statistics
- Likert-type scales techniques
- Correlation analysis
- Multinomial logistic regression

Descriptive statistics.

Descriptive Statistics was used in describing the adaptation strategies to climate change in sorghum production. A descriptive disposition of the socio-economic and demographic characteristics of the sorghum farmers in the study area using tables of frequencies, cumulative frequencies, percentages, bar chart, ranking, mean and standard deviation. This tool is used to examine both the socio-economic and demographic characteristics of sorghum farmers in order to discover the level of adaptation strategies employed as a result of climate change.

Likert-type scales.

This tool was used to explain the constraints to climate change adaptation strategies in the study area. Likert-type scales is one of the most popular measurements because it is easy to measure attitudes. The likert-type scale is made up of a series of opinion statements about some issues. Thurstone scale, a person's attitude is measured by asking respondents to indicate the extent of agreement or disagreement with each item. In this study, this is done by having the person rate each item on a 5point scale of response (very great extent, great extent, some extent, little extent, not at all).

A person's attitude score is the sum of respondent individual ratings. Likert-type Scale assumes that each statement that is used in the scale is linear function of the same attitude dimension. This assumption is the basis for the operation of adding up a person's individual scores (or summing the ratings, to put it more formally) to obtain the final score. Likert-type scale can provide information on the ordering of people's attitudes on a continuum, but this is unable to indicate how close or how far apart different attitudes might be strong.

The study selected whether to design positive or negative statements, then to determine the scores of each statement to assess attitude towards an experimental task. Each respondent had a minimum

score of 20 points and maximum score of 100 points. The respondents' perception was therefore judged by the mean scores.

Correlation analysis

This tool is used to analyze the effects of the extent of usage of adaptation strategies to climate change on sorghum yields.

The sample correlation coefficient (**r**) is a measure of the degree of the linear relationship between dependent variable Y and the independent variable X. It is a measure of the mutual relationship between two variables.

$$r = \frac{\epsilon XY}{\sqrt{\epsilon X^2 \epsilon Y^2}}$$

It is a measure of the mutual relationship between two variables.

NB:

Where: Y is the extent of usage of adaptation strategies to climate change by sorghum farmers (measured in nominal value) and X is the Sorghum yields (Kg/ha).

Multinomial logistic regression

This tool is used to analyze to the determinants of sorghum farmer's decision to the usage of climate change adaptation strategies (Field Survey, 2015).

Several methods have been used in measuring climate change adaptation strategies by various researchers. According to Deressa *et al* (2009) and Hassan and Nhemachena (2008) use Multinomial Logistic Model to study the determinants of farmers' choice of adaptation strategies and the determinants of farm level climate change adaptation in Africa using Multinomial Logistic Model on a cross sectional survey data collected in 2002 of over 8000 farmers across 11 countries of Africa respectively.

Multinomial Logistic Model was used to examine the determinants of sorghum farmer's decision or choice to the usage of adaptation strategies to climate change in the study area, Kwara State. The Multinomial Logistic Model is based on the adaptation strategies model (Oluoch-Kosura *et al*, 2001). The adaptation strategies to sorghum farmers is a linear function of socio-economic and demographic characteristics of sorghum farmers.

To test relationship between the probabilities of determining factor and to use the estimated coefficient to generate the probabilities of the respondents using some of the adaptation strategies to climate change.

Ordinary Least Square (OLS) regressions

This is used to determine the determinant of investment on adaptation strategies. On the hand, other hand, it was used to determine the relationship that exists among other covariates (factors)) on the sorghum farmers' investment on adaptation strategies. Ordinary Least Squares Linear Regression is the most widely used type of regression for predicting the value of one dependent variable from the value of one independent variable. It is also widely used for predicting the value of one dependent variable from the values of two or more independent variables. When there are two or more independent variables, it is called Multiple Regression.

Model Specification

Multinomial logistic regression model

Implicitly,

$$Y = f(X_i, D_j) + U$$

$i = 1$ to 7 and $j = 1$ to 5

where, Y is the dependent variable while X is the independent variable (i.e. explanatory variables) and ranges from X_1 to X_7 and D_1 to D_5 .

Explicitly,

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, D_1, D_2, D_3, D_4, D_5, U)$$

Where Y is the dependent variable and denoted by 0, 1 and 2 for low, medium and high level of usage of adaptation strategies respectively. And X_1 = age (years); X_2 = marital status; X_3 = educational level; X_4 = farming experience (years); X_5 = household size (number); X_6 = farm size (ha); X_7 = number of access to market; D_1 = gender (1=yes, 0=otherwise); D_2 = farming as source of income (1=yes, 0=otherwise); D_3 = access to credit facility (1=yes, 0=otherwise); D_4 = member of cooperative societies (1=yes, 0=otherwise); D_5 = contact with extension officers (1=yes, 0=otherwise); U = random error term

Data collected during the field work were collated, coded, and analyzed. The computer software for Social Sciences (SPSS) was used to analyze the data in the study.

Ordinary Least Square

The model is implicitly stated thus:

$$Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + \dots + b_{14} X_{14} + U$$

Where, Y is the value of the Dependent Variable (Y), what is being predicted or explained, a (Alpha) is the Constant or intercept, b_1 is the Slope (Beta coefficient) for X_1 , X_1 First independent variable that is explaining the variance in Y , b_2 is the Slope (Beta coefficient) for X_2 , X_2 Second independent variable that is explaining the variance in Y , b_3 is the slope (Beta coefficient) for X_3 ,

X_3 Third independent variable that is explaining the variance in Y , U is the random error term. R is the proportion of the variance in the values of the dependent variable (Y) explained by all the independent variables (X s) in the equation together; sometimes this is reported as adjusted R , when a correction has been made to reflect the number of variables in the equation F whether the equation as a whole is statistically significant in explaining Y .

The OLS regression model specification is as follows:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{11}, X_{12}, X_{13}, X_{14}, U)$$

where, Y = Costs incurred per each sorghum farmers (N) and X_1 = age (years); X_2 = gender (1=yes, 0=otherwise); X_3 = marital status; X_4 = educational attainment; X_5 = farming as source of Income (1=yes, 0=otherwise); X_6 = farming experience (years); X_7 = farm income/Season (N); X_8 = household size (number); X_9 = Farm size (ha); X_{10} = access to credit facility (1=yes, 0=otherwise); X_{11} = member of cooperative societies (1=yes, 0=otherwise); X_{12} = contact with extension officers (1=yes, 0=otherwise); X_{13} = sorghum market/season; X_{14} = number of strategies used; U = random error term. $B_1, B_2, \dots, B_{14}$ each is a partial slope coefficient and measures the change in the estimate for a unit change in the value of the given factor (holding other factors constant). e_i = error term, assumed to be uniformly dis-

tributed.

The relationship between the costs of investment on the adaptation strategies and each of the exogenous variables (X_i) were examined using four (4) functional forms; linear, semi-log, double-log, and exponential.

Linear:

$$Y_i = a + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_{14} X_{14} + e_i$$

Semi – log:

$$Y_i = a + \beta_1 \log X_1 + \beta_2 \log X_2 + \beta_3 \log X_3 + \dots + \beta_{14} \log X_{14} + e_i$$

Double-log:

$$Y_i = a + \beta_1 \log X_1 + \beta_2 \log X_2 + \beta_3 \log X_3 + \dots + \beta_{14} \log X_{14} + e_i$$

Exponential:

$$\log Y_i = a + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_{14} X_{14} + e_i$$

The best equation which should be the Best Linear Unbiased Estimate (BLUE) functional form was chosen based on statistical significance, economic theory and a priori expectation of variables.

Data collected during the field work were collated, coded, and analyzed with the aid of Computer Software for Social Sciences (SPSS).

Results and Discussion

This chapter deals with the presentation, analysis, interpretation and inference of the data collected during the field survey of the study.

Socio-economic characteristics of sorghum farmers

Table 2 presents the socio-economic characteristics that express information such as farming as sources of income, farming experience, farm size, access to credit facility, membership of cooperative societies, contact with extension officers and number of access to market per week playing a very important role in the performance of the sorghum production. These characteristics may influence the sorghum farmers' adaptive strategies to climate change in one way or the other.

From Table 2, majority of the respondents have farming as their primary occupation (99%) in the study area. This shows that majority of the respondents were farmers. This could be because over 70 % of Nigeria populations are rural dwellers where farming is a major occupations (Mark, 2011). Farming is also one of the simplest and commonest occupations to practise in the study area. It can be deduced that most of the population are highly vulnerable to the impacts of climate change as their major source of income is farming. On the other hand, the respondents are involved in several secondary occupations because they have to diversify their livelihood to cope with not only the effect of climate change or but also the other challenges associated with farm work. Diversification is one of the adaptation strategies to climate change by farmers as stated by Rudolf and Hermann (2009) that the main strategies for reducing climate risk is to diversify production and livelihood system.

The modal farming experiences of the respondents are between 21 and 30 years. Farmers that fall below the mean have relatively smaller years of farming experience while farmers that were above the

Table 2. Socio-economic characteristics of sorghum farmers (n=145)

Characteristics	Frequency	Percentage	Cumulative Frequency
Farming as source of Income			
Farming	144	99.31	144
Non-farming	1	0.69	145
Total	145	100	
Farming Experience (years)			
<10	11	7.59	11
11-20	44	30.34	55
21-30	59	40.69	114
31-40	24	16.55	138
>40	7	4.83	145
Total	145	100	
Farm Size(ha)			
1.00 - 2.00	75	51.72	75
2.01 -3.00	42	28.97	117
3.01 - 4.00	22	15.17	139
>4.00	6	4.14	145
Total	145	100	
Access to Credit facility			
Yes	102	70.3	102
No	43	29.7	145
Total	145	100	
Membership of Cooperative Society			
Yes	89	61.38	89
No	56	38.6	145
Total	145	100	
Contact with Extension Officers			
Yes	35	24.14	35
No	110	75.86	145
Total	145	100	
Number of Access to Market/Week			
None	33	22.8	33
1	47	32.4	80
2	58	40	138
>2	7	4.8	145
Total	145	100	
Number of Users of Adaptation Strategies			
Low	53	36.55	53
Medium	28	19.31	81
High	64	44.14	145

Source: Field Survey, 2015

mean have many years of farming experience. This implies that, the more experienced the farmer is, the more he or she is better informed about climate changes and the more he or she is likely to employ adaptation strategies that reduce the impact of climate change on sorghum production. This likely suggests that the respondents could have knowledge about climate change and its effects. Study conducted by Maddison (2006) indicates that, more farming experience increases the probability of a farmer to adapt to climate change. Similarly, Hassan and Nhemachena (2007) found that, it is farming experience that matters more than merely the age of the farmer when it comes to adaptation to climate change.

This likely suggests that the respondents could have knowledge about climate change and its effects.

Farm size is the total landholding of farming household. This variable is measured in hectares. Farm size determines the land allocation of the modern crop varieties. The bigger the size of the farm, the greater the proportion of land allocated for modern crop varieties (Gershon *et al*, 1985), the adaptation strategies that the farmer is likely to adopt. The bigger the farm size, the more likely the farmer is to adopt suitable strategies. The expected sign is positive and the variable will be continuous recording the number of hectares of the farm. The results, in the table 2, revealed that 52% of the respondents have farm size of between 1 and 2 hectares. This implies that farmers in the study area were small-scale farmers operating at subsistence level.

Also, access to credit eases the financial constraints faced by the farmer. Availability of credit enhances probability of a farmer to adopt strategies that reduce the negative impact of climate change to his/her household. About 70% of the respondents gained access to credit while about 30% did not. The farmer will be in a position to finance adoption of new technologies such as the use of improved seed varieties and fertilizer application. Findings by Gbetibouo (2009), Deressa *et al* and Fosu-Mensah *et al* (2010) show that access to credit significantly influences the farmer to adapt to climate change. The expected sign is positive and this dummy variable coded 1 if the farmer has access to credit and 0 otherwise.

Furthermore, access to Cooperative Societies enhances probability of a farmer to adopt strategies that reduce the negative impact of climate change to his/her household because he/she is likely to be informed through the Societies. About 61% of the respondents gained access to Cooperative Societies while about 39% did not. The farmer will be in a position to finance adoption of new technologies through the help of the cooperative societies, such as the use of improved seed varieties and fertilizer application. The expected sign is positive and this dummy variable coded 1 if the farmer has access to cooperative societies and 0 otherwise.

Of greater concern is the extension service system that when improved technologies on climate change (adaptation strategies) are available they often fail to reach farmers. It is evidenced from the Table 2 that about 24% gained access to extension services while 76% did not. Aymone (2009) argue that farmers who have access to extension services are more likely to be aware of changing climatic conditions and to have knowledge of the various management practices that they can use to adapt to changes in climatic condition. The expected sign is positive and this dummy variable coded 1 if the farmer has access to extension services and 0 otherwise.

The number of times a farmer takes his or her sorghum produce to the market determines the level of production, the farm size and the labour force as well. In the study area, 40% of the sorghum farmers supply their produce to the market 2 times, 32% just once while about 23% of them farm to feed themselves and their family. About 37% of the sorghum farmers used low level of adaptation strategies, 19% were on medium level of usage while 44% used high level of adaptation strategies in the study area. This implies that most sorghum farmers frequently used the adaptation strategies to combat climate change effects in the study area. Carter (1997) pointed out that farmers react to climate change through adaptation.

Demographic characteristics of sorghum farmers

Table 3 presents the demographic characteristics that express information on age, gender, marital status, educational level and household size play a very significant role in the level of usage of adaptation strategies to climate change in sorghum production. These characteristics may in one way or the other reflect the relationship between sorghum farmers' adaptive strategies to climate change and sorghum production.

Table 3. Demographic characteristics of sorghum farmers (n=145)

Characteristics	Frequency	Percentage (%)	Cumulative Frequency
Age			
21 -30	7	4.83	7
31-40	15	10.34	22
41-50	55	37.93	77
51-60	48	33.1	125
61-70	13	8.98	138
>70	7	4.83	145
Total	145	100	
Min	21		
Max	78		
Gender			
Male	123	84.8	123
Female	22	15.2	145
Total	145	100	
Marital Status			
Single	3	2.1	3
Married	142	97.9	145
Total	145	100	
Educational level			
No Formal Education	8	5.5	8
Qur'anic Education	59	40.7	67
Adult Education	13	9	80
Primary Education	42	29	122
Secondary Education	19	13.1	141
Tertiary Education	4	2.7	145
Total	145	100	
Household Size			
<5	23	15.86	23
5-10	102	70.34	125
11-15	18	12.41	143
>15	2	1.39	145
Total	145	100	

Source: Field Survey, 2015

The age of an individual, to a large extent, determines his output. This variable is included to control for the possibility of decreasing marginal effects of age. A negative relationship between age squared and the likelihood of the farmer to adapt to climate change is expected. Young farmers are more likely to be willing to adapt to climate change as older farmers may be less willing to adapt given the heavy labour requirements that may be involved. Sorghum farmers that were below the mean age were younger farmers, who are at their prime age, while those at above the mean age were older farm-

ers. The modal age group of the respondents is between 41 – 50 while the average is 51 years. These imply that majority of the respondents were in the productive age ranging from 41 to 50 years because they are still agile and capable of engaging in climate change adaptation strategies. Thus, there exist a great potential to increase sorghum production in Kwara State. Mudzonga (2011) found that, younger farmers are more likely to be willing to adapt to climate change as older farmers may be less willing to adapt. Also, Adesina and Zinnah (1993) opined that, as farmers grow older they are less amenable to change from their old practices. However, Deressa *et al.*, (2010) stated that, age of the respondents represents experience in farming, the older the farmer, the more experience he/she is in farming and the more he or she is exposed to the challenges of past and present climatic condition over longer horizons of his or her life span.

The results of the findings show that male and female gender engage in climate change adaptation strategies. However, the number of male (85%) is more than that of female (15%). Thus, most of the respondents are male. This could result from the fact that the male are more capable of carrying out tedious activities associated with climate change adaptation strategies than the female. According to the prevailing culture in the study area, men are to cater for the households' needs and may be assisted by other members of the household. The finding is in tandem with Olaleye (2000) who revealed that, female were usually involved in farming as helpers or suppliers of labour in light farm operations such as planting, weeding, harvesting, processing and marketing and not in muscular labour demanding activities like threshing, farm clearing and digging among other activities.

Majority of the respondents are married with about 98%. This likely implies that the respondents have family labour to assist in climate change adaptation strategies as this would save cost. It is observed that married individuals are more concerned with feeding for food than the singles or divorced individuals who may tend to consider their personal wellbeing alone. This finding corroborates Ofuaku (2011) who found that, married farmers had responsibilities that must be reflected in their farming activities. Education is expected to have a significant influence on the use of climate change adaptation strategies. Empirically, education has been proven to be related to early adopters and to greater productivity of improved production of cereals. Maddison (2006) argues that education diminishes the probability that no adaptation is taken. About 84.2% of the respondents have less than secondary education. The result implies that sorghum production is a popular enterprise in the study area. This finding corroborates Edeghon *et al.*, (2008) that, most farmers had one form of education or another which should be used to boost agricultural production.

Farm household size is measured by the number of members in a household. The variable is continuous. It is assumed to represent the labour input to the farm. The average (i.e. mean) household size of the respondents falls between 5 and 10 while the modal household size falls between 5 and 8 with 102 respondents. This likely implies that the respondents have family labour to assist in climate change adaptation strategies as this would save the cost. This implies that farmers in the study area have large household size. Farmers that have members in their household below the mean have small household size while farmer with household with household size above the mean have larger household size. Large household size is mostly inclined to divert part of its labour force into farming activities as a means of adaptation strategies to climate change. This corroborates Gbetibouo (2009), who found that, household size enhances the farmers' adaptive capacity to respond to climate change.

The capacity of farmers to adapt to climate change can be significantly influenced by the level of awareness about climate change in their communities. The UNDP (2010) reported that the level of awareness about climate change is rather low in Nigeria, and it is likely to continue if no intervention measures are taken. In order to improve agricultural production, it is very important for the stakeholders especially the farmers to acknowledge the existence of climate change and react appropriately to its effects. However, developing countries in Africa, like Nigeria, have low level of coping capabilities which has resulted in crop failure and generally reduced agricultural productivity (Enete and Amusa, 2010). Though, sorghum is a drought-resistant crop but the impacts of the changing climate cannot be over emphasized. Thus, there is need for a response through adaptation because the ability to adapt is low in Kwara State, Nigeria. The levels of awareness of climate change and adaptation strategies adopted by the farmers are as presented in Table 4.

Table 4. Sorghum farmers' awareness to climate change

Variables	YES		NO	
	Frequency	%	Frequency	%
More frequent drought	85	58.62	60	41.38
Delayed on-set of rainfall	129	88.97	16	11.03
Earlier on-set of rainfall	118	81.37	27	18.63
Erratic rainfall pattern	132	91.03	13	8.97
Hailstorm	67	46.20	78	53.08
Too much rain	83	57.24	62	42.76
Less rain	84	57.93	61	42.07
Higher temperature	86	59.31	59	40.69
A change in climate has adverse effect on crop production	133	91.72	12	8.28
Increased possibility of loss of soil nutrients	128	88.28	17	11.72
Prevalence of insect pests in recent decades	118	81.38	27	18.62
Reduced yields	131	90.34	14	9.66

Source: Field Survey, 2015

The awareness level on climate change in the study area was high as it was reflected in the table. This implies that the large number of farmers is aware of changes of the climatic situation in the study area. Thus, a large number of the farmers will make use of adaptive strategies or combative action against climate change in the study area. Erratic rainfall pattern is the only climatic variable that attracted the highest response with 91%. It is evidenced from the farmers' response that a change in climate has adverse effects on crop production, loss of soil nutrient, prevalence of insects pests and these subsequently resulting to reduced yields with 91%, 88%, 81% and 90% respectively.

Adaptation strategies to climate change in sorghum production

Carter (1997) pointed out that farmers react to climate change through adaptation. Using climate change adaptation as driver to undertake activities with multiple benefits can catalyze progress in achieving a country's sustainable development goals. Adaptation options are many and include behavioural change at the individual level, technological and engineering options, risk management and reduction strategies such as early warning systems for extreme events, promotion of adaptive management strategies, development of financial instruments such as insurance schemes, and promotion of

ecosystem management practices (United Nations Convention on Climate Change, 2010). Table 5 presents the Level of usage of adaptation strategies with their respective percentages (%).

As shown in Table 5, organic manure (60%), fertilizer (83%), crop rotation (86%), and ploughing (87%) are the frequently used strategies among sorghum farmers in the study area while zero tillage (85%), seed treatment (75%), taungya system (86%) and alley cropping (95%) were rarely used by the farmers. About 22 %, 8% and 12% of the sorghum farmers did not use seed treatment, taungya system and alley cropping as adaptation strategies respectively. Only 36% of the farmers used improved varieties occasionally while the use of pesticides is uncommon in the study area. This implies that the farmers used more of the strategies they are familiar with and less of others. Enete and Amusa (2010) indicated that farmers may find it difficult to change or modify the traditional practices they are accustomed to even if such practices have serious implications as climate change adaptation measures.

Table 5. Adaptation strategies used by farmers against the effects of climate change

Adaptation Strategies/ Variables (n=145)	Frequent. Freq.	Used %	Occasional. Freq.	Used %	Rarely Freq.	Used %	Not Used Nil
Improved Varieties	42	28.97	53	36.55	50	34.48	0
Organic Manure	88	60.69	43	29.65	14	9.65	0
Fertilizer	121	83.45	8	5.52	16	11.03	0
Zero Tillage	0	0	21	14.48	124	85.52	0
Seed Treatment	4	2.75	0	0	109	75.17	22.08
Pesticide	48	33.1	49	33.79	48	33.1	0
Crop rotation	125	86.2	15	10.34	5	3.45	0
Taungya System	0	0	7	4.82	126	86.89	8.29
Alley Cropping	3	2.06	6	4.13	118	81.38	12.33
Ploughing	127	87.59	18	12.41	0	0	0

Freq. = Frequently and Occasion = Occasionally

Source: Field Survey, 2015

Constraints to climate change adaptation strategies

As shown in Table 6, the most rated constraints (1st) in the course of adapting to climate change is the irregularity of extension services while cultural influence is rated the least with 10th position. Subsidies on planting material and government policy on climate change adaptation strategies were rated 2nd and 3rd respectively. It is therefore inferred that extension service is inadequate to the farmers in the study area. In addition; there is need for subsidized planting materials for the farmers because they are poor. There should be a well pronounced and all-encompassing government policy on climate change adaptation strategies so that more extension workers would be made available to the farmers.

Table 7 shows that the respondents on the constraints encountered in the process of adapting to climate change. The mean scores for the use of stubbles to control erosion, irregularity of extension services, no subsidies on planting materials, lack of access to information, limited knowledge adaptation measures, low institutional capacity and absence of government policy on climate change adaptation strategies suggest these aforementioned points are known to the level of very great extent in the study area while cultural influence is not at all considered as one of the constraints encountered by the sorghum farmers. The bench mark is 3.0 as any score above 3.0 is severe while score below 3.0 like

absence of water management techniques, low level of cultural awareness and cultural influence are not severe.

Table 6. Result of likert-type scale for constraints faced by sorghum farmers (n=145)

S/No	Constraints	VGE	GE	SE	LE	NA	Total	Mean Score	Rank
1	Use of stubbles to control erosion	55	43	11	34	2	550	3.79	4 th
2	Low level of awareness	12	7	47	61	18	369	2.54	9 th
3	Irregularities of extension services	87	21	17	13	7	603	4.15	1 st
4	No subsidies on planting materials	79	35	12	4	15	594	4.09	2 nd
5	Absence of water management technique	28	36	27	25	29	411	2.83	8 th
6	Lack of access to information	43	38	21	20	23	493	3.40	7 th
7	Limited knowledge on adaptation measures	52	43	13	18	19	529	3.64	5 th
8	Cultural influence	12	18	18	23	74	306	2.11	10 th
9	Low institutional capacity	54	24	19	34	14	505	3.48	6 th
10	Absence of government policy on climate change adaptation strategies	61	38	16	15	15	550	3.80	3 rd

Source: Field Survey, 2015

Table 7. Summary of the sorghum farmers' constraints encountered in the course of adapting to climate change.

S/NO	Constraints	Mean Score on Likert Scale	Majority of Respondents	Rank
1	Irregularity of Extension services	4.15	VGE	1 st
2	No subsidies on planting materials	4.09	VGE	2 nd
3	Absence of government policy on climate change adaptation strategies	3.8	VGE	3 rd
4	Use of stubbles to control erosion	3.79	VGE	4 th
5	Limited knowledge on adaptation measures	3.64	VGE	5 th
6	Low institutional capacity	3.48	VGE	6 th
7	Lack of access to information	3.4	VGE	7 th
8	Absence of Water Management Techniques	2.83	GE	8 th
9	Low level of awareness	2.54	SE	9 th
10	Cultural influence	2.11	NA	10 th

Source: Field Survey, 2015

Costs implications of adaptation strategies to sorghum farmers

Adoption of appropriate strategies for combating climate change in sorghum production may require empirical evidence. In order to examine the effects of the extent of usage of adaptation strategies, Pearson Correlation Analysis was used where Y is the level of use of the adaptation strategies adopted by the sorghum farmers while the X is the yield of the respective respondents.

The effect of the extent of usage of adaptation strategies to climate change on sorghum yields was determined by adding up each respondent's scores in consistently with the level of each adaptation strategies adopted. Then, the gross scores were divided by the total number of the respondents to get Y while X is determined by the sorghum yields of respective respondents. The effect of adaptation strategies on sorghum production is as presented in Table 8.

Table 8. Effect of usage of adaptation strategies on sorghum production

		ADAPTATION	YIELDS
YIELDS	Pearson Correlation	0.274**	1
	Sig. (2-tailed)	0.001	
	N	145	145
YIELDS	Pearson Correlation	0.274**	1
	Sig. (2-tailed)	0.001	
	N	145	145

** Correlation is significant at the 0.01 level (2-tailed)

Source: Field Result of the Survey, 2015

The result in Table 8 shows that an increase (100%) in the use of all adaptation strategies will increase the yield of sorghum by 27%. This implies that as farmers increase their usage of effective adaptation, there will be a resultant increase in their output. Sultan *et al* (2013) observed that traditional cultivars of millet and sorghum used by local farmers seem more resilient to future climate conditions than modern cultivars. However, there is large difference in mean yields between modern and traditional varieties and the modern varieties would still yield more under optimal fertility conditions in a warmer climate, even if they are more affected by climate change. Mabe, Sarpong and Osei-Asare (2012) also found that farmers with high adaptive capacity or with high ability to adjust to climate change, has more output than those with low capacity. Table 9 shows the costs implication of adaptation effect of climate change.

Results on Table 9 show that about 12% of sorghum farmers that failed to use adaptation strategies, due to the traditional belief that sorghum is naturally drought tolerant, reaped a low average output when compare with other 88% that employed the adaptation strategies. It was observed that more the usage of the strategies, the better the output as well as the average sorghum enterprise income.

Most of the variable costs are synonymous with the adaptation strategies employed by the sorghum farmers. Though, most farmers pay less agronomic attention to sorghum because of its potentiality to withstand drought, high temperature and low level of soil nutrient than less output under the conditions where the rest of all cereals have trouble to survive. Thus, sorghum is a low production cost crop.

Table 9. Costs implication

No of Strategies used	Frequency	Percentage (%)	Av. Cost of usage	Av. Output (50kg=1 bag)	Income (N)
0	18	12.41	-	45 bags	270,000
1-3	52	35.86	N 2,000	676 bags	4,056,000
4-6	41	28.28	N 3,800	1,230 bags	7,380,000
> 6	34	23.45	N 5,000	1,411 bags	8,466,000
Total	145	100.0			

Source: Field Survey, 2015.

Given the same farm size, it was indicated in the Table 10 that there is an increase in the level of output of the Sorghum farmers after the usage of adaptation strategies to the changing climate by about 30%. Thus, with increasing output, there is a corresponding increase in the income of the sorghum enterprise.

Table 10. Impact of the usage of adaptation strategies in sorghum production. (n=145)

Variables	Before the use of AS to CC	After the use of AS to CC
Farm Size (ha)	227 ha	227ha
Output (kg)	149,139	204,300kg
Income	N 894, 834,000	N1,225,800,000

Source: Field Survey, 2015

Determinants of choice of adaptation strategies among sorghum farmers in the study area

Successful adaptation can reduce vulnerability by building on and strengthening existing adaptation mechanisms and assets, targeting climate change vulnerability with specific measures, and integrating vulnerability reduction into wider policies (Mitchel & Tanner, 2006). Taking actions that would improve the usage of appropriate adaptation strategies would require understanding of the factors affecting it. The results of the analysis of determinants of usage of adaptation strategies are as presented in Table 11 using multinomial logistic regression analysis. This analytical tool was used to examine the factors that determine the usage of adaptation strategies in production among sorghum farmers.

Table 11. Multinomial logistic regression results of determinants of sorghum farmers' decision to the usage of adaptation strategies to climate change in the study area

Adaptation Strategies	Coefficient	Standard Error	t-Value
1. Low level of usage			
Intercept	0.392	1.62	0.809
Income	-0.004	0.024	0.865
Loan	-0.18	0.526	0.733
Cooperative	0.512	0.6	0.393
Extension	-0.039	0.507	0.938
Age	-0.071	0.047	0.128
Gender	-0.099	0.609	0.871
Education	-0.006	0.181	0.973
Occupation	-0.382	0.363	0.293
Experience	0.061	0.05	0.225
Household size	0.21*	0.108	0.051
Farm size	0.383	0.277	0.166
Market	-0.367	0.337	0.276
2. Medium level of usage			
Intercept	-2.583	2.034	0.204
Income	-0.017	0.033	0.603
Loan	0.169	0.616	0.783
Cooperative	-0.195	0.681	0.775
Extension	0.1	0.601	0.868
Age	0.043	0.051	0.391
Gender	0.562	0.794	0.479
Education	0.086	0.215	0.688
Occupation	-0.13	0.443	0.769
Experience	-0.055	0.055	0.321
Household size	-0.5	0.123	0.687
Farm size	0.261	0.342	0.446
Market	-0.234	0.401	0.561

* Significant at 10%.

The Reference Category is 3: High Level of Usage of Adaptation Strategies.

Source: Computer Result of the Survey, 2015

Cox and Snell = 0.834

Nagelkerke = 0.942

McFadden = 0.830

Chi-Square = 261.783

P. value = 0.05

1 represents Low level of Usage; 2 represents Medium level of Usage and 3 represents High level of Usage. The Reference Category is High level of use of the adaptation strategies.

Table 11 shows the result of determinants of sorghum farmers' decision to the usage of adaptation strategies to climate change in the study area using Multinomial Logistic regression model. Only the household size is positively significant at ($p < 0.1$) 10%. This implies that the rate of change in climate change adaptation strategies to the unit of household is less than one. Out of the estimate, this explains that one unit increase in household size lead to 0.2010 unit increase in climate change adaptation strategies. As household is positively correlated with climate change adaptation strategies, this could result from the use of family labour to carry out adaptation strategies in order to safe cost. Parameters with significant negative coefficients decrease the likelihood of that response category with respect to the reference category; while parameters with positive coefficient increase the likelihood of that response.

The coefficients of determination (R^2) with value 0.942 indicate that about .94% of the total variations in the determinants of sorghum farmers' choice of adaptation strategies is explained by the fitted model while the remaining 6% which remained unexplained is due to error or other factors not captured in the model. The Nagelkerke's R^2 94% is higher than the Cox and Snell's R^2 indicating a moderately relationship of 83% between the predictors and prediction.

Determinant of sorghum farmers' investment on adaptation strategies

Table 12 shows the OLS Regression Results of the Determinants of Sorghum Farmers' Investment on the Usage of Adaptation Strategies to Climate Change. The selection of the best functional form was based on the value of R^2 (Coefficient of Multiple Determination), F-ratio and signs of Coefficients of regression.

From Table 12, the R^2 was 0.339 indicating that about 34% of the total variations in the usage of adaptation strategies to climate change by farmers is explained by the fitted model, the remaining 66% which remained unexplained is due to error or other factors not captured by the model. The results of the regression analysis showed that marital status, farming experience, farm income, and number of times the farmer take sorghum to market are significant at 1% level of significance; farm size and access to credit facility are significant at 5% level of significance while gender and farming as source of income are significant at 10% level of significance. Farming as source of income, farm income farm size and number of strategies used are positively related with the use of adaptation strategies which implies that increase in any of the parameters would result in increased in sorghum output and subsequently the income of the sorghum enterprise.

Table 12. OLS regression results of the determinants of sorghum farmers' investment on the usage of adaptation strategies to climate change.

Variable	Linear	Semi-log	Double-log	Exponential
Constant	0.265 (2.851)	-0.715 (-2.645)	1.887 (4.251)	3.396 (22.861)
Age	0.038 (1.099)	0.146 (1.414)	0.21 (1.611)	0.611 (1.606)
Gender	1.256** (2.368)	1.8107* (4.185)	9.772* (3.109)	1.176** (2.538)
Marital Status	1.332*** (3.435)	0.388 (1.413)	1.6784*** (7.448)	2.126*** (4.011)
Educational Attainment	0.751 (1.169)	0.546 (1.472)	1.892 (1.546)	1.613 (1.376)
Farming as Source of Income	0.157* (1.713)	0.167* (1.910)	0.182* (1.674)	0.178* (1.932)
Farming Experience	0.243*** (3.604)	0.151 (1.521)	0.164*** (2.741)	0.258 (1.441)
Farm Income/Season	0.326*** (4.144)	0.281*** (3.365)	0.261*** (3.116)	0.310*** (3.921)
Household Size	0.278 (1.274)	0.343 (1.542)	0.325 (1.543)	0.262 (1.071)
Farm Size	0.193** (2.443)	0.211** (2.412)	0.193** (2.321)	0.192** (2.424)
Access to Credit Facility	2.114** (2.414)	0.367** (2.435)	0.192** (2.251)	0.250** (1.967)
Membership of Cooperative	1.831 (1.154)	1.401 (1.118)	1.223 (1.104)	1.641 (1.138)
Access to Extension Services	0.575 (1.064)	0.682 (1.604)	0.847 (1.140)	0.847 (1.524)
Sorghum to Market/Week	1.938 (1.233)	0.218*** (2.911)	1.766*** (4.942)	2.149*** (3.492)
Number of Strategies Used	4.722 (2.454)	6.403 (2.403)	4.409 (2.424)	8.473 (2.473)
R ²	0.326	0.316	0.339	0.324
Adjusted R ²	0.286	0.276	0.301	0.281
F-Ratio	8.087	7.929	8.923	8.741

***, **, * = Variable is Significant at 1%, 5%, and 10% respectively.

Source: Computer Print Out of the Field Survey, 2015

Conclusion and Recommendation

Climate change has adverse effect on sorghum production in the country. Sorghum is a major cereal crop among the crop farmers in Kwara State. In view of the weather dependent nature of sorghum production in the State, climate change indicates in advance the negative implication for its production and availability. All the respondents were not only aware of climate change, but also made use of adaptation strategies to changes in climate. Most of the strategies used by the farmers were based on traditional practices some of which cannot effectively reduce the effect of climate change on sorghum production. The study concluded that household size, extension visits and non-farm income significantly impact on the various strategies used in the adaptation to climate change. Therefore, based on

the findings of this study it was recommended that farmers should be trained and supported on the use of adaptation strategies. Policies that will increase development and farmers' access to extension services and improved sorghum varieties should be encouraged. Sorghum farmers should also be encouraged to apply more of the other adaptation strategies like use of treated seeds, zero tillage, alley cropping and improved sorghum varieties. This will increase their adaptive capacity and in effect increases the yield of sorghum in the area.

Furthermore, the farmers should be assisted to increase the area of farm land to cultivate sorghum; this will also increase their capacity to cope with climate change in the study area. Also, farmers should be empowered through sensitization workshops on the effective strategies for combating climate change in the study area. Additionally, the research institute should develop more improved sorghum cultivars/varieties and that would be accessible to farmers. More so, the sorghum farmers should share their knowledge within the farming community and with researchers working in this field. This will provide synergy that will guide the process of identifying and implementing climate change adaptation strategies. Farmers should form association and campaign to draw the attention of government and stakeholder to the impact of unmitigated and ill-coped climate change on the agronomy of sorghum. Anything done to develop sorghum farmers will equally help builds up their adaptive capacity and resilience to the impact of climate change. Finally, policies in support of incentive for training on agriculture and capacity building for farmers as well as integration of indigenous and modern knowledge on climate change adaptation strategies should be made by the government.

However, this study may be repeated using other crops. Finally, comparative analysis of two different crops should be investigated in the light of adaptation strategies to climate change in the study area.

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