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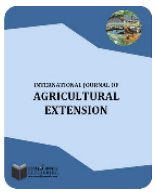

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ANALYSIS OF THE PERCEIVED EFFECTS OF CLIMATE CHANGE ON CROP PRODUCTION AMONG FAMERS OF ARGUNGU ZONE OF KEBBI STATE AGRICULTURAL DEVELOPMENT PROGRAMME - ADP

[a]Ango A. Kamba, [a]Jibril F. Yelwa, [b]Ibenihi E. Ojomugbokenyode, [a]Ibrahim L. Yaji
[a] Department of Agricultural Extension and Rural Development, Usmanu Danfodiyo University, Sokoto, Nigeria.
[b] Department of Agricultural Extension and Rural Development, Faculty of Agriculture and Agricultural Technology, Federal University, Dutsin-Ma, Katsina State, Nigeria.

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ABSTRACT

This study analyzed the perceived effects of climate change on crop production and other agricultural activities in the study area. Multi-stage sampling technique was used to arrive at the sample size of 120 farmers. Structured questionnaire was used to collect data from the farmers and the collected data obtained was analyzed using both descriptive and inferential statistics. Findings unveiled that the mean age of the farmers was 33 years and majority (78.3%) of them were married. Majority (82.5%) of the farmers were male and literate with both western and Qur'anic education. Around 69.2% of the farmers had a farm size of 1-3hectares and majority (69.20%) had farming as their prominent occupation. There was non-significant relationship (P>0.05) between the perceived effects of climate change on crop productions and climate change adaptation measures. This study concludes that the farmers experienced the effects of climate change in their farming practices and hence the study recommends that extension workers should provide more information to the farmers on the adaptation strategies to adopt in curtailing the effects of the change on agricultural activities.

Corresponding Author: Ango A. Kamba
Email: aakamba2@gmail.com

INTRODUCTION

Climate change is witnessed due to the recurrent occurrence of droughts and floods threatening the livelihood of many farmers that depends on rainfall for farming practices due to the high concentration of Carbon dioxide (CO_2) in the atmosphere. However, CO_2 is the predominant greenhouse gas leading to increased temperature in the atmosphere for a long period. The increased in temperature influences the distribution of rainfall to be erratic with short term and long-term adverse effects on the farming activities, crops growth and yield (Intergovernmental Panel on Climate change-(Intergovernmental Panel on Climate Change - IPCC, 2007). Change in the state of climate that can be identified by changes in the mean and or the variability of its properties that persist for an extended period of time (Intergovernmental Panel on Climate Change - IPCC, 2007). Also, United Nations Framework Convention on Climate Change - UNFCCC (2006) reported that climate change directly or indirectly affects human activities due to anthropogenic factors that alter the composition of the global atmosphere and in addition, it has effect on the natural climate variability observed over a comparable period.

The impacts of global climate change on agricultural production are of a serious source of worry to farmers in sub-Saharan Africa. This is because their economies mainly depend on agriculture which is now affected by climate change catastrophes. Climate change in recent years has a lot of adverse effects on farming practices as expressed by different farmers in the study area. The question is how farmers are coping with its effects? The answer to this question was provided by studies carried out by Maginness and Stephens (2008) and Lal *et al.* (2011), who recommended that efforts should be geared towards developing and making available crop varieties and livestock breeds that are tolerant to adverse condition associated with climate change. Crop production could be affected by climatic extremes such as flooding during wet seasons and drought during the dry seasons. These effects could be avoided due to application of skilful seasonal climate forecast information that could become important to farmers' production decisions because weather information would help farmers in their decision-making regarding farm activities while farm management practiced could be better practiced with the aid of seasonal climate forecast (Portele *et al.*, 2021).

Climate is termed as the statistics of weather, usually over a 30-years interval and it is measured by assessing the patterns of variation in temperature, humidity, atmospheric pressure, wind, precipitation, atmospheric particle count and other meteorological variables in a given region over long periods of time (Carey, 2009). Climate differs from whether in that, the weather only describes the short-term conditions of these variables mentioned above in a given period. According to Colbert *et al.* (2013), climate encompasses the temperature, humidity, atmospheric pressure, wind, rainfall and numerous other meteorological elements in a given area over a long period of time, as opposed to weather, which refers to the condition of a particular place over a short period. Based on the definitions of climate and weather, subsistence farming practices will be vulnerable to adverse effects of climate change and the immediate weather because of its nature of relying on rainfall, temperature and humidity which are sensitive to climate change. According to Daily Trust (2018), Kebbi State farmers are cautioned on the adverse effects of climate change by Oxfam International Organization (OIO) working with other stakeholders of Agriculture in the state to improve the livelihood of farmers that are vulnerable to climate change. Consequently, the OIO report revealed that farming practices in the state are projected to decline by 50% by the year 2018 due to adverse effects of climate change in the State (Daily Trust, 2018). The actual and potential impacts of climate change in Kebbi state are considerable and have far-reaching effects. As such, all sectors of the farmers' socio-economic development, including agriculture are vulnerable to climate change. Climate change effects on agriculture is a fact well known to every farmer due to its year-to-year variation in growth and development of the crops and the consequent harvest of the farmers are largely affected due to variation in temperature and precipitation that makes the difference between bountiful crops and economic ruin.

Climate change is a major hindrance to the production and profitability of farmers and it may serve as a factor that hinders crop yield and as such bring to an end to agricultural activities. It's a problem that if farmers have no means to face and tackle could affect their yield and can maximally decline both the farmer's productivity and outcomes. Notwithstanding, it's believed that climate change can be controlled through the adoption of adaptation measures proposed and laid down by experts. It's based on the aforementioned problems of climate change on faming activities that the following study objectives were addressed: (i) Describe the socio-economic characteristics of farmers in the study area (ii) Examine the farmer's awareness of the effects of climate change in the study area (iii) Determine the farmer's perceived effects of climate change on crop production and other agricultural activities in the study area (iv) Determine the differences in climatic effects between the common agricultural activities in the study area and (v) Identifying the climate change adaptation strategies adopted by the farmers in the study area.

Hypothesis

H_0I: There is no significant relationship between the perceived effects of climate change on crop production and other agricultural activities and climate change adaptation strategies adopted by the farmers in the study area.

METHODOLOGY

Description of the Study Area

This study was conducted in Argungu zone of Kebbi State Agricultural and Rural Development Authority –

KARDA. Kebbi state is located in the north western region of Nigeria, and it is located on latitude$10^0 05'$N and $13^0 27'$N and Longitude $3^0 35'$E and $6^0 03'$E. The state is located in the Sudan Savannah agro-ecological zone of Nigeria. The state has an area of 36,800 km^2 with a projected population of about 4,723,968 people (Daily Trust, 2017). Kebbi state is characterized by two climatic seasons, dry season (November – April) and the rainy season (May – October). The annual rainfall of the state is 800mm to 1100mm. The annual minimum temperature of the state is 23.9^0C and the annual maximum temperature is 34.8^0C with a mean temperature of 26^0C. There is significant variation in the soil quality in the study area, and the land is broadly divided in two; Fadama (low land) and Tudu (upland).

The study area has networks of Rima River Basins, River Niger, River Zamfara and its tributaries that traversed a long distance and are used for farming, fishing and herding activities for the agricultural development of the area. Majority of the inhabitant of the study area are peasant farmers and farming are generally in subsistence level and mostly done through traditional method using traditional farming tools. The major occupation of the people in the study area is farming and rearing of domestic animals. Different types of crops such as millet, maize, rice and wheat, cowpea, groundnut, soybean, yam, cocoyam, sweet potato and cassava) and livestock and fishery activities are also practiced in the state. The inhabitants of the state include Hausa, Fulani, Dakarkari (Lelna), Zabarma, Kambari and other Nigeria tribes.

Sampling Procedure and Sample Size

A multistage sampling technique was used to arrive at the sample size of 120 respondents for the study. At the 1st stage, Argungu zone of Kebbi state ADP was purposively selected from the zones in the state due to the effects of climate change on different agricultural activities in the area. In 2nd stage, two Local Governments Areas - LGAs (Arewa and Argungu) out of four LGAs that formed the zone were randomly selected. In 3rd stage, three districts in Arewa LGA (Laima, Yeldu and Kangiwa); and three districts in Argungu LGA (Gulma, Lailaba and Argungu) were randomly selected from each of the selected LGAs.

The 4th stage includes the selection of two villages from the selected districts. The fifth stage involves the random selection of 20 farmers from the selected villages making the sample size of the study to constitute 120 farmers.

Method of Data Collection

Both Primary and secondary source of information was used for this study. The primary data was collected through the use of structured questionnaire which was administered to the farmers through an interview schedule questionnaire administration method. While the secondary information was obtained through the related literature, published and un-published materials, journals, textbooks, ADP official documents, students' projects, dissertations and theses and internet sources.

Measurement of the Study Variables

The dependent variable of the study is the effects of climate change on crop production while the independent variables included the socio-economic characteristics of the farmers; farmer's awareness of the effects of climate change; farmer's perceived effects of climate change on crop production; differences in climatic effects between the common agricultural activities and the climate change adaptation strategies adopted by the farmers.

Data Analysis

Data were analyzed using both descriptive (frequency counts, percentages mean values and standard deviation) and inferential (Multiple regression analysis and t-test) statistical analyses. Descriptive statistics were used to achieve objective 1, 2, 3 and 5. t- test was used to achieve objective 4 while Multiple regression analysis was used to test Hypothesis I of the study.

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10} + b_{11}X_{11}$$

Y= Perceived effect of climate change on crop production

b_0= Regression intercept

b_1-b_{10}= Regression coefficients

X_1 = Sex

X_2= Marital Status

X_3= Age

X_4= Educational attainment

X_5= Household size

X_6= Major occupation

X_7= Membership association

X_8= Extension contact

X_9= Land acquisition

X_{10}= Farm size X_{11}=use of climate change adaptation strategies

Table 1. Description of variables.

Variables	Description
Age	Measured as an interval variable, according to the number of years of the farmers
Sex	Measured as either male or female: male = 1 and female = 2
Marital status	Measured as single =1 married =2, divorced =3 and widowed = 4.
Educational attainment	Measured as primary education = 1, secondary = 2, tertiary education = 3, adult education = 4 and Qur'anic education only = 5
Household size	Measured based on the number of people in the household
Major occupation	Measured base on civil servant =1, trading = 2, hand work = 3
Secondary occupation	Measured base on civil servant =1, trading = 2, hand work = 3
Membership of association	Fadama Users Association =1, Water Users Association =2, farmers club =3
Extension contact	Measured based on number of visits by extension agents: weekly=1, monthly=2, yearly=3
Land acquisition	Inheritance = 1, purchased =2, rent = 3, borrowed = 4
Farm size	Measured based on hectare
Perceived effects of climate change on crop production	changing in planting time = 1, changing in harvesting time =2, poor crop yield = 3
Information on the level of climate change awareness	don't know = 1, know little = 2, reasonable extent = 3, and great extent = 4
Information on the farmers' perceived effect of climate change on crop production and other agri. practices	Change in crop growing season = 1, poor crop growth = 2, changes in crop harvesting time = 3 and poor crop yield = 4
Information on the effects of climate change on common agricultural activities	Mild = 1, Moderate = 2 and Severe = 3
Information on climate change adaptation strategies adopted by the farmers	use of crop resistant varieties = 1, use of irrigation system= 2, use of cover crops = 3 and use of mix cropping = 4

RESULTS AND DISCUSSION

Socio-economic Characteristics of the Farmers

Table 1 reveals that 82.5% of the farmers were male while 17.5% were females with a mean age of 33.31years. The findings further show that the majority of the farmers had one form of education or the other and which will aid their ability to adopt adaptation strategies toward reducing the effects of climate change in the study area. The findings also reported a mean household size of 9 people indicating that the household size of the farmers in the study was moderate and the majority of them acquired their farmlands through inheritance where most of their lands range between 1-3 hectares with inappreciable extension contacts.

Awareness Level of Farmers Regarding Climate Change and its Effects on Agricultural Activities

Results in Table 2 revealed that an overwhelming majority (99.2%) of the farmers were aware of the changes in the climate in the study area and only few (0.8%) of the farmers were not aware of the climatic changes. Awareness changes to the climate among the farmers could be due to extension contact or based on its direct effects on their agricultural activities. These findings are in accordance with those of Mertz *et al.* (2008) as they reported that most of the farmers become aware of climate change and its effects as a result of a series of trainings carried out by extension agents and sometimes by climate change mobilization agents under the CCAA project. According to them, such training gives farmers a platform for seeking clarifications and feedback on farming activities related to climate change.

Regarding source of awareness regarding effects of climate change on crops, more than half (55.83%) of the farmers believed that they got aware of the effects of climate change through the extension workers and 27.5% of the farmers got aware of the effects of climate change through the nongovernmental organizations

operating in the state. Majority of the farmers were aware of the effects of climate change on their crops through extension agents and the nongovernmental organizations that mobilize and sometimes conduct training sessions for the farmers. Regarding level of awareness regarding climate change, Table 2 shows that slightly less than half (47.5%) of the farmers knew little about climate change, 38.3% of them were aware of climate change to a reasonable extent while few (14.2%) of the farmers were aware of climate change at a greater extent. These findings are similar to that of Kadi *et al.* (2011), which have reported that the information on climate change and its variability was not well communicated to the farmers in Africa.

Table 1. Distribution of the farmers according to their socio-economic characteristics (n= 120).

Variables	Frequency	Percentage	Mean	SD
Sex				
Male	99	82.5		
Female	21	17.5		
Age (years)				
18-23	13	10.83		
24-29	17	14.17	33.31	9.54
30-35	33	27.50		
36 years and above	57	47.50		
Marital status				
Single	17	14.17		
Married	94	78.30		
Divorced	7	5.8		
Widow	2	1.7		
Educational attainment				
Primary school education	25	20.8		
Secondary school education	33	27.50		
Tertiary education	16	13.30		
Qur'anic education only	46	38.30		
Household size (people				
4-10	83	69.16		
11-16	34	28.33	9 people	
17 people and above	3	2.50		
Major occupation				
Farming	83	69.20		
Fishing	14	11.70		
Livestock breeding	23	19.20		
Secondary occupation				
Civil servant	17	14.20		
Trading	61	50.80		
Handwork	42	35.00		
Land acquisition				
Inheritance	107	89.20		
Purchased	4	3.30		
Lease	1	0.80		
Gift	8	6.70		
Farm size (hectares)				
0.1-3	89	74.16		

3.1—6	30	25.0	2.67	1.40
6.1 hectares and above	1	0.0		
Extension contacts				
No contact	23	19.17		
Monthly basis	57	47.50		
Every year	40	33.33		

Source: Field survey, 2019

Table 2. Distribution of respondents regarding the effects of climate change on agricultural activities based on their level and source of awareness (n =120).

Variables	Frequency	Percentage
Level of awareness regarding effects of climate change		
Knows little	57	47.5
To reasonable extent	46	38.3
To a greater extent	17	14.2
Sources of awareness regarding effects of climate change		
Extension workers	67	55.83
Newspapers	12	10.0
Nongovernmental organizations	33	27.5
Farmer experience	8	6.67

Source: Field survey, 2019

Perceived Effects of Climate Change on General Agricultural Practices

This study endeavours to assess the perceived effects of climate change on the agricultural activities of the famers in the study area. The study restricted itself to the effects of some climatic factors (temperature, rainfall, wind and humidity) on the general agricultural management practices of the farmers. Results in Table 3 reveals that all (100%) the farmers perceived the effect of climate change in their farming practices in the study area. This finding is in line with Sowumi and Akintola (2009) who reported that farmers diversify their agricultural businesses due to the effect of climate change on some of their familiar agricultural practices. Table 3 further shows that more than half (59.2%) of the farmers perceived that the moisture retention of the soils in their farmlands was moderate, 28.3% of the farmers reported soil moisture retention ability of their farmlands was very high while few (12.5%) of the farmers perceived that the soils of their farmlands easily got dried.

This finding therefore, indicated that almost all the farmers observed varying moisture -retentive ability of the soils in the study area. As such, there is need for extension effort to disseminate improved seeds of crops that have minimum moisture requirements to the farmers' crop.

Frequency of seeds germination

Results in Table 3 further posits that a large majority (71.7%) of the farmers observed abnormal germination of their sown seeds (more than three days), more than one-fourth (27.5%) of them observed that the germination of their sown seeds has taken only three days and only a few (0.8%) of the farmers perceived those seeds sown did not germinate at all. This finding implies that most of the sown seeds in the study area did not germinate within the normal time of germination (three days) provided all the conditions of germination are met. This could be due to low or extremely high temperatures caused by climate change. Finding is in line with Allison *et al.* (2009) as they found that climate change effects were high on crop germination due to inadequate moisture content and varying temperatures.

Perceived effect of climate change on crop growth

Table 3 also shows that slightly less than one-third (31.7%) of the farmers perceived the effect of climate change on their crops growing season, 26.7% of them observed poor crop yield and 25.8% of the farmers

believed that their crop growth was poor. This finding implies that the climatic change in the study has invariably affected each of the farmers' agricultural activities. This finding is in line with National Academy of Science (2015) reported that increase in temperature might have a negative effect on farming practices.

Table 3. Distribution of respondents based on perceived effects of climate change on development of crops.

Variables	Frequency	Percentage
Perceived effect of climate change on moisture retention rates		
Very high retention rate	34	28.3
Moderate retention rate	71	59.2
Soil easily dry	15	12.5
Effect of climate change on germination of seeds		
Germinated within three days	33	71.7
Germinated more than three days	86	27.5
No germination at all	1	0.8
Effect of climate change on crops growth		
Change in crop growing season	38	31.7
Poor crop growth	31	25.8
Change in crop harvesting period	19	15.8
Poor crop yield	32	26.7
Effects of climate between common agricultural activities		
Yes	120	100
No	00	0.0

Source: Field survey, 2019

Perceived Differences in Agricultural Practices due to Climate Change Before and after

Perceived differences in soil moisture retention before and after

Results in Table 4 show that more than half (50.8%) of the respondents perceived the soil moisture retention of their farmlands before was moderate compared to 15.8% of the respondents who opined that the soil retention of their farmlands was low now and 43.3% of the respondents who observed that the soil retention of their farmlands was high before compared to 30% of the respondents who were of the view that the moisture retention of the soil of their farmland was high now. These findings of the study revealed a significant difference in soil moisture retention abilities of the respondents' farmland before and now, hence there is a need for the farmers to be advised on measures that could lead to a decrease temperature rise in the study area.

Perceived differences in seed germination before and after

Table 4 also revealed that 31.7% of the respondents perceived that seed germination in their farmlands was low before compared to more than half (53.3%) of the respondents who reported low germination rate now. Also, the results in the Table reported that 58.3% of the respondents' farmland witnessed a high seed germination rate before compared to 29.2% of the respondents who were of the view that the seed germination rate was higher now.

Perceived differences in crop growth rate before and after

Table 5 indicates 49.2% of the respondents reported that crop growth rate before was higher compared to45% of the respondents who were of the view that crop growth rate was low now. Most of the respondents perceived that the crop growth rate before was higher compared to the present time and this could be as a result of changes observed by the farmers on temperature, rainfall humidity and the wind blowing in the study area. Findings in the Table further posit that differences had been perceived by the respondents based on climate change effects. More than half (55.8%) of the respondents reported that crop maturity before was high as compared to 34.2% of the respondents who opined that crop maturity was high now. As shown in the findings, most of the respondents perceived that

crop maturity before were high due to the adequate temperature and timely rainfall in the study area.

Table 4. Perceived differences on the effect of climate change on agricultural activities (n = 120).

	Differences Before		Differences Now	
Variables	Frequency	Percentage	Frequency	Percentage
Perceived differences in soil moisture retention before and now				
Low	61	50.8	19	15.8
Moderate	7	5.8	65	54.2
High	52	43.3	36	30.0
Perceived differences in seed germination before and now				
Low	38	31.7	64	53.3
Moderate	12	10.0	21	17.5
High	70	58.3	35	29.2

Field survey, 2019

Table 5. Respondents perceived difference on crop growth and maturity rate before and after.

	Differences	Before	Differences	Now
Variables	Frequency	Percentage	Frequency	Percentage
Perceived differences in crop growth rate before and now				
Low	51	42.5	30	25.0
Moderate	10	8.3	36	30.0
High	59	49.2	54	45.0
Perceived differences in crop maturity before and now				
Low	46	38.3	47	39.2
Moderate	7	5.8	32	26.7
High	67	55.8	41	34.2

Source: Field survey, 2019

Perceived differences in crop diseases infestation before and now

Table 6 reported that 8.3% of the respondents perceived that crop diseases infestation now was higher as opposed to the vast majority (86.7%) of the respondents who were of the view that crop diseases infestation before was high. The findings therefore, entails that the number of farmers who perceived that the effects of climate change on crop disease infestation was higher compared to the few who shared the same perception. The results in the Table further reported that a vast majority (89.2%) of the respondents perceived that animal diseases infestation before was higher as opposed to few (3.3%) of the respondents who believed that animal diseases infestation now was higher than before. This finding indicated that the majority of the respondents reported that animal infestation before as compare to the present time.

Table 6. Respondents' perceptions regarding diseases infestation on crops and animals before and now (n=120).

	Differences	Before	Differences	Now
Variables	Frequency	Percentage	Frequency	Percentage
Perceived differences in crop diseases infestation before and now				
Low	9	7.5	57	47.5
Moderate	7	5.8	53	44.2
High	10	8.3	104	86.7
Perceived differences in animal diseases infestation before and now				
Low	6	5.0	102	85.0
Moderate	7	5,8	14	11.7
High	107	89.2	4	3.3

Source: Field survey, 2019

Level of differences on the effects of climate change on agricultural activities before and now

Results in Table 7 reported that about half (49.2%) of the respondents had assessed the cumulative differences in climate change on their agricultural activities as moderate, 30.8% had perceived the cumulative differences in climate change as high while one - fifth (20.0%) of the respondents believed that the cumulative effects of climate change on their agricultural activities were low.

These findings therefore, imply that majority of the respondents in the study area assessed and perceived those cumulative effects of climate change on agricultural activities in the area was moderate as it does not fail their agricultural activities but the realization of reduction in their output.

Table 7. Distribution of respondents based on the level of differences in climate change on agricultural activities before and now (n=120).

Variables	Frequency	Percentage
Low difference	24	20.0
Moderate difference	59	49.2
High difference	37	30.8

Source: Field survey, 2019

Climate Change Adaptation Strategies Adopted by the Respondents

Adapting to climate change entails taking the right measures to reduce the negative effects of the change (or exploit the positive ones) by making the appropriate adjustments and changes. Table 8 reveals that all the respondents reported that they adopted one form of adaptation strategies or the other in coping with the adverse effect of the change on their agricultural activities.

Adaptation Strategies Adopted

Table 8 revealed that one–third (34.2%) of the respondents reported adopting the use of irrigation system in coping with adverse effects of climate change, 26.7% reported adopting the use of crop resistant varieties and 23.3% adopted the use of mix cropping. This implies that the majority of the respondents perceived that the use of a dry season irrigation system in the study area was the best alternative for coping with the adverse effect of climate change. This finding is in corroboration with Bradshaw *et al.* (2004) who reported that important adaptation strategies in agricultural production include the use of crop resistant varieties, mixed cropping, changing in planting date and harvesting time and adoption of irrigation systems.

Table 8. Distribution of respondents based on adaptation strategies adopted (n = 120).

Adaptation strategies	Frequency	Percentage
Use of crop resistant varieties	32	26.7
Use of irrigation system	41	34.2
Use of cover crop	19	15.8
Use of mix cropping	28	23.3

Source: Field survey, 2019

Tests of Research Hypothesis

Hypothesis I: No significant relationship between perceived effects of climate change on crop production and climate change adaptation strategies adopted.

A linear regression analysis model was used to test the relationship between the hypothetical variables. The result of the analysis in Table 9 indicated a significant relationship (β=0.241) between the climate change adaptation measures and the perceived effects of climate change on crop production activities in the study area. The findings, therefore, indicated that the adaptation measures adopted by the respondents was based on the perceived effects on their crop production and hence could assist in reducing total crop failure (Table 9).

Table 9. Relationship between effects of climate change and adaptation strategies adopted.

Variables	β - coefficient	SE	β - coefficient	T-ratio	P- value
Constant		2.050	20.010	2.040	0.000***
Adaptation strategies	0.114	0.098	0.241	1.170	0.244
ΔR^2	0.038*				

CONCLUSION AND RECOMMENDATIONS

Based on the findings of the study it is concluded that most of the respondents were aware of the effects of climate change on their crop production and majority of them were of the view that there was a significant difference in almost all their crop production before and now. The study further concluded that, as a result of the adverse effects of the climate change, majority of the

farmers adopted one type of adaptation strategies and the strategy mostly adopted by the respondents was the application of irrigation system of farming. Based on the findings and conclusion drawn from this study rigorous campaign on awareness creation on the effects of climate change on general agricultural activities is recommended. Farmers in the study area are recommended to use early maturing crop as an additional adaptation strategy. Agro-chemicals (pesticides) that reduce the effects of pest infestation on the crops are recommended.

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