Examination of Farmers' Perception on Adaptation Measures Toward Modifying Climatic Challenges for Agricultural Sustainability in Northern Nigeria

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ABSTRACT

This study examines farmers' perceptions on adaptation measures toward modifying climatic challenges for agricultural sustainability in northern Nigeria. The data were mainly derived from several sources, including maps of Nigeria and the selected States, population figures from records of the National Population Commission and from internet and library sources, as well as from questionnaire survey of farmers' opinions. Stepwise sampling technique was employed in the selection of respondents for the questionnaire survey. Frequency tabulations and ANOVA were used to collate and analyze the variations within and between states in the farmers' measures of modifying environmental challenges in northern Nigeria. It was concluded that 86% of the farmers were positive about climatic adaptation measures in Northern Nigeria, to the extent that there is no variation within and between states (F-value = 0.016), across the region. It was recommended that efforts at improving local or indigenous practices of water harvesting and soil water conservation should be promoted.

Key words: Perception, Adaptation, Climatic Challenges, Agricultural Sustainability.

INTRODUCTION

The growth of human population coupled with increased economic activities and increased consumption of goods and services in towns and cities can focus our minds on the understanding of the climatic influence on peoples' daily economic activities. For instance, high summer temperatures, due to higher insolation and low winter temperatures, due to lower insolation. Equally, days are usually longer in summer and shorter during winter. These seasonal changes are widely experienced all over the globe as they originate from the regular orbit around the sun (Iwena, 2007).

One of the Bottom–up theories of perception pointed out by Démuth (2017) showed that the content and quality of sensory input play a determinative role in influencing the final percept. Sensory input, in their view, represents the cornerstone of cognition and by its own nature, it determines further sensory data processing. For example, when perceiving a tree, our sensors collect the basic data (such as points, horizontal or vertical lines) as the main individual characteristics of the object, which are later connected to build more complex, assembled surfaces and shapes in order to create a complex perception of the object we identify as a tree. Therefore, we can call this data-driven processing perception. With respect to the emphasis these theories put on the nature of sensory input. It is not surprising that most of them significantly

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correlate with philosophical realism, which suggests that our precepts are directly induced by external objects and more or less correspond to them.

Patterns of the impact of climate change on agriculture were classified by Khanal (2009) into biophysical and socioeconomic impact. The biophysical impacts include physiological effects on crop and livestock, change in land, soil and water resources, increased weed and pest challenges, shifts in the spatial and temporal distribution of impacts, sea level rise and changes to ocean salinity and sea temperature rise causing fish to inhabit in different ranges. The socioeconomic impacts result in a decline in yield and production, reduced marginal GDP from agriculture, fluctuation in world market price, changes in the geographical distribution of trade regime, increased number of people at risk of hunger and food insecurity, migration and civil unrest. Adaptation measures to climate change involve living with the climate change itself; for example, agroforestry, conservation agriculture, inter-cropping, biodiversity and collection of rainwater for agricultural use which are referred to as rainwater harvesting. This process is particularly important in arid and semi-arid Northern Nigeria.

Northern Nigeria is characterized by rainy and dry seasons as the two major distinct seasons. The former usually occurs between May to September, whereas the latter between October to April (Iwena, 2007). For instance, Agricultural activities comprising livestock and crop production are some of the most important economic activities in the study area. Northern Nigeria is an agricultural region with vast fertile soils as an added advantage for agricultural production. Agriculture, therefore, contribute a greater percentage of the peoples' income in the region.

Seasonal changes have resulted in several pervasive effects on people economic activities. The rainy season is meant for planting and weeding, while the dry season is a period for harvesting and trading. Farmers are conditioned to adapt their activities to seasons. The question now is: how sustainable are the agricultural activities and what influence do climatic variations have on agricultural activities in Northern Nigeria? Why is it that when rainfall starts earlier than expected, a farmer is obliged to plant earlier? It is therefore important to know the farmers adaptation measures on the influence of climate on agricultural sustainability.

Despite the relevance of agriculture as an occupation and source of food supply in the study area, it might, however, be envisaged that the climate can influence this great economic activity, hence the need for examining farmers' adaptation measures toward modifying climatic influence for augmenting agricultural sustainability in northern Nigeria, with the view of creating more awareness on climatic influence towards achieving profitable agricultural productivity.

The Study Area

Northern Nigeria is located between Longitudes 3º and 15º east of Greenwich Meridian and Latitudes 9º and 14º north of the Equator. Extreme Northern Nigeria can be described as all the states that are entirely located in the far Northern portion of the Country. The States located in this zone are Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe – in the North East and Jigawa, Kano, Kaduna, Katsina, Kebbi, Sokoto and Zamfara – in Northwest (Fig. 1).

The climate of the region is characterized by alternate wet and dry seasons in response to the changes in pressure patterns. The rainy season in this region is associated with late-onset and earlier cessation, the onset and cessation are also characterized by destructive storms which destroy lives and property (Abdulkadir *et al* ., 2013). Further to that, the seasonal and latitudinal variations affect diurnal and seasonal temperature ranges. Also, in areas north of latitude 9º within Northern Nigeria, maximum and minimum air temperatures recorded mainly occur between March/April and between December/January, respectively.

The general relief of this belt is between 300m to 900m, except the Niger-Benue trough, Sokoto and Chad

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Basins that are below 300m. Extreme Northern Nigeria is dominated by savanna vegetation types; Guinea, Sudan and Sahel savanna, the density of trees and grasses decrease northwards responding to climatic conditions. Agriculture is the most dominant economic activity in the region.

REVIEW OF RELATED LITERATURE

Climate and management can affect the incidence of insects, pests and diseases, which in turn have a negative influence on crop yields and quality of produce and producer's costs and returns. In this regard, Ayanlade *et al.*, (2018) observed a significant relationship between the length of farming experiences and farmers' perceptions of climate change adaptation techniques. The researchers pointed out that water-related (about 53%) and nutrient-related (about 52%) technologies appear to have a high preference among the farmers. The major driver that determines farmers' preference for climate change adaptation techniques is their incomes and experiences. Temperature and water supply also vary over the long term, including response to climate change, with major implications for crop yield. This was

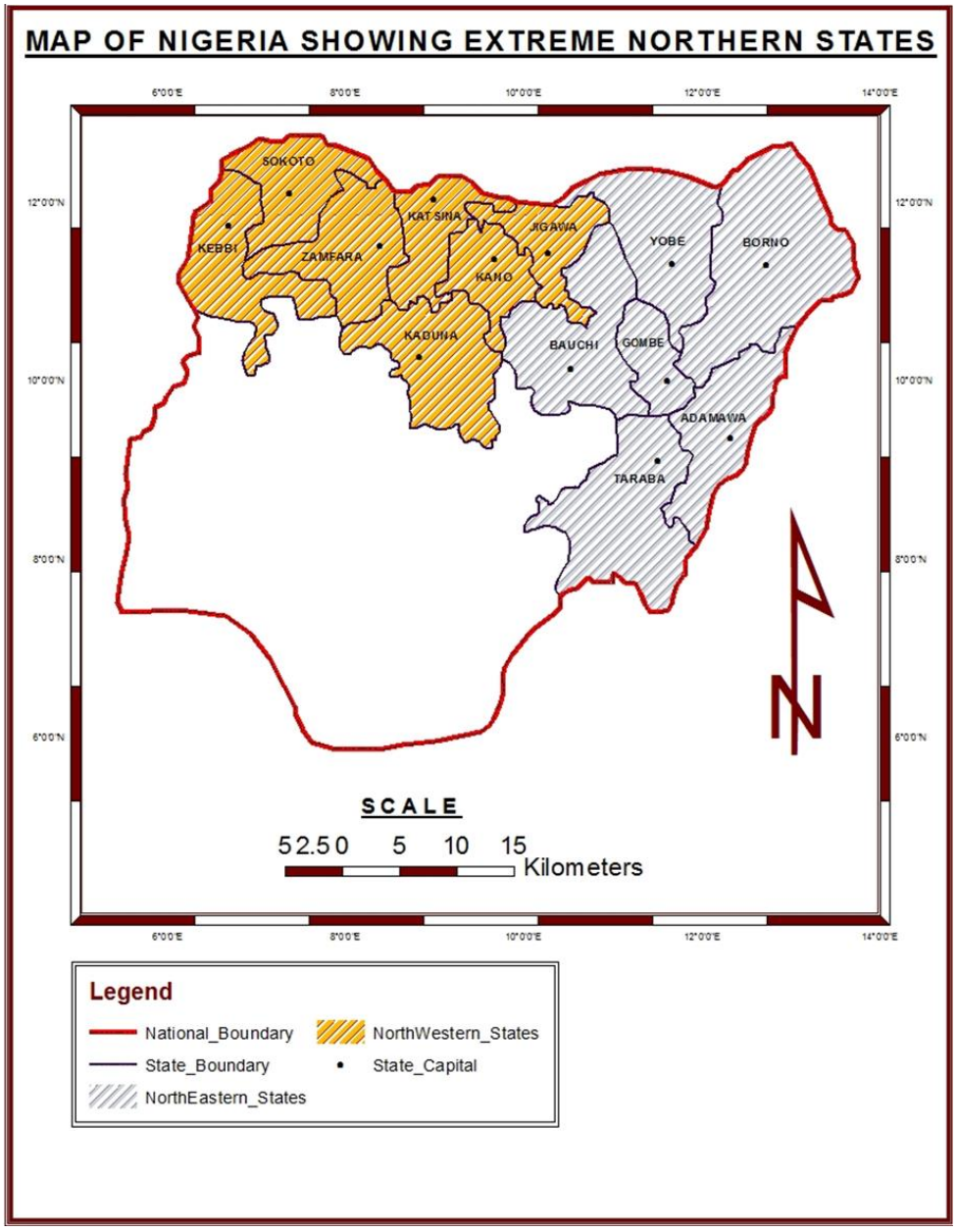

Figure 1: Location of the Study Area

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exemplified by the recent climatic condition of 8th June, pointed out by Nigeria Meteorological Agency (NiMet) (Daily Trust, 2021), that severe dry spell will hit Northern states, especially the states of Katsina, Kebbi, Niger, Sokoto, Yobe, Zamfara, and some parts of Borno.

Climatic factors are key determinants to crop production processes; solar radiation, rainfall and temperature fluctuations lead to water shortage, rising tide, altering soil moisture content, pest and disease occurrence that restrict crop growth and can account for 15 – 80% of the deviation of inter-annual yield resources (Dahiya *et al*., 2018). Therefore, studying the major determinants of climate on crop productivity will extremely be beneficial. In this vein, the researchers pointed out that: Temperature mainly indicates the heat concept of a physical structure. It shows the intensity of heat energy or degree of hotness or coldness. Temperature mainly affects the plant activities that govern the mechanisms of hormones and genes. Temperature affects crops from sowing to final yields with various degrees. The growth and development of plant occur in the range of about 0 to 35°C. Within most of this range, with every 10°C rise in the temperature, increases the growth by 2-3 times. However, hot-temperature fruits and vegetables that require hot temperatures to grow, such as watermelons, peppers and tomatoes, grow faster and have better quality, including higher sugar content, as temperatures rise until it reaches the growth inhibition limit (35°C). On the contrary, for open-field vegetables that favour cool temperatures such as radish and Korean cabbage, high temperatures may result in lowered quality.

Further to that, Light quality (sunshine), duration and intensity influence plant growth and development to varying levels in different plants; Full range of visible spectrum of light is needed for the normal growth and development; Duration of light extremely affects vegetative as well as reproductive growth; The rate of photosynthesis increases logarithmically with the increasing light intensity. But there occurs a point at which further increases in light intensity will not increase photosynthesis, known as light saturation intensity. Radiation (solar radiation) is the principal source of energy for various agricultural purposes. Out of the total spectrum, the visible part of the spectrum (0.4 to 0.7 μ) contributing about 45% of the total global radiation, which affects a number of plant functions and controls the plant growth and developments (Dahiya *et al*., 2018). Rain fed crops directly depend on rainfall. Rainfall is the most important climatic factor for agriculture. In agriculture, rainfall mainly manifests itself through its effect on edaphic factors (soil moisture, soil temperature and aeration). In this regard, agricultural management practices have been encouraged by Mutimura *et al*. (2019) to improve the productivity of crop species, considering the low farmers' adoption level.

METHODOLOGY

This study adapted stepwise sampling approaches. Based on Griffin and Hauser (2013) that recommend selecting a sample size of 20 – 30 in a homogenous target audience/segment, the purposive sampling technique was used to select four settlements practising agricultural activities. The selection was made LGA wise from the randomly selected states in extreme Northern Nigeria. Accordingly, 40 sample size per sample point was employed, which yielded a total sample of 640 (Table 1 and 2). The structured questionnaire developed by the researchers was the data collection instrument used to generate information from the farmers as regards their perception on the adaptation measures toward modifying climatic influence in the Northern region.

Quantitative and qualitative data were analysed using the Statistical Package for Social Sciences (SPSS – Version 20) and frequencies tabulations. Furthermore, farmers' opinions were examined using ANOVA to analyse variations within and between states in the influence of climate on agricultural sustainability in northern Nigeria.

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RESULTS AND DISCUSSION

Sex and Age Characteristics of Respondents

The respondents in this work were farmers in extreme Northern Nigeria whose demographic characteristics were presented in Table 3. The Table showed that 97% of the respondents were males, while females representing about 3% in the sample appear disproportionately fewer. Even though there is a wide discrepancy in the proportion of males to females in the sample, it is a true representation of the population because the males turn out to be the dominant agriculturalists in Northern Nigeria. This could further be explained by the common fact that, in the structure of farming activities in most of our communities in Northern Nigeria, the males dominated in the activity, hence influencing their representativeness in the sample. In terms of age distribution, it has shown that about 74% of the respondents from this sector were in the age range of 30 – 50 years and represented the active age group. About 24% were aged less than 30 years. By implication, a substantial majority of the people engaged in Agricultural activities were in their active (productive) age group. This age structure may have positive implications for job performance and effectiveness in agricultural productivity.

Based on the above presentation, it would appear that majority of the respondents in this research were males, whereas by age they mostly fall between the ages of 30 – 50 years. This showed that, they are also within the active economic age group with enabling and better perception, understanding to actively involve, serve and contribute to community development in various capacities in extreme Northern Nigeria. What needs to be provided in motivating the

Table 1: Districts and Major Settlements in Northern Nigeria by LGAs

STATE	LGA	Settlements
Adamawa	Numan Mayo Belwa	Numan Mayo Belwa
	Shelleng	Kiri
	Girei	Girei
Bauchi	Itas/Gadau	Yashin Gabu
	Katagum	Madara
	Ningi	Nasaru
	Kirfi	Kirfi
Jigawa	Hadejia	Hadejia
	Birnin kudu	Birnin Kudu
	Kafin Hausa	Kafin Hausa
	Kiyawa	Kiyawa
Zamfara	Gusau	Mada
	Kaura Namoda	Kaura
	Tsafe	Tsafe
	Talata Mafara	Mafara

Source: Field work, 2023

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Table 2: Sampling points and sample size Distribution by LGA

STATE	LGA	Settlements	Number of respondents by settlements	Total
Adamawa	Numan	Numan	40 x 4	160
	Mayo Belwa	Mayo Belwa		
	Shelleng	Kiri		
	Girei	Girei		
Bauchi	Itas/Gadau	Yashin Gabu	40 x 4	160
	Katagum	Madara		
	Ningi	Nasaru		
	Kirfi	Kirfi		
Jigawa	Hadejia	Hadejia	40 x 4	160
	Birnin kudu	Birnin Kudu		
	Kafin Hausa	Kafin Hausa		
	Kiyawa	Kiyawa		
Zamfara	Gusau	Mada	40 x 4	160
	Kaura Namoda	Kaura		
	Tsafe	Tsafe		
	Talata Mafara	Mafara		
Total				**640**

Source: Field work, 2023

Table 3: Sex and Age Characteristics of the Respondents by State and LGAs

STATE	LGA	Sex (Number)		Age (Number)			
		Male	Female	Years			
				<30	30 – 40	41 - 50	50>
Adamawa	Numan	33	07	11	25	4	0
	Mayo Belwa	40	00	12	24	3	1
	Shelleng	36	04	5	30	4	1
	Girei	39	01	10	23	7	0
Bauchi	Itas/Gadau	40	00	12	22	6	0
	Katagum	40	00	10	25	5	0
	Ningi	37	03	11	23	6	0
	Kirfi	38	02	9	26	4	1
Jigawa	Hadejia	40	00	10	25	4	1
	Birnin kudu	40	00	9	23	6	2

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	Kafin Hausa	40	00	11	27	2	0
	Kiyawa	40	00	6	29	5	0
Zamfara	Kaura Namoda	40	00	9	23	7	1
	Tsafe	39	01	10	25	5	0
	Talata Mafara	40	00	12	22	3	3
	Maru	40	00	9	28	3	0
Total		622	18	156	400	74	10
Percentage (%)		97.19	2.81	24.38	62.50	11.56	1.56

Source: Field work, 2023

level of perception and productivity of farmers with this caliber is government support through enhancing their welfare, job security improvement and adequate supply of equipment and materials, among others. These if fully actualized, improved productivity will be realized, and thence the augmentation and actualization of more awareness on climatic influence, benefits/difficulties as well as modifying measures towards achieving profitable agricultural productivity.

Farmers' Adaptation Measures Toward Modifying Climatic Challenges

The farmer's perception about adaptation measures toward modifying climatic challenges in northern Nigeria is presented in Table 4. Pertaining farm strategies, the Table depicted that 99% of the respondents were positive about changes in soil tilling pattern and/or frequency in order to uphold the soil capacity hold more moisture, against 1% who held a negative opinion and disagreed. About 84% agreed with shifting from traditional farming practices and adopting modern farming technologies, against 16%. In the whole, farmers' opinions were positive about adaptation measures ranging from 73% (mitigating effects of irregular seasonal changes) to 99% (adopting new seed varieties such as drought-resistant seeds and early maturing seeds).

Table 4: Farmers Perception about Adaptation Measures toward Modifying Climate Challenges in Northern Nigeria

Adaptation Indicators	**Frequency of Responses**				**Total**
	Agree	**%**	**Disagree**	**%**	**%**
On Farm Strategies					
Changes in soil tilling pattern and/or frequency in order to uphold the soil capacity hold more moisture	633	98.91	7	1.09	100
Shifting from traditional farming practices and adopting modern farming technologies	539	84.22	101	15.78	100
Shifting and re-strategizing planting periods in order to adapt to sporadic seasonal changes	465	72.66	175	27.34	100
Shifting farm activities such as plough, weeding, inputs (such as fertilizer and sprays) to mitigate effects of irregular seasonal changes	512	80.00	128	20.00	100
Adopting new seed varieties such as drought resistant seeds, early maturing seeds etc.	633	98.91	7	1.09	100

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Adopting resistant livestock varieties that are more adept to seasonal changes	576	90.00	64	10.00	100
Change in grazing patterns and adopting new ways to adapt to seasonal variations	453	70.78	187	29.22	100
Change in grazing routes to more friendly routes adept to seasonal variations	449	70.16	191	29.84	100
Information and Education					
Paying more attention to weather information in order to plan better on variations in seasons	634	99.06	6	0.94	100
More careful about climate prediction and warnings as opposed to negating them	525	82.03	115	17.97	100
General Activities					
Tree planting to mitigate the effects of seasonal variations especially in the face of climate change and to replenish the soil, ecosystem, ground water sources and protect the environment	453	70.78	187	29.22	100
Avoiding deforestation so the more tree can survive to replenish the soil, ecosystem, ground water sources and protect the environment	500	78.13	140	21.88	100
Sustainable management of water resources so it can be better and available for longer periods without damaging it	639	99.84	1	0.16	100
Looking for Alternatives					
Conservation of water resources to be better utilized	568	88.75	72	11.25	100
Watering and other irrigation method as an alternative for mitigating the effects of seasonal variations on agriculture	637	99.53	3	0.47	100
Alternative energy sources for households to safeguard the environment, ecosystem and ultimately agriculture	578	90.31	62	9.69	100

Source: Field work, 2023

Similarly, on information and education, 99% were positive about paying more attention to weather information in order to plan better on variations in seasons, and 82% about being more careful on climate prediction and warnings. These views were contracted by about 1% and 18% respectively. Relative to general activities, about 71% of the respondents agreed with Tree planting to replenish the soil, ecosystem, groundwater sources and protect the environment, as opposed to only 29% who held a contrary opinion and disagreed. This was followed by avoiding deforestation (78%) and sustainable management of water resources (100%). Pertaining alternatives, the majority of the respondent (89%) opined conservation of water resources against only 11%. This opinion was followed by such positive alternative responses as; watering and other irrigation method (100%) and house hold's energy alternative sources (90%)

Based on these findings can be deduced that farmers' in northern Nigeria have a positive perception toward mitigating climatic challenges by opting to several measures of modifying seasonal variations, including, but not limited to; i) Farm Strategies such as: changes in soil tilling pattern and/or frequency in order for soil to hold more moisture; and Adopting new seed varieties such as drought-resistant and early maturing seeds; ii) Information and Education regarding paying more attention to weather information in order to plan better on variations in seasons; iii) General Activities concerning: Sustainable management of water resources so it can be available for longer periods; and iv) Looking for alternatives that have to do with watering and other irrigation methods for mitigating the effects of seasonal variations on agriculture and alternative energy

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sources for households to safeguard the environment, ecosystem and ultimately agriculture.

The spatial pattern of farmers' perception about the adaptation measures were presented in Table 5 where it was observed that 87% of the respondents in Jigawa were positive about the adaptation measures. On the contrary, only about 13% held a negative opinion and disagreed with it. On the whole, 86% agreed with the adaptation measures in Adamawa, Bauchi and Zamfara States. Furthermore, the results in Table 6 were obtained by subjecting the data

Table 5: Spatial Pattern of Farmers' Perception about Adaptation Measures toward Modifying Climatic Challenges by States in Northern Nigeria

State	Frequency of responses				Total
	Agree	%	Disagree	%	%
Adamawa	2202	86.02	358	13.98	100
Bauchi	2188	85.47	372	14.53	100
Jigawa	2214	86.48	346	13.52	100
Zamfara	2190	85.55	370	14.45	100
Total	8794		1446		

Source: Field work, 2023

Table 6: Variation Within and Between States on Measures of Modifying Climatic Challenges and Agricultural Sustainability in Northern Nigeria

Source of variation	Sum of squares	Degree of freedom	Mean square	F ratio	Critical F
SSA	0.020	1	0.020	0.016	3.84
SSE	12799.980	10238	1.250		
SST	12800.000	10239			

Source: Field work, 2023

in Table 5 to Analysis of Variance (ANOVA) to test for variations within and between the state on measures of modifying climatic challenges and agricultural sustainability in northern Nigeria. The outcomes from Table 6 showed that the calculated F-value (0.016) is less than the critical F-value (3.84) at 0.05% level of significance. Hence, the null hypothesis that "there is no variation between states in the measures of modifying climatic challenges and agricultural sustainability was accepted. As such, it can deduce with 95% confidence level that there is no variation between states on measures of modifying climatic challenges and agricultural sustainability in northern Nigerian.

The results here indicated that the majority of farmers in the extreme northern Nigeria adapt several adaptation measures toward modifying climatic challenges in their farming activities. This level of acceptance was with no variation between states across the region. For instance, farmers adopt sustainable management of water resources so it can be available for longer periods as well as watering and other irrigation methods to mitigate the effects of climatic influence on agriculture. This finding further confirmed the work of Mati *et al.,* (2006) where it was pointed out that water harvesting in Lare Division, Kenya has improved access to clean water and consequently improved health status of the local community. It has also increased agribusiness activities in the area that include the production and sale of livestock and farm products.

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CONCLUSIONS

Farmers in northern Nigeria adapt several sustainable agricultural adaptation measures toward climatic challenges. These measures were explained by (99%), (84%), (73%) and (99%) respective farming strategies pertaining soil tillage pattern and/or frequency in order to uphold the soil capacity to hold more moisture, shifting from traditional farming practices and adopting modern farming technologies, mitigating effects of irregular seasonal changes as well as adopting new seed varieties such as drought-resistant and early maturing seeds.

The farmers in Nigeria's northern region were 99% and 82% educated and informed about paying more attention to weather information in order to plan better on variations in seasons, being more careful on climate prediction and warnings. Also, 71% of them were planting trees to replenish the soil, ecosystem, groundwater sources and protecting the environment, 78% were avoiding deforestation and almost 100% were sustainably managing water resources in relation to general agricultural activities. Pertaining to agricultural alternatives, 89% of the farmers were conserving water resources, about 100% adapt watering and other irrigation methods and 90% adapt house hold's energy alternative sources. This by implication, is a pointer to strong adaptation measures taken by farmers in northern Nigeria toward climatic challenges to have a sustainable agricultural production. In all the states across Nigeria's northern region, positive adaptation measures (F-Value of 0.016) were taken to maintain sustainable agricultural production despite the climatic challenges.

RECOMMENDATIONS

In consideration of the findings in this work, the following recommendations are hereby offered:

1. Farmers need to be more encouraged by governments and NGOs to continue and improve on adapting and exploring other means of sustainable agricultural activities despite climatic challenges obtained in Nigeria's northern region. These if fully actualized, agricultural activities will be more augmented and improved sustainability and productivity is guaranteed in the Northern Nigeria.
2. Nigeria's northern region farmers are to be encouraged and supported by governments through ministries of agriculture and environments by equipping them with modern skills and ideas about variations in seasons for being more careful on climate prediction and warnings. Same can be extended to water resources conservation as well as alternative energy sources. This way, a sustainable agricultural production. This way, increased farmers' production, income and national food availability will be realized.

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