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Climate Change

Assessment of indigenous climate change coping strategies among small scale farmers in Jos East L.G.A, Nigeria

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ABSTRACT

Climate change is conceivably the most serious environmental menace to agricultural production globally. Hence, this study assessed the indigenous strategies employed by small scale farmers to cope with these adverse effects of climate change in Jos East Plateau State. It was carried out in three districts of the local government area. Samples of 150 farmers were randomly selected for this study. Structured questionnaire and interview were employed for data collection. The data collected were analyzed using descriptive statistics, Coping Strategy Index (CSI) and regression analysis. The study found out that farmers are aware of climate change in the study area. Important sources of information on climate change were found to be: other farmers (90.7%), radio (85.3%), television (84.0%) open market (84.7%), government extension agent (56.0%), print media (40%) and internet (36.7%).Key

indicators of climate change in the study area include flooding (93.3%), erratic rain pattern, (86.0%), increase in disease incidence (80.7%), warmer temperatures (76.3%), increase in pest incidence (79.3%) and longer dry season (4.0%).Findings also revealed that mixed cropping, use of organic manure, change in sowing date, seed selection, afforestation, seasonal migration, change in date of harvest were the most important indigenous strategies used by the respondents to cope with climate change.Inferential analysis revealed that, age of the respondents, total land size and years of membership of farmers' cooperative were found to be positive and significant at 1% probability level. Also, the parameters regressed are responsible for 54.1% of variation in the CSI. Capacity building and advisory services that enhance documentation and complementing the use of indigenous and modern strategies against climate change particularly in areas of information accessibility and weather prediction are recommended.

Keywords: Climate change, coping strategies, indigenous, adaptation, knowledge, small-scale

1. INTRODUCTION

Climate variation is a persistent change in the mean of climate parameters (temperature, rainfall, humidity and soil moisture) due to change in the composition of atmospheric gases (Alade and Ademola, 2013). Krishna (2011) stated that the change in the atmospheric composition is attributed to the emissions of greenhouse gases such as Methane (NH4), Carbon dioxide (CO2), Nitrogen oxide (N2O) and other gases. Climate variation is a shift in the average weather that a given area experiences. It occurs over a period of time which may range from several decades to centuries (Alade and Ademola, 2013).

Agriculture is the most important sector but it is predicted to be negatively impacted by climate change (Deressa, 2006; Jain, 2006). Climate change is perhaps the most serious environmental threat to agricultural production (Adejuwon, 2004; Odewumi, Awoyemi, Iwara and Ogundele, 2013). Direct impact of climate change on agricultural systems are: changes in temperatures and rainfall which could impact on agro-climatic conditions, altering planting and growing seasons and harvesting calendars, water availability, pest prevalence, weed and disease populations (Nelson *et al.,* 2001). Agricultural production is apparently affected by climate-related shock; this usually manifested by the occurrence of pest and insect infestations as well as land degradation problems. Climate change would also have an impact on alteration in evapo transpiration, photosynthesis and biomass production and land suitability for agricultural production (Obioha, 2009; Ozor and Madukwe, 2012).

Recently, there has been a growing awareness that scientific knowledge alone is inadequate for solving climate crisis. Thus, the indigenous local farmers experience has been recognized as an important source of mitigation on climate change and a key factor for developing policy to mitigate and cope with its effects (Natural Sciences, 2012; Wuyep, Samueland Yakubu, 2015). The knowledge of the local and indigenous farmers is increasingly recognized as important source of climate knowledge and adaptation strategies incorporation of this indigenous experience can promote local participation in the development of sustainable cost-effective climate change mitigation and adaptation strategies rich in local content which will increase food security (Nyong, Adesina and Elasha, 2007; Natural Sciences, 2012, Simane *et al.*, 2016).

Following Intergovernmental panel on Climate Change (IPCC), (2007) adaptation to climate change refers to the adjustment in natural or human systems in response to actual or expected climatic stimuli or its effects, which moderates harm or exploits beneficial opportunities. Adaptation can be implemented by small-holder farmers themselves (autonomous adaptation) or by government policies aimed at promoting appropriate and effective adaptation measures (planned adaptation) (McCarthy, Canziani, Leary, Dokken, and White, 2001; Smith and Wandel, 2006). However, in order to implement appropriate interventions, there is a need to understand location-specific opportunities, challenges, and the key drivers behind adaptation.

Adaptation can also be affected at different scales: individual/farm-level, national level, or international level. Although there is some autonomous adaptation at farm-level, it is usually inadequate and requires the intervention of different institutions (Maddison, 2007; Simane, Zaitchik and Foltz, 2016). Moreover, adaptation at national or international level entails an understanding of the process of location-specific autonomous adaptation at farm-level (Bryan, Deressa, Gbetibouo and Ringler, 2009).

Maddison, (2006) revealed that adaptation to climate change requires that farmers must first perceive that climate has changed, then identify useful adaptations and implement necessary adaptation responses. In order to enhance policy towards tackling the challenges climate poses to farmers, it is important to have knowledge of farmers' perception on climate change, choice of adaptation methods and the barriers affecting adaptation to climate change. In this regard, adaptation appears to be an efficient and friendly way for farmers to reduce these negative impacts of climate change (Füssel and Klein, 2006).

It is clear that climate change will bring about substantial welfare losses especially for small-holders whose main source of livelihood is derived from agriculture (Bulus and Nimfa, 2017). Therefore, there is a need to neutralize the potential adverse effects of climate change if welfare losses to this vulnerable segment of the society are to be averted. However, developing such strategies

will require information from the farmers since the ability to adapt and cope with climate change depends on the experiences, knowledge, skills and other socio-economic factors (Maharjan, Sidjel, Sthapit and Regmi, 2011).

It is against this background that this study seeks to assess the indigenous climate change coping strategies among small scale farmers in Jos East LGA. This is achieved through the following objectives: Assess small holder farmers' perception of climate change, identify the indigenous climate change coping strategies employed by small holder farmers determine the socio-economic and institutional factors that influence the use of indigenous coping strategies, investigate how to compliment the use of indigenous climate change strategies and modern coping strategies and examine the constraints to the use of coping strategies against climate change. Therefore, the focus on understanding and explaining the effects of climate change on agriculture is well deserved in order to suggest mitigation and cooping measures. It is hoped that this paper will contribute to existing literature on agro-climatology in Nigeria and Africa. Findings will be of relevance to governmental and non-governmental agencies in designing and implementing policies, programs and projects aimed at combating climate change and food insecurity and improving standards of living in the study area.

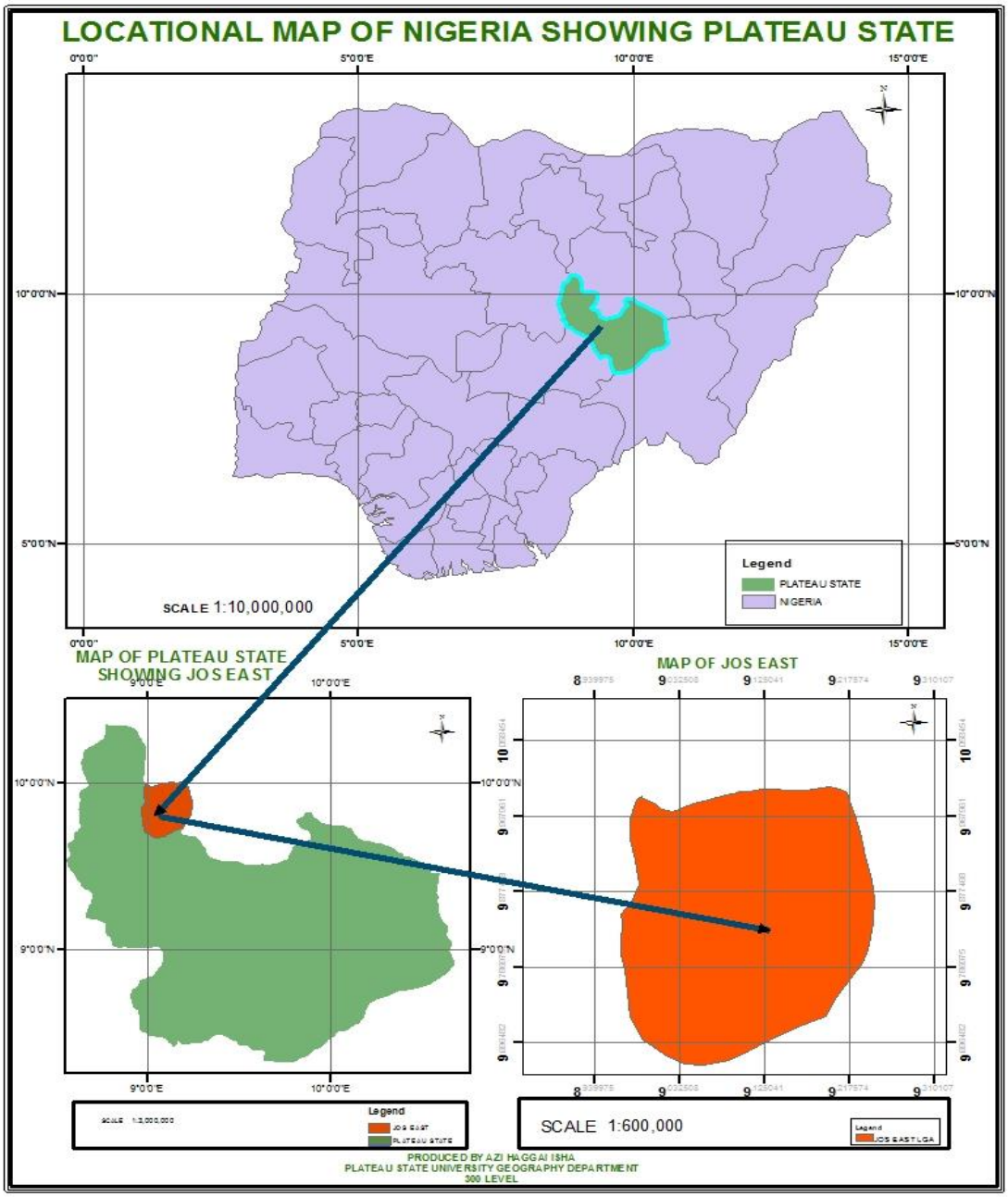


Figure 1 Map of the Study Area

2. STUDY AREA AND METHODOLOGY

Jos East Local Government Area (L.G.A) was created out of Jos South L.G.A of Plateau State in December 1996. It has a land area of 2,540 km^2, and bounded by Jos North L.G.A in the western part, Barkin-Ladi in the south-western area. The East and Northern areas are bounded by Bauchi State (Fig. 1). The estimated population of Jos East L.G.A in 2006 by the growth rate of 0.023 of the 2006 population census is 117,295 (National Population Commission (NPC), 2006). About 80 percent are rural based, the remaining twenty 20 percent live in the semi-urban and urban centers. The L.G.A is made up of six districts namely; Fobur, Maigemu, Maijuju, Furusum, Federe and Shere. The Headquarters of the Local Government Area is Angware about 25km east of Jos the state capital. The Local Government Area is exclusively inhabited by the Afizere ethnic group. The climate is influenced by height above sea level and spatial position across the seasonal migration belt of the Inter-Tropical Discontinuity (ITD). Jos East falls within the wet and dry climatic type as a Tropical Rainy (AW) climate (Köppen, 1923). Mean annual rainfall is 1260 mm, and peaks between July and August; meanwhile, the mean annual temperature is about 22◦C (Adzandeh, Akintunde and Akintunde, 2015). The economy is largely agrarian with majority of the people being subsistent farmers who cultivate crops such as achar, millet, guinea corn, coco-yams, and vegetables (Hassan, Choji, and Wuyep, 2014).

Both close and open-ended questionnaire were used in this study. The questionnaire-administered and interviews were undertaken from April 2017 to June 2017. These interviews were conducted only after prior informed consent was obtained from the responding farmers. Simple random sampling method was used to collect a sample size of 50 respondents in each of the three districts making a total of 150 respondents.

Close-ended questions were focused on perception of climate change, coping strategies, socio-economic and institutional variable, compliment the indigenous climate change strategies and modern coping strategies. Furthermore, all data collected in this manner were then subsequently analyzed using the coping strategy index and regression analyses. Descriptive statistics such as frequency distribution and percentage were used to achieve objectives. On the other hand, qualitative data were collected from respondents by means of addressing open-ended questions during semi-structured interview. In such interviews, different narratives from respondents were transcribed to help understand the constraints to the use of coping strategies against climate change. These qualitative data were then subjected to content analyses whereby the main ideas, salient points, and meanings were identified and summarized as part of the results in this paper. The multiple regression models and linear regression are used as recommended by Umar *et al.,* (2013).

Thus: $Y=a+b_1x_1+b_2x_2+b_3x_3+b_4x_4+b_5x_5+b_6x_6+b_7x_7+b_8x_8+b_9x_9+b_{10}x_{10}+b_{11}x_{11}+e$

Where: Y = use of indigenous coping strategies against climate change (to be measured using Coping Strategy Index – CSI).

a=constant

b_1-n= regression coefficients

X_1= age of respondent (years)

X_2 = educational attainment (years of schooling)

X_3 = household size (number of people)

X_4 = membership of cooperative (years of membership)

X_5 = farm size (hectares)

X_6 = extension contact (number of visits in a production cycle)

X_7 = income (naira)

X_8 = farming experience (years)

X_9 = amount of credit accessed (naira)

e = error term

3. RESULTS AND DISCUSSION

Sources of information on climate change.

Respondents differ in their sources of information regarding issues of climate change and how it has manifested in their communities (Table 1). Most farmers (90.7%) identified other farmers as important source of their information on climate change. This implies that information on climate change is majorly disseminated informally in the study area. This was followed by radio (85.3%), open market (84.7%), television (80.0%), extension agents (56.0%), print media (40.0%), internet has lowest frequency (38.7%). This indicates that Information and Communication Technology (ICT) are still not widely adopted in the study area. In other study conducted by Umar *et al.,* (2013) found that majority (96%) of the respondents obtain information from friends and relatives through conversation.

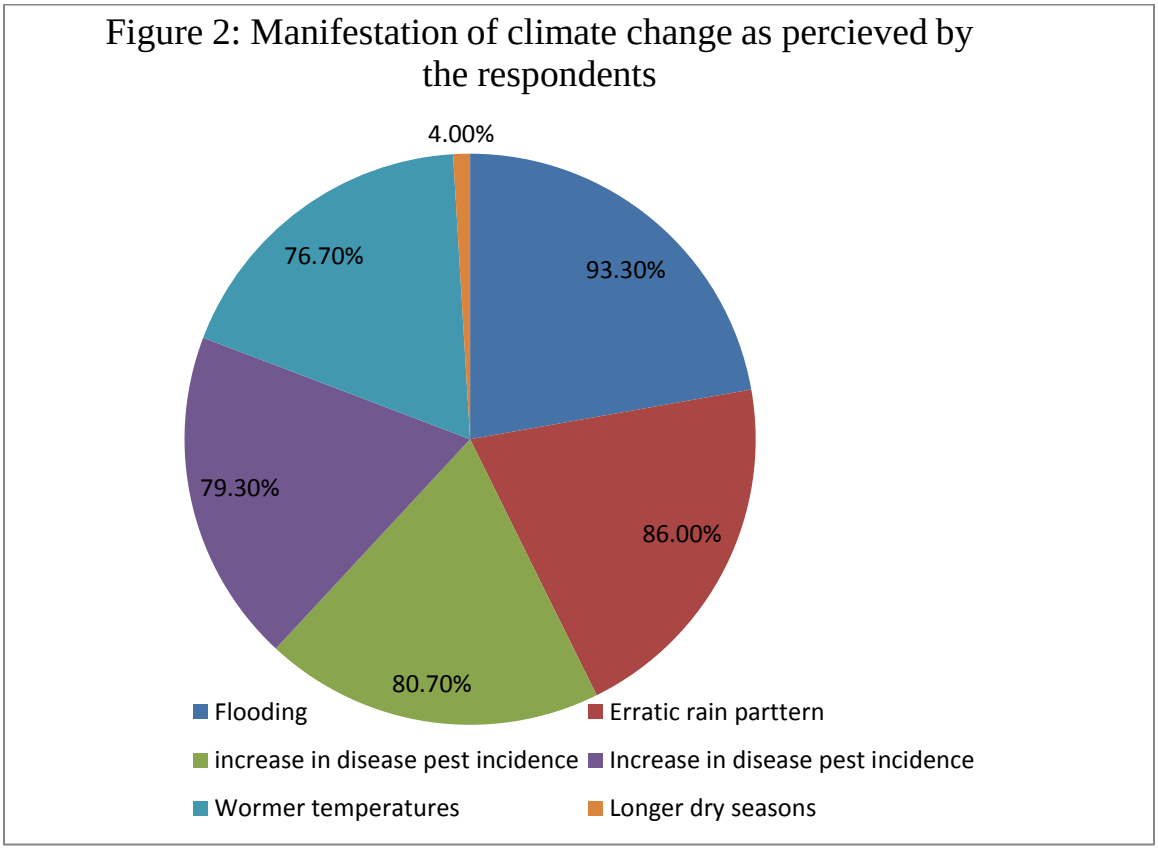
Table 1 Sources of information on climate change.

Source of information	Fobur district(n=50)	Maigemu district(n=50)	Federe district (n=50)	Pooled data (n=150)	Rank
Other famers	45 (90)	48 (96)	43 (86)	136 (90.7)	1
Radio	44 (88)	43 (86)	41 (82)	128 (85.3)	2
Open market	43 (86)	40 (80)	44 (88)	127 (84.7)	3
Television	40 (80)	45 (90)	41 (82)	126(84.0)	4
Extension agent	30 (60)	28 (56)	26 (52)	84 (56.0)	5
Print media	25 (50)	20 (40)	15 (30)	60 (40)	6
Internet	20 (40)	15 (30)	20 (40)	55 (38.7)	7

Note: multiple responses accepted. Figures in parentheses are percentages.

Manifestation of climate change as perceived by the respondents

Figure 2, shows what the respondents consider as indicators of climate change in the study area. Further investigation revealed that all of these indicators have been occurring in the study area, their intensity and the rate at which they occur in recent times indicate that the climate is changing. The most important manifestation of climate change in the study area is flooding (93.3%). Conversely, these means flooding has negative effect on agricultural production in the study area and hence the need for afforestation to cope with the menace. The respondents also identified erratic rain pattern as another indicator of climate change with (86.0%), increase in disease incidence (80.7%), and increase in pest incidence (79.3%), warmer temperatures (76.7%), and lastly longer dry season with (4%). Different studies (Farauta, *et al.,* 2012) shows farmers perceived manifestation on climate change to include: unusual early rains that are followed by weeks of dryness, higher temperatures, loss of soil fertility, reduction in farm yields, high rate of disease and pest incidence, delay in onset of rains, less rainfall, erratic rainfall pattern, long periods of harmattan and heavy and long period of rainfall which do result in flooding.



Note: Multiple responses accepted.

Indigenous coping strategies against climate change employed by the respondents

Respondents have identified the strategies they employ in adapting to and mitigating the adverse effects of climate change on small scale agricultural production (Table 2). Mixed cropping was identified as the most important strategy used. This is because different crops have different climatic requirements. Hence, several crops on a plot reduce the risk of loss due to unfavorable climatic conditions, these findings support the results that have been mentioned in other research (Asrat and Simane, 2018) that farmers in Ethiopia employ mixed cropping and crop diversification among other strategies to cope with climate change. Other important coping strategy in the study area includes use of organic manure, change in planting and harvesting date, seasonal migration, prayer and supplications. Hence, they seek spiritual intervention to ameliorate problems threatening their wellbeing. This is through prayers in churches; mosque and traditional worshipers do appease the gods by offering sacrifices. This finding corroborates the results of Morlia *et al.,* (2011) in Sierra Leone that important indigenous climate change adaptation technologies/strategies include performance of ancestral ceremony/spiritual invocation. Other strategies employed include afforestation, household fuel conservation and minimum tillage which could help in minimizing greenhouse effect through the use of clean energy sources and overall mitigate the effect of climate change as reported by Adesina *et al.,* (1999) in Lagos State Nigeria.

Table 2 Result of pair wise scoring and ranking of indigenous coping strategies

Indigenous coping strategies.	Fobur district(n=50)	Maigemu district(n=50)	Federe district (n=50)	Pooled data (n=150)	Rank
Mixed cropping	40	48	46	139	1
Use of organic manure	44	47	46	137	2
Seed selection	47	40	38	125	3
Prayer and supplication	40	43	41	124	4
Afforestation	30	40	41	111	5
Change in sowing date	40	35	32	107	6
Seasonal migration	35	37	32	104	7
Change in harvesting date	35	31	28	94	8

Note: multiple answers accepted.

However, to attach more objective values to the coping strategies, the CSIs were computed thus:

$CSI_i = \sum(D_{ij} * S_j)$

Where:

CSI_i= coping strategy index of i^{th} respondent.

D_{ij}= duration of usage of j^{th} coping strategy by i^{th} respondent (years).

Sj= score of usage of j^{th} coping strategy by the sample, computed in table 3

Coping strategy index (CSI) which is a summation product score of communal usage of each coping strategy and its duration by the respondents was computed for each household. Therefore, the product obtains range from a minimum 2083 to maximum of 4664 and arithmetic mean of 3170.99 and a standard deviation 454.964. These measures of central tendency and dispersion are shown in (Table 3).

Table 3 Socioeconomic and institutional factors influencing the use of indigenous coping strategies

Statistics	Fobur district	Maigemu district	Federe district	Pooled data
Minimum	2083	2321	2132	2083
Maximum	4664	4663	4653	4664
Mean	3143.7	3201.14	3401.8	3170.99
Standard deviation	447.735	463.318	456.348	454.964

Sum	330089	304108	364186	634197

Distribution of socioeconomic distribution of respondents

In table 4 the respondents in this study have a mean age of 54.5 years and a standard deviation of 6.9. These groups of respondents are expected to have acquired substantial knowledge and understanding of the research; indigenous coping strategies, small scale agriculture and climate change in the environment. Furthermore, most of the respondents are household heads that are major decision-making processes and are believed to have the required information for the study. This is compounded by the farming experience of the respondents' accumulated between15-60 years of active involvement in agricultural activities. The mean years of formal education are 4.60 which imply that the average respondents do not have up to complete primary education. The range of 0 to 18 years indicates that though some farmers have not acquired any formal education there are others that have obtain up to tertiary education among the respondents. The study area is characterized by relatively large households ranging from 3-24 members with a mean of 12 and standard deviation of 6.92. Even though agricultural lands in the study area have been subjected to fragmentation, the average range is 1 to 8 and standard deviation is 1.06. Land is a vital resource in agriculture hence; larger farm size is expected to enable farmers to experiment different coping strategies and technologies. The average credit obtained by a household in the last production cycle from all sources, for all purposes was ₦30,620.00 with a range of 0.00 to 200, 0000 and standard deviation of 57142.03. The average respondent received less than 1 extension visit in a production cycle. The number of visit ranges from 0 to 4 with a standard deviation of 0.99. The mean year of members in cooperative groups were 5.625 years with a range of 2 to 16 years and standard deviation of 6.151229.

Table 4 Statistical distribution of socioeconomic distribution of respondent

Variable	Mean	Standard deviation	Minimum	Maximum
Age of the respondents	54.5	6.89584	30	79
Educational attainment	4.60	6.2285	0	18
Farming experience	28.425	8.093284	15	60
Household size	12.165	6.928195	3	23
Land size	4.35	1.064503	1	8
Extension agent visit	0.53	0.991978	0	4
Credit obtain	22626	57142.03	0	200000
Membership of cooperation	5.625	6.151229	2	16

Factors influencing the use of indigenous coping strategies

The study found that age is positively related to CSI and significant at 1% (Table 5). The coefficient of 18.407 means that a farmer who is a year older will have a CSI that is higher by 18.407. This implies that older farmers tend to have higher CSIs than younger ones; this is because elderly people are the custodians of the indigenous knowledge and practices. This supports the findings of Umar *et al.,* (2013) that age, educational level, and amount farm credit received were found to be significant in managing of climate change among farmers. However, contrary to Umar *et al.,* (2013) this study found that farm size is highly significant and positively related to CSI. This indicates that an increase in one hectare of farm size result in a higher CSI by 58582, this shows higher tendencies of using indigenous coping strategies against climate change. These findings are in line with the findings of Salau *et al.,* (2012) and Simane, Zaitchik and Foltz (2016) in separate studies in Nigeria (Nasarawa) and Ethiopia respectively. Years of membership of cooperatives also are positively related to CSI and significant at 1%. This implies that, the more years a farmer spends in cooperative groups, the more he would learn and get exposed to the benefits, knowledge and practices abound in the society. Parameters regressed are responsible for 54.1% of variation in the CSI.

Table 5 Factors influencing the use of indigenous coping strategies

Model	B	Unstandardized coefficients Standard error	Standardized coefficient Beta	t	Sig.
(constant)	1248.278*	176.017		7.092	.000
Age	20.407*	3.350	.037	.802	.423

Educational attainment	27.256	33.977	.037	.802	.423
Farming experience	-1.020	2.470	-.021	-.413	.680
Household service	1.501	3.541	.020	.424	.672
Land size	68.528*	20.637	.162	3.321	.001
Extension visit	-27.945	21.161	-.061	-1.321	.188
Credit	.000	.000	-.017	-.365	.715
Cooperative membership	23.533*	3.689	.373	6.380	.000

Dependent variable: Coping Strategy Index. * = significant at 1% level of probability

Complimenting indigenous with modern coping strategies against climate change

Table 6 shows the distribution of respondents' in terms of awareness and usage of some modern coping strategies. Apart from indigenous strategies there are many modern strategies developed to combat the negative effect of climate change in the study area. It was found that most (93.3%) of the respondents are aware of modern coping strategies against climate change. However, a total of 6.7% respondents expressed that they have not used any of the modern coping strategy against climate change. It could be deduced that all those using modern coping strategies (88.0%) were involved in complementing both indigenous with modern coping strategies.

Table 6 Distribution of respondents according to awareness and usage of modern coping strategies

	Fobur district (n=50) frequency %	Maigemudistrict (n=50) Frequency %	Federe district (n=50)frequency %	Pooleddata (n=150) frequency %
Awareness				
Aware	47(94)	45(90)	48(96)	140(93.3)
Not aware	3(6)	5(10)	2(4)	10(6.7)
Usage				
Used	45(90)	45(86)	44(88)	132(88)
Never used	5(10)	7(14)	4(8)	16(10.6)

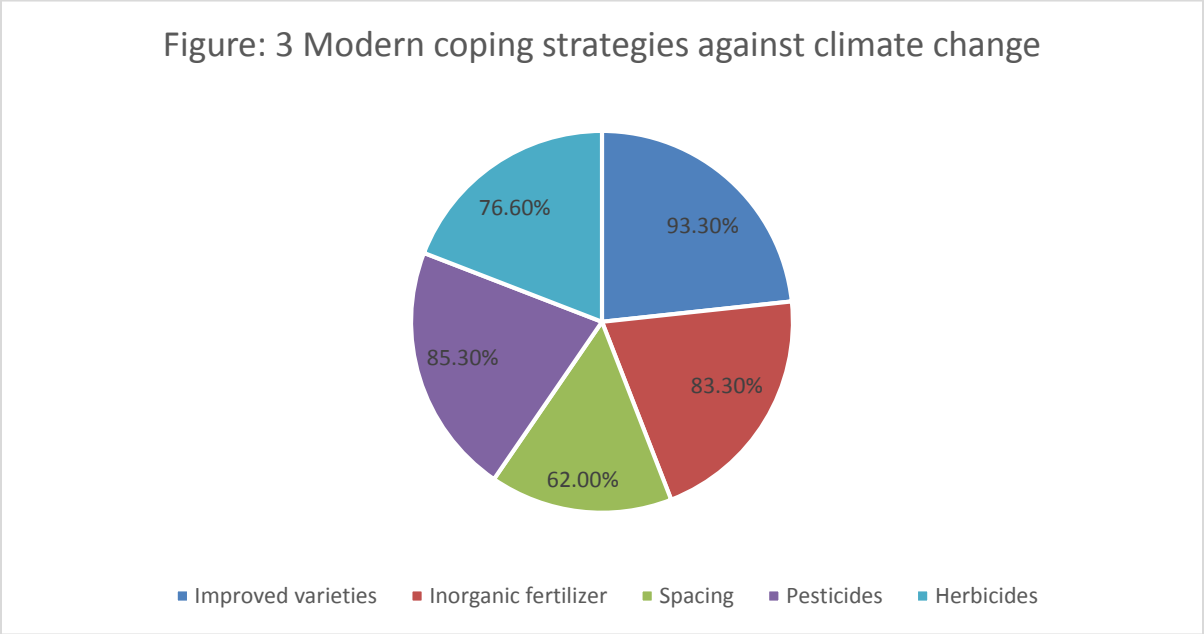
Note: multiple answers accepted.

Awareness and usage of modern coping strategies according to respondents

Table 7 went a step further to disclose the reasons why 10 of the respondents (Not aware) did not use any of the modern coping strategies and therefore did not complement the two. The most important reasons for not complementing are lack of awareness, followed by satisfaction with the indigenous strategies. These 16 respondents (Never used) reported that they are satisfied with the effectiveness of the indigenous strategies in coping with climate change and therefore saw no need to use the modern strategies. This is followed by higher cost of modern coping strategies such as improved seeds and their difficulty of using (complexity). No socio-cultural reason such as taboo or religious prohibition was identified as a constraint to using modern coping strategies against climate change.

Modern coping strategies against climate change

Figure 3 shows the modern coping strategies used in the study area. Majority of the respondents (93.3%) use improve crop varieties to cope with the impact of climate change on small scale agriculture. Commonly used improved varieties include early maturing cultivars, pest and disease resistant varieties, inorganic pesticides are also used among the modern coping strategies (85.3%) incidence of pest and diseases have increased with the phenomenon of climate change. Other important modern coping strategies used are organic fertilizer (83.3%), and herbicides (76.6).



Note: multiple answers accepted.

Constraints to the use of indigenous coping strategies

The respondents identify what they believed are constraints against efficient utilization of indigenous coping strategies against climate change. Table 7 shows that the first is poverty which was identified by 88.7%. Following poverty was poor record keeping and documentation with 80.0%. Proper documentation is required for effective reference to environmental challenges encountered and best possible remedies tested, thereby enabling transmission to subsequent generations and improvement. Poor access to information on climate change was identified by a total of (78.7%), this was followed by low level of education (76.7%), uncertainty of agricultural enterprises due to reliance on natural conditions (73.3%), land tenure system (65.3%) and inadequate physical and social infrastructure in the rural areas (60.0%) in that other. This assertion is further supported by some pertinent remark made by some respondents during the interview held on the 14thApril 2017:

"Poverty, poor record-keeping and documentation of indigenous knowledge, lack of information on climate change and low level of education has been our major predicaments, in fact if not because of some of these challenges we are facing in indigenous coping strategies we could have been food sufficient in Jos East"

Another testimony from some respondents on the 3rd June 2017 that lends credence to the challenge face by respondent is summarized below:

"If I had better knowledge of climate change effects on my vegetable farming business ten years ago, I would not have lost in my farming business due to flooding".

Table 7 Constraints to the use of Indigenous Coping Strategies in the Study Area

Constraints	Fobur district (n=50) %	Maigemu district (n=50) %	Federe district (n=50) %	Pooled data (n=150) %	Rank
Poverty	45(90)	42(84)	46(92)	133(88.7)	1
Poor record keeping and documentation of indigenous knowledge	40(80)	38(78)	42(84)	120(80)	2
Poor access to information on climate change	36(72)	40(80)	42(82)	118(78.7)	3
Low level of education	37(74)	40(80)	38(76)	115(76.7)	4
High level of uncertainty in agricultural enterprise	32(64)	38(76)	40(80)	110(73.3)	5

Land tenure system	40(80)	30(60)	28(56)	98(65.3)	6
Poor physical and social infrastructure	28(56)	32(64)	30(60)	60(40)	7

Note: multiple responses accepted.

4. CONCLUSION AND RECOMMENDATIONS

This study assessed the indigenous strategies employed by small scale farmers of Jos East L.G.A. From our findings, it is evident that, rural farmers in the study area are among the victims of the global danger of climate change. Fortunately, they are aware and even identified indicators of the environmental phenomenon. It is also clear that, despite the constraints hindering small scale farmers in the study area, farmers are able to develop both indigenous and modern coping strategies to reduce the effects of climate change on their source of livelihood. Therefore, indigenous knowledge in coping climate change related challenges in agriculture are effective in ameliorating environmental challenges in Jos East, hence, enhancing livelihood of the rural farmers.

Base on the findings of this study the following recommendations are hereby made. There is need for capacity building and advisory services that enhance complementing the use of indigenous and modern coping strategies against climate change particularly in areas of information accessibility and weather prediction by the National Metrological offices around the state. This should target both the extension personnel and the farmers.

Government and non-governmental organizations involved in intervention projects and programmes should take in to cognizance the documentation prioritization of indigenous coping strategies as use by farmers for further development and utilization. This is because it has been found that the indigenous practices are working for the communities in mitigating climate change effects on their livelihood.

Though majority of the farmers possess little or no formal education they are mostly knowledgeable on climate related issue. Hence, farmers should endeavor to keep records of their indigenous knowledge and practices for further use. Also, agencies responsible for adult literacy should intensify their efforts especially in rural areas.

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