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AN ASSESSMENT OF INDIGENOUS FARMERS PERCEPTION TOWARDS CLIMATE CHANGE IN MUBI REGION OF ADAMAWA STATE, NIGERIA

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ABSTRACTS

The study assessed indigenous farmer's perception towards climate change in Mubi Region of Adamawa State, Nigeria. The primary data were obtained through the use of structure questionnaires survey of 927 respondents from 28 communities of the study area. The data collected were analyses using, descriptive statistics, simple percentage, multiple regression and principal components analysis. While a good percentage (94.4 percent) of the respondents had knowledge of climate change with farmers perceiving the impacts of climate change which includes increased temperature 55.5%, decrease rainfall 23.1% decrease rainfall duration 11.9% and increased rainfall intensity 9.2%. The PCA results showed that use of insecticide, herbicide, increase in land disturbance, burning of fossil fuel/deforestation, clearing of swamp and bush burning were the main factors responsible for 77.4 percent of climate change in the area. Multiple regression results indicated that education, age and years of farming had significant influence of farmers knowledge of climate change ($F=9.786$, $P<0.05$); with years of farming exerting the most influence on farmers level of awareness towards climate change. It is recommended that government policies and strategies should mobilize, facilitate and promote the realization of farmers needs based on understanding of the farmers perception on climate change and measures to mitigate them in the study area.

KEYWORDS: *Farmers Perception, Climate Change, Perceive Factors Temperature, Rainfall.*

INTRODUCTION

Farmers in different regions of the world have diverse perception concerning the impacts of climate change. Wolka and Zeleke (2017) examined farmers' perception on climate change and adaptation strategies in Karetha Watershed, Omo-gibe Basin, Ethiopia. Result found that across the three considered agro-ecological areas, all the respondents perceived a higher temperature when compared with the situation in the past. Fluctuation in rainfall also perceived as an evidence of climate change by 94 per cent of respondents in the highland areas. Eighty-seven and 85 per cent of respondents in lowland (SuboTulama) and middle area (ElaBacho) respectively perceived decline of rainfall. Majority of interviewees identified deforestation as the major driver of the climate change. In Nigeria, the study carried out by Adebayo *et al.,* (2012) in their study found that majority of the farmers believed that temperature in the area has been increasing; a small percentage stated that temperature trend in the state has been decreasing, while about 4 per cent claimed to have noticed no change. Majority of the farmers claimed that rainfall trend has been decreasing; 41 per cent opined that rainfall trend has been on the increase, while 2 per cent of the respondents claimed not to have noticed any change in rainfall trend in the area. The study further found that 39 per cent of the farmers noticed an increase in the occurrence of dry spells; 36 per cent observed a decrease in number of dry spells; 16 per cent claimed not to have noticed any change, while about 9 per cent claimed ignorant.

In another study, Escarcha, Lassa, Palacpac *et al.,* (2018) reported a very high awareness among water buffalo farmers on the relationship between extreme weather events and climate change. The study found that almost all the farmers stated that they observed that both the frequency and severity of extreme events such as heat,floods, typhoons and drought, had increased, reflecting the actual trends in precipitation and temperature recorded in the study area. Perceptions of climate change risks was observed to strongly depend on the level of experience of exposure (as informed by age or length of lived experience) and vulnerability to these extremes (farmer's adaptation characteristics and context). Babatolu and Akinnubi (2016) in their study found that a significant number of the smallholder farmers attested to the stated that they were aware of the changing climate which had resulted in increasing temperatures, unpredictable, erratic, heavy and increasing rainfall, late onset and early retreat of rains. The study further revealed that smallholder farmers in the study areas possessed knowledge of the impacts of climate change and variability which helped them to cope with climate change and variability. Pashupalak (2009) found that rainfall has become irregular and more unpredictable in Orissa over the last decade. The intensity of rainfall is also increasing. Out of 1500 mm rainfall, 500 mm to 700 mm precipitation falls within a span of 3-4 days, which, sometimes causes severe floods.

Dev (2010) reported that according to villagers feel the amount of winter precipitation has decreased significantly. Dhaka *et al.,* (2010) revealed that majority of farmers believed that the rainfall levels had decreased. Similarly, the overall perception on changes in precipitation is that the region is getting drier and that there are pronounced changes in the timing of rains and frequency of droughts. Krishna, Tiwari, Awasthi *et al.,* (2011) reported that more than 80 per cent of the respondents perceived rainfall variability with untimely, late monsoon start, no winter rain and high intensity pattern with short periods. Furthermore, they have been experiencing an unpredictable rainfall patterns over the past 10 years. Akponikpe *et al.,* (2010) found that the later onset of the first rainy season and the earlier cessation were reported by a higher proportion of farmers in Benin (65-90 per cent) than Togo and Ghana (35-50 per cent) and by higher proportion of Sahelian farmers (70-90 per cent) than Sudanian and Guinean ones (40-67 per cent). Further, he mentioned that the number of rainfall events during the first rainy season was perceived to have decreased consistently with the number of dry spells perceived to have increased. A higher proportion of farmers in Benin, Burkina Faso and Niger (70-95 per cent) mentioned this change compared to Ghana (25-50 per cent) and Togo (25-35 per cent). Exceptionally in Togo, more farmers even said that the numbers of rainfall events have increased (53 per cent).

Sorhang and Kristiansen (2011) reported that 71.7 per cent of the respondents in HagereSelam said rainfall had decreased. 5 per cent said rainfall had decreased and was also more irregular, while, 3.3 per cent said rainfall was more irregular, 98 per cent of the respondents in Kofele can remember negative changes in rainfall and 2 per cent of the respondents said there had been no changes in rainfall. Bhushal, Tiwari and Timilsina (2009) revealed that 92 per cent of the local people interviewed perceived long-term changes in temperature. While, most of them (90 per cent) perceive the temperature has been increased. Only 2 per cent noticed the contrary, a decrease in temperature.

Dhaka *et al.,* (2010) and Kemausuar, Dwamena, Bart-Plange *et al.,* (2011) indicated that most farmers perceived the temperature distribution has undergone a significant shift in addition to an overall increase in temperatures. By contrast almost none believed they had decreased. Tripathi (2010) argued that the people in the Indo-Gangetic Region indeed perceived a significant change in temperature distribution and a definite reduction in the number of winter months, which then lasted for only two months. Almost 100 per cent of the respondents perceived the changes in winter. These perceptions were not in line with traditional weather descriptions because temperatures were way above the normal temperatures. Akponikpe *et al.,* (2010) mentioned that generally in the year, the number of hot days had increased, but it had reduced during the rainy season periods. Farmer reported that temperatures (>60 per cent) and the number of hot days (>50 per cent) have increased. Sorhang and Kristiansen (2011) reported that 38.3 per cent of the respondents in HagereSelam said temperatures have increased over the last thirty years. The respondents in Kofele were very clear when it came to temperature, 86 per cent of them said that they think the temperature has increased over the last twenty years.

OBJECTIVES OF THE STUDY

i. To ascertain how farmers in Mubi Region perceive climate change
ii. To examine farmers perceive cause of climate change in Mubi Region

iii. To determine farmers perception on the direction of change change phenomena
iv. To ascertain farmers perception of extreme weather events in Mubi Region

RESEARCH HYPOTHESIS

Farmer's knowledge of climate change is not significantly influence by years of farming, age and education

The Study Area

Mubi Region lies between latitude $9^{0}30^{1}$, 11^{0} North of the equator and longitudes $13^{0}45^{1}$ East of the Greenwich meridian. The Region is bounded by Borno State to the North; West by Hong and Song Local Government Areas of Adamawa State and to the South and East by the Republic of Cameroon (See figure 1) it has a land area of $4728.77km^2$, with a population of 960,223 projected from 2006-17. The Region has five Local Government Area and 24 Districts, dry season last for a minimum of five (5) months (November to March) while wet seasons spans from April to October. The mean annual rainfall in the Region ranges from 900mm-1050mm (Adebayo, 2004). Generally planting of crops begins earlier in the mountainous area due to orographic factors. Agriculture is the mainstay of about 80% of the inhabitants of the area.

Research Method

A multistage sampling technique was used in the selection of the registered farmers from the study area. The first stage involved the consideration of the Five Local Government of the study area. While the second stage adopt the simple random selection of 60 percent of the District in each Local Government Area of the study area, the third stage constitute consideration of 5 percent of the registered farmers from each selected District as shown in Table 1, which resulted to 927 respondents for the research. Then two farming settlement were chosen through simple random sampling method from each of the selected District for the study, this yielded 28 settlements.

The study utilizes a structure questionnaires, participant observation and interview. Such structure questionnaire sought the respondents' opinion, knowledge or suggestion on farmer's perception of climate change. The questionnaire is close and open ended response format and was designed in a manner to capture all the variables in the study.

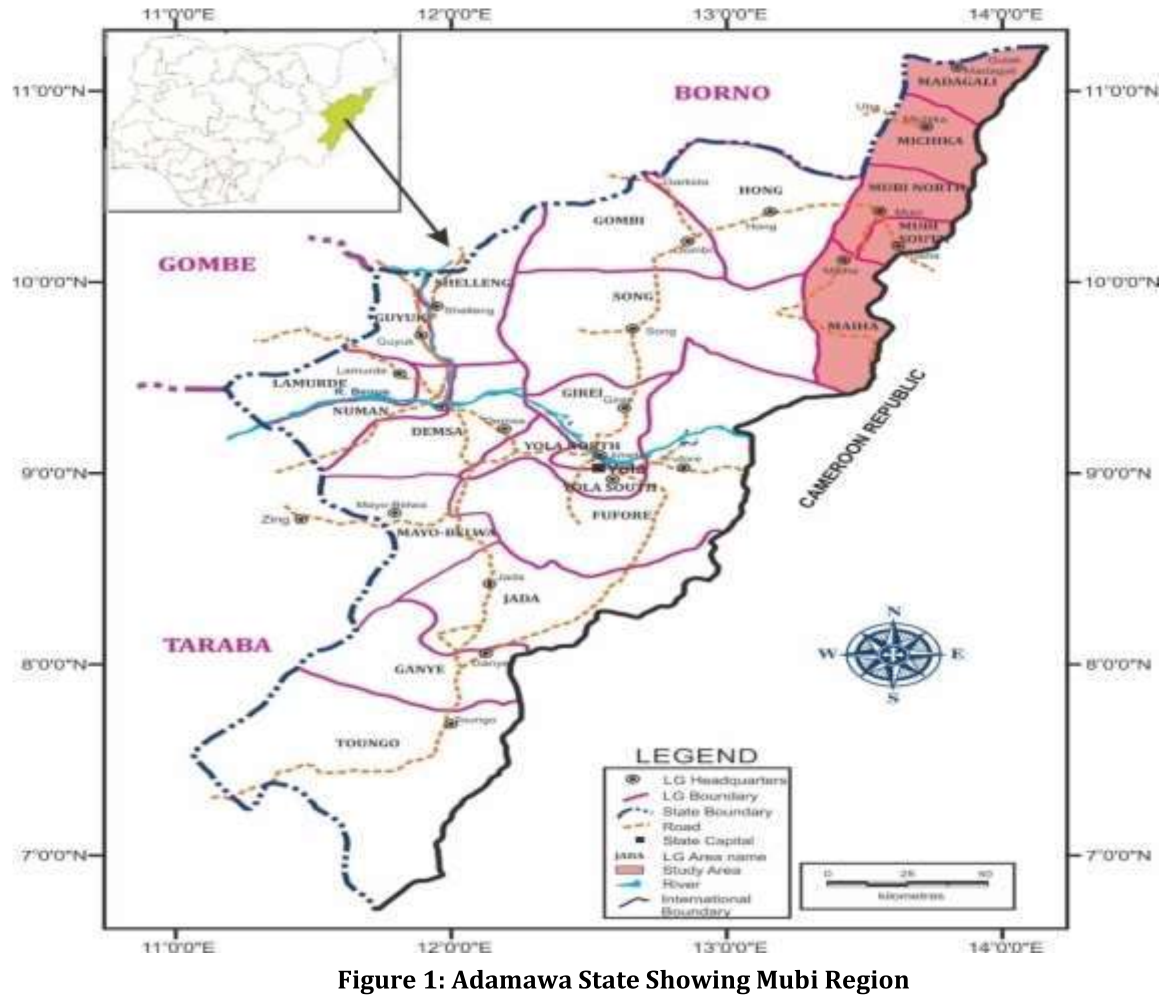

Figure 1: Adamawa State Showing Mubi Region
Source: Mubi Region, Geographical synthesis (2004)

TABLE 1

Number of farmers in each sample district with their sample size and total number of questionnaire copies administered

S/No	L.G.A	Selected District at 60 per cent	No. of register farmers in each selected district	A sample size of 5 per cent farmers	No. of settlement selected
1	Madagali	Madagali	1440	72	2
		Gulak	1220	61	2
		Mildo	1704	85	2
	Total		**4364**	**218**	**6**
2	Maiha	Maiha	1221	61	2
		Belel	806	40	2
		Sarou	1440	72	2
	Total		**3467**	**173**	**6**
3	Michika	Bazza	2342	117	2
		Vih	906	45	2
		Garta	2494	125	2
		Futu	890	45	2
		Zah	901	45	2
	Total		**7533**	**377**	**10**
4	Mubi North	Bahuli	1206	61	2
	Total	Mayo Bani	986	49	2
			2192	**110**	**4**
5	Mubi South	Gella	984	49	2
	Total				
			984	**49**	**2**
Total		**14**	**18,450**	**927**	**28**

Source: Federal Ministry of Agriculture and Rural Development (2018)

Technique of data analysis

Descriptive and inferential statistical techniques were used to analyze data collected. The data obtained were analysed using tables, simple percentages, and multiple regression and principal components analysis. Multiple regression analysis is a generalized statistical technique used to analyse the relationship between a single dependent variable and several independent variables. In this technique, non-metric variables (binary or categorical) can only be used by creating dummy variables (Hair, Black, Babin & Andersen, 2010). In the present study, multiple regression analysis was used to understand the influence of years of farming, age and education on farmers' knowledge of climate change. The test was used to identify the main factors or variables that contribute most to farmers' knowledge of climate change as well as show the level of explanation accounted by the predictor variables.

Also, Principal components analysis was used to identify significant factors responsible for perceive causes of climate change and farmers perceived extreme weather events in Mubi Region. PCA is a very powerful multivariate statistical technique which is performed to reduce the dimensionality of a data set consisting of a large number of interrelated variables, while retaining as much as possible the variability present in data set (Jianqin, Jingjing & Xiaojie, 2010). PC provides information on the most meaningful parameters, which describe the whole data set affording data reduction with minimum loss of original information (Vega, Pardo & Barrado, 1998). PCA attempts to transform a large set of inter-correlated indicators into a smaller set of composite indicators, uncorrelated (orthogonal) variables called principal components (PCs), and simplifies the structure of the statistical analysis system (Jianqin *et al.,* 2010).

PCA was performed in the present study to reduce the farmers perceive causes of climate change and famers extreme weather events, the data set as well as to extract a small number of latent factors for analyzing relationships among the elements (Wang, Guo & Jin, 2009). This was achieved by extraction only components with eigenvalues >1 after Varimax rotation (Otitoju & Enete, 2016). Component loadings according to Liu, Lin and Kuo (2003) can be classified as strong (>0.75), moderate (0.75-0.50) and weak (0.50-0.30).

RESULTS AND DISCUSSION

a) Farmers' perception of the climate change pandemic in Mubi Region

Table 2 showed that a good percentage of the respondents across the selected communities had knowledge of climate change. The result obtained means therefore that climate change is not a new word to residents in the respective communities. The increased knowledge may be attributed to the global cry about the threat of climate change over the past two decades. The changes in rainfall duration and intensity and other extreme weather events have increased people knowledge of climate change. The result obtained agrees with the finding of Adebayo *et al.,* (2012), Williams et al (2015) in Michika, Adamawa State where 89.9% of the farmers were aware of climate change and about 70% had knowledge of its causes. In a related study in

Bangladesh, Kabir, Rahman, Smith*et al.,* (2016) found that majority of the participants (54.2%) had some knowledge about climate change.

Farmers in the area also perceived climate change differently and as glaringly shown in Table 2, a good number of the respondents who are knowledgeable of climate perceived the impacts in terms of increased temperature (55.8%), decreased rainfall (23.1%), decreased rainfall duration (11.9%) and increased rainfall intensity.

With these varying climate change indices, it is apparent that climate change is not a new phenomenon to farmers in Mubi Region. In a related study in Bangladesh, Kabir*et al.,* (2016), Williams et al (2015) stated that majority of knowledgeable participants' perceived the impacts of climate change to include excessive temperature (83.2 %); 94.5 % perceived change in climate and extreme weather events; 91.9 % observed change in rainfall patterns and 97.8 % people believed increased in healthcare expenditure due to extreme weather events. The results obtained therefore shows that people across the study communities are aware of the impacts of climate change and they have diverse perception on its impacts in Mubi Region. Similar assertions were given by Kabir *et al.*, (2016) and Ajuang *et al.,* (2016). Farmers in the area held the opinion that climate change occasioned by extreme weather events such as increased temperature has impacted on their agricultural activities. This is expected as 87.3% of the farmers stated that climate change have had considerable effects on farming. This suggests that a good number of the farmers in the area have witnessed extreme changes in climate and weather conditions and these changes over time have had some effects on crop cultivation and other agricultural activities in the area. Nonetheless, a small group of the farmers did not feel or perceive any impact of climate change on agricultural activities.

TABLE 2

Farmers knowledge of climate change

Variables	Communities					Total %
	Madagali (%)	**Michika (%)**	**Mubi north (%)**	**Mubi south (%)**	**Maiha (%)**	
Knowledge of climate change						
Yes	95.9	97.2	98.9	100.0	93.1	96.4
No	4.1	2.8	1.1	-	6.9	3.6
Perceived indices of climate change						
Increased temperature	54.8	55.2	61.8	55.6	55.3	55.8
Decreased rainfall	22.3	23.7	20.2	22.2	24.5	23.1
Decreased rainfall duration	12.7	11.4	11.2	11.1	12.6	11.9
Increased rainfall intensity	10.2	9.7	6.7	11.1	7.5	9.2
Perceived impact of climate change						
Yes	77.7	90.8	93.3	100	84.9	87.3
No	22.3	9.2	6.7	-	15.1	12.7

Source: Researchers' fieldwork, 2018

This group believes the effect of changing climate conditions becomes a challenge in the absence of adaptation measures aid at managing the problems posed by changing climate.

b) Farmers' perceived causes of climate change in Mubi Region

Farmers have diverse understanding on factors responsible for climate change in Mubi Region. Principal components analysis (PCA) is employed in this part to identify principal components perceived by the farmers to be responsible for climate change in the area. This statistical technique was employed due to the number of variables used to measure the perceived causes of climate change in Mubi Region. The result obtained is shown in Table 3. PCA result of 10 variables resulted in the extraction of five components that accounted for 77.4% of the variation in the data set. Using component loadings of ±≥0.8 as the criteria for selecting variables, principal component one (PC_1) had strong and positive loading on two variables; the variables were use of insecticide/pesticides(0.970) and use of herbicide (0.967). PC_1 was accountable for 19.4% of total variance in the perceived set of data on the causes of climate change in the area and the positive loadings of the variables indicated increase in the use of insecticide/pesticides and herbicide. As a result of the two variables that loaded on PC_1, it therefore represented use of insecticide/herbicide. PC_2also had two variables that loaded positively on it; the two variables were overgrazing (0.959) and continuous cropping (0.938). $PC_2$was responsible for 18.8% of the total variance in the variable set and represented increase in land disturbance.

PC_3 was accountable for 18.4% of total variance in the perceived set of data on the causes of climate change in the area and had also two variables that loaded on it. The two variables were burning of fossil fuel (0.938) and deforestation (0.936). The positive loadings of the variables indicated increase burning of fossil fuel and deforestation. Based on the nature of variables that loaded in PC_3, it could be said to represent burning of fossil fuel/deforestation.PC_4 was accountable for 10.7% of total variance in the set of data and had only one variable that loaded on it. The variable was swamp rice production (0.845). PC_4symbolised clearing of swamp. The result further showed that F_5had one variable that loaded positively on it and the variable was bush burning (0.927). PC_5 was responsible for 10.2% of the variance in the data set and it represented bush burning. From the result presented in Table 3, it is glaring that five principal perceived factors responsible for climate change in the area include use of insecticide/herbicide, increase in land disturbance, burning of fossil fuel/deforestation, clearing of swamp and bush burning.

These five factors to a large extent contribute to climate change in the area. Insecticide/herbicides are used by farmers to control insect and pest as well as weeds in order to achieve improved crop production. The use of pesticides has increased as a result of the increasing climate change events such as increased temperature favouring the growth of pests and weed flora. Swedish University of Agricultural Sciences (2016) stated that higher moisture and higher temperature will increase the pressure from pests, and almost certainly result in an altered weed flora which is expected to increase the need for pesticides. In our agricultural fields, most of the pesticides used fall within herbicides, but climate change may result in a greater need for insecticides and fungicides in the future. The increased use of insecticides and fungicides will increase the concentration of chlorofluorocarbons in the atmosphere. In a related study, Palikhe (2007) stated that the use (and abuse) of pesticides has increased to combat insect-pests and diseases. However, the major causes concern of are the undesirable side effects of these chemicals on biodiversity, environment, food quality, human health and climate change.

It is interesting to observe that farmers across the selected communities are aware that human activities are the main causes of climate change. This result lends support to the findings of Ojomo, Elliott, Amjad *et al.*, (2015) when they found that 90% of study participants attributed climate change in southern Nigeria to human activities. The result also agrees with those of Pandve, Chawla, Fernandez *et al.,* (2011) in India when they found that 81.40% respondents attributed climate change to human activities.

Increase in land disturbance in terms of overgrazing and continuous cropping is other human activities that cause climate change. Increase in these practices over time results in the loss of vegetation thereby increasing the daily temperature due to the loss in vegetal cover that would have helped in carbon sequestration. Since forest vegetation and soils are principal reservoirs of carbon, help to reduce the atmospheric consequences of carbon dioxide (CO_2) concentration which results in global temperature rise; this is however interrupted and rendered functionless with the disappearance of green areas due to intensive farming systems and overgrazing (Offiong and Iwara, 2012). Burning of fossil fuel/deforestation also causes climate change because the practice results in the emission of greenhouses gases that heat up the lower atmosphere. These practices among others identified in Table 3 jointly cause climate change if not properly managed.

TABLE 3

PCA result showing the farmers' perceived causes of climate change[a]

Variables	Principal components				
	PC_1	**PC_2**	**PC_3**	**PC_4**	**PC_5**
Use of insecticide/pesticides	<u>0.970</u>	-0.018	-0.003	0.018	0.003
Use of herbicides	<u>0.967</u>	-0.026	0.011	0.007	0.010
Overgrazing	-0.017	<u>0.959</u>	-0.007	-0.004	-0.004
Continuous cropping	-0.025	<u>0.948</u>	0.040	-0.055	0.019
Burning of fossil fuel	0.016	0.039	<u>0.938</u>	-0.015	-0.025
Deforestation	0.009	0.015	<u>0.936</u>	-0.055	-0.012
Swamp rice production	-0.038	-0.067	-0.074	<u>0.845</u>	0.126
Use of fertilizer	0.205	0.132	-0.097	0.608	-0.322
Urine/droppings from cattle	-0.109	-0.126	0.259	0.363	0.196
Bush burning	0.045	0.043	-0.040	0.053	<u>0.927</u>
Eigenvalues	1.94	1.88	1.84	1.07	1.02
% variance	19.35	18.82	18.41	10.66	10.18
Cumulative exp.	19.35	38.17	56.59	67.24	77.42

[a]the underlined with coefficients ±≥0.8 are considered significant

Source: Researcher's fieldwork, 2018

c) Influence on farmers' education, age and years of farming on knowledge of climate change

The hypothesis which states that farmers' knowledge of climate change is influenced by years of farming, age and education was tested using multiple regression analysis. Before this analysis was performed, the usual transformation or recoding of variables was carried out to make the selected data set suitable for parametric test. The result of the multiple regression analysis is presented in Tables 4 to 6. It showed that education, age and years of farming jointly contributed 23.4 per cent of the changes in farmers' knowledge of climate change. The remaining percentage of 76.6 per cent simply suggests that education, age and years of farming are not the sole or principal factors that determine farmers' knowledge of climate change. This is expected as several factors interaction and come into play in influencing the knowledge base of farmers concerning climate change.

Table 5 shows the ANOVA result and it indicated that education, age and years of farming have significant influence on farmers' knowledge of climate change ($F = 9.786$, $p<0.05$). This result obtained therefore shows that to a greater extent farmers' knowledge and they way they adapt to changing climate scenarios is influenced by their level of education, age and years of farming. This implies that these three factors go a long way in making farmers have real on-field and off-field experience on climate change, its impacts and how the impacts can be minimized for improved agricultural production (meaning the 23.4% R^2 is significant).

The significance of the predictor variables indicated that the three predictor variables exerted significant influence on farmers' level of knowledge of climate change (Table 6). The strength of each predictor was ranked using the product of standardized regression coefficients (beta). From the results obtained, years of farming exerted the most influence on farmers' level of knowledge of climate change; this was followed by age of farmer. However, among the predictor variables, education was the least factor that exercised immense influence on farmers' level of knowledge of climate change. The fact that years of farming is the most important factor that affects farmers' level of knowledge of climate change is anticipated. This is because farmers who have spent good number of years in farming have better experience on how to manage extreme weather events than their counterparts that have spent just five years or less. Since they have been in the business for years and have been affected by weather outcome in the past, the knowledge gained over time will help them in putting in appropriate measures on time to mitigate the consequences of climate change.

TABLE 4

Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.484	0.234	0.231	0.215

TABLE 5

ANOVA of the influence of education, age and years of farming on farmers' knowledge of climate change

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	1.355	3	.452	9.786*	0.000
Residual	38.542	835	.046		
Total	39.897	838			

*Significant at 5% alpha level

TABLE 6

Coefficients

	Unstandardized Coefficients		Standardized Coefficients		
Model	B	Std. Error	Beta	t	Sig.
(Constant)	.785	.032		24.634	.000
Education	.044	.021	.073	2.119*	.034
Farming years	.098	.029	.118	3.367*	.001
Age	.047	.019	.086	2.478*	.013

*Significant at 5% alpha level

Also, years of farming enables farmers to understand changes in crop behaviour and the possible reasons for the observed changes and the exact measure to put in place to mitigate the impacts. A little discussion held with some of the farmers affirms the result obtained. For instance, some of the rice farmers who have been in the farming business for over 15 years gave detailed account on how climatic factors affect rice production and they stated that rice yield tend to be poor during season of excessive rainstorms and that increased rainstorms are associated with rice diseases. The result obtained and reported in the present study is consistent with those of Odewumi, Awoyemi, Iwara et al., (2013) when they found length of farming to exert significant influence on farmers' perception of climate variation. They stated that years of farming enable a farmer to understand changes in crop behaviour and the possible reasons for the observed changes by comparing yearly harvest and rainfall duration among other variables. It is also consistent with the study by Nhemachena and Hassan (2007) that farming experience increases the probability of uptake of all adaptation options because experienced farmers have better knowledge and information on changes in climatic conditions and crop and livestock management practices. The second potent factor as shown in Table 6 is the age of farmers. Age like years of farming is a significant factor that enables farmers to relate farming events and outcome to reasoning. Older farmers and those who have been in farming business for years have a better understanding of crop changes and can be attributed to perceived changes in climatic conditions. Older farmers are more experienced than young farmers and are able to use their age in making effective decisions.

d) Farmers' perception on the direction of change of climate phenomena

Further attempts are made to assess and understand farmers' direction of change (increase or decrease) of climate phenomena in Mubi Region for over 20 years. The result in Table 7 shows the uncertainties in the onset of farming activities in the area. One of the obvious uncertainties is the early rains that are not sustained throughout the farming season. As shown in Table 7, across the communities, a good percentage of the farmers believed there is increasing uncertainties in the direction of rains as the early rains ends up to be sporadic and erratic and this can have substantial impact on farming activities. Farmers as a result of the uncertainties in the early rains are not influenced into cultivating their crops. This is influenced by experience gained in the previous years where the early rains made farmers to plant their crops and after which, there were periods of increased dry spells resulting in the dead of plants and crops. However, not all the farmers held the opinion of increasing uncertainty in the early rains. This is because 34.5% of the farmers had the opinion that over time, the uncertainties in the early rains have decreased. This group of farmers believes that over time, the early rains have been sustained with little periods of dry spell which are inconsequential to harm crops.

It could therefore be said that farmers in the area have varied perception on the sustainability of the early rains with a higher percentage believing in the increased uncertainties in the early rains. In addition, a larger percentage of the farmers across the selected communities believed the over time, the possibility of crops planted to become smothered by heat waves has decreased, while 33.6% had a contrary view. This group feels the possibility of crops planted to become smothered by heat waves is in the increase. They believe with increased temperature and deduced wet spell, crops become withered by dropping their leaves. It therefore suggests decrease possibility in crops to become smothered by heat waves. Also, as a result of the uncertainties in the rains, there has been sustained increase in crop planting and replanting. As already argued above, the increase unsustainability of the early rains has resulted in the dead of crops, and to meet up with food supply and to generate income, farmers in the area plant and replant crops. Dead crops are replanted as well as those that do not grow well are destroyed or removed and new ones planted. This approach is aimed at mitigating the adverse effects of climate change on farmers' livelihood.

A good number of the farmers (44.2%) believed the shift in the start or end of the rains has also decreased. This is apparent as the start or end of the rains has remained unpredictable as a result of increasing changing climate. The variability has become unpredictable as the events recorded in the present year may not be the same for next year and so on. Over time, the shift in the start or end of rains has decreased and the reduction is attributed to changing phenomena. Result obtained is consistent with those of Wolka and Zeleke (2017) when they reported that all farmers in Gessa Chare, Ela Bacho and Subo Tulama kebeles unanimously perceived the prevalence of climate change in their areas. Major evidences were change of rainfall trends and intensity and also perceived increase in temperature. Also, majority of the respondents in all kebeles perceived that high temperature and low and erratic rainfall as their evidences.

TABLE 7

Direction of change of climate phenomena as perceived by farmers

Variables	Communities					Total %
	Madagali (%)	Michika (%)	Mubi north (%)	Mubi south (%)	Maiha (%)	
Early rains that are not sustained						
No change	4.6	10.0	3.4	2.8	3.1	6.4
Decreasing	40.1	40.9	24.7	13.9	23.3	34.5
Increasing	55.3	49.0	71.9	83.3	73.6	59.0
Crops planted become smothered by heat waves						
No change	32.0	30.6	25.8	5.6	10.7	25.6
Decreasing	46.2	31.5	39.3	77.8	47.8	40.8
Increasing	21.8	37.9	34.8	16.7	41.5	33.6
Crops planting and replanting						
No change	17.3	27.9	6.7	58.3	9.4	21.0
Decreasing	39.1	27.6	47.2	19.4	44.7	35.2
Increasing	43.7	44.6	46.1	22.2	45.9	43.8
Shift in the start or end of rains						
No change	22.8	26.2	5.6	13.9	10.1	19.6
Decreasing	42.6	41.5	46.1	72.2	44.7	44.2
Increasing	34.5	32.3	48.3	13.9	45.3	36.2

Source: Researchers' fieldwork (2018)

In a related study, IPCC (2007) stated that agricultural productivity is responsive to two broad factors of climate-induced effects which are (1) direct effects caused by changes in temperature and precipitation, and (2) indirect effects through changes in soil moisture and the distribution and frequency of infestation by pests and diseases. The study stated that crops such as rice and wheat yields may possibly decline noticeably with climatic changes.

e) Farmers' perception of extreme weather events

Farmers in Mubi Region have different perception on climate phenomena mostly as it relates to changes in extreme weather events or scenarios. There are several extreme weather events used by farmers to address or portray climate change. Fifteen extreme weather events are used to understand farmers' assessment of climate related extremes (Table 8). Results of principal components analysis (PCA) revealed that out of the 15 variables used, five components accounting for 50.1% of the variation in the data set were extracted. Using component loadings of ±≥0.7 as criteria for selecting variables, PC_1 had strong and negative loading on one variable; the variable was declining soil fertility (-0.778). PC_1 was responsible for 11.2% of total variance in the data set and the negative loading indicated decrease soil fertility with the increase in the manifestation of climate change events. PC_1 represented decline in soil fertility. PC_2 was responsible for 10.7% of the total variance in the variable set and represented increase in disease outbreak. PC_3 was accountable for 10.5% of total variance and represented increase in rill erosion. PC_4 signified increase in floods and explained 9.4% of the variation in the data set, while PC_5 was responsible for 8.3% of the variance in the data set and it represented increase in heavy rainfall. The result presented in Table 4.18, based on the extracted components identifies five principal factors as farmers' perceived extreme weather condition and the factors include decline in soil fertility, increase in disease outbreak, increased rill erosion, increase in floods and increase in heavy rainfall.

These five factors represent the apparent situation of extreme weather condition in Mubi Region. The first extracted component depicts decline in soil fertility. This is expected due to intensive farming and loss of vegetal cover that has made farmland vulnerable to extreme weather events like rainfall and wind as well as result in the decline in soil carbon. The increase in human population over time has also put more pressure on available land thereby increasing the rate of land use change which in the long-run affects soil fertility conservation and Carbon storage in the soil. The felling down of trees to cater for human needs exposes the land to the direct effects of rainfall and wind, these two extreme weather or climate events affect soil fertility conservation.

TABLE 8

PCA result showing the farmers' perceived extreme weather events[a]

Variables	Principal components				
	PC1	PC2	PC3	PC4	PC5
Declining fertility	<u>-0.778</u>	-0.016	0.128	-0.113	-0.006
Sheet erosion	0.677	0.218	0.194	-0.085	-0.112
Wind erosion	0.657	-0.150	0.039	0.013	0.006
Diseases	0.140	<u>0.788</u>	0.010	0.191	-0.038
Weeds	0.081	0.658	-0.018	-0.121	0.446
Pests	-0.244	0.595	0.110	-0.023	-0.248
Rill erosion	0.067	0.151	<u>0.707</u>	0.042	0.058
Thunderstorms	-0.106	0.032	0.591	-0.027	-0.119
Drought	0.124	-0.142	0.588	0.107	0.089
Floods	-0.084	0.137	-0.210	<u>0.801</u>	-0.036
Gully erosion	0.171	-0.137	0.239	0.601	-0.016
Heavy winds	-0.017	0.203	0.345	0.475	0.272
Heavy rainfall	-0.181	0.016	0.124	0.012	<u>0.789</u>
Heart waves	-0.154	0.225	0.317	-0.078	-0.407
Eigenvalues	1.56	1.5	1.47	1.32	1.16
% variance	11.15	10.74	10.49	9.44	8.31
Cumulative exp.	11.15	21.89	32.38	41.81	50.12

[a]the underlined with coefficients ±≥0.7 are considered significant

Source: Researcher's fieldwork, 2018

Also increase in CO_2 can impact on soil properties. In a related study, Carney, Hungate, Drake*et al.,* (2007) observed soil organic Carbon levels decline under increased atmospheric CO_2 levels as a result of increased microbial activity. Also, Hobbs and Govaerts (2010) stated that human actions strongly affect the Carbon balance in managed soils. Soil management technique like no-till systems can result in lower CO_2 emissions from and greater C sequestration in the soil as compared to intensive tillage.

Climate change phenomena such as increased temperature and rainfall resulting in flood have led to the increase in disease outbreak in different parts of the globe. Increase in temperature and rainfall can favour the growth and survival of certain insects and pest which are harmful to humans and other biotic lives. Flood results in water pollution and can be breeding ground for pest and insect. Increase in pest mostly on farmland affect crop yield. Also, increase in temperature favours the growth of insects like mosquitoes resulting in the prevalence of malaria mostly in the tropics. This if not adequately managed can result in million deaths. Shuman (2010) stated that the changing rainfall patterns and rising global temperatures are already affecting the incidence and geographic distribution of certain infectious diseases. A recent study carried out by Siraj, Santos-Vega, Bouma et al., (2014) reported to a shift in malaria distribution towards higher altitudes in both Ethiopia and Colombia in warmer years. Higher rates of illness and death due to malaria have also been observed in highland regions of East Africa (Zegarac, 2017).

Increased rill erosion and increase in floods are other perceived extreme weather events associated with climate change. These two ecological problems are triggered by the increase in rainfall mostly heavy rains and increased rainfall duration cum intensity. Centre for Climate and Energy Solutions (2018) stated that the most abrupt impact of heavy rainfall is flooding and that the risk can be worse in urban areas where impermeable pavements force water to quickly run off into sewer systems. Apparently, when heavy rainfall is experienced in an area and it lasts for hours or days, it results in flooding and the surface runoff results in soil erosion which if not controlled can be destructive to farmlands and infrastructure. The early rains and winds bring about rill erosion and over time with the development of channels and increase amount as well as surface runoff, it develops into gully erosion. This damages farmland and makes land unproductive. In a related study, Chinweze (2017) stated that Africa is one of the most risk continents to climate variability and change as a result of multiple stresses and low adaptive capacity. The study stated that Nigeria have experienced major climate-change-induced natural disasters, evidenced through high precipitations that lead to flooding and soil erosion thereby destroying plants and properties. Another perceived extreme weather condition is the increase in heavy rainfall. Studies like those of Centre for Climate and Energy Solutions (2018) have shown that extreme rainfall events and trends will continue as the planet continues to warm. It is stated that warmer air holds more water vapour and for each degree of warming, the air's capacity for water vapour increases to about 7% (Centre for Climate and Energy Solutions, 2018).

The result obtained is consistent with the findings of Villarini, Smith, and Vecch (2013) when they reported increasing trends in the frequency of heavy rainfall over large areas in the US. Though, the frequency of rains according to the farmers has declined over time, but heavy rainfall is still being experienced in the area. Heavy rainfall has a lot of consequences: it can result in the loss of topsoil nutrient, destroy crops, result in serious soil erosion problem, increase the incidence of disease and result in surface water pollution among others.

CONCLUSION AND RECOMMENDATION

The study has shown that climate change phenomena exist in Mubi Region and a significant proportion of the farmers are knowledge on the issue. The study clearly shows that farmers in the area perceive climate change impact differently with a significant number understanding the impacts in terms of increased temperature, decrease rainfall, decrease rainfall duration and increased rainfall intensity. The farmers also perceived cause of climate change as a result of use of herbicides, overgrazing, continuous cropping, deforestation and bush burning. Famers in the Region have different perception or perceive extreme impact of weather events in terms of declining soil fertility, diseases, rill erosion, flows and heavy rainfall.

Finally, it is recommended that government policies and strategies should mobilize, facilitate and promote the realization of farmers needs based on understanding of the farmers perception on climate change and measures mitigate them in the study area.

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