INDIGENOUS CLIMATE CHANGE ADAPTATION STRATEGIES AMONG FARMERS IN JOS-SOUTH LOCAL GOVERNMENT AREA, PLATEAU STATE, NIGERIA

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Abstract

Climate change is considered to be one of the most unprecedented environmental threats of modern history. Particularly, climate change has devastating effects on crops and other farming activities. In order to minimize losses, adaptation measures are taken to prepare for inevitable challenges that come with changing weather patterns. The study adopted mixed research methods, consisting of a structured questionnaire administered to 120 respondents and key informant interviews with two participants selected from six districts of Jos-South Local Government Area, Plateau State, Nigeria. The collected data were analyzed using simple descriptive, graph, inferential, and Linkert scales. Results showed that farmers in Jos-South Local Government Area have distorted knowledge of climate change and this information is acquired through radio, television, and personal experience. The study also revealed an increase in temperature and the spread of pests, diseases, and weeds on farmlands, which led to a decrease in agricultural output. Farmers use fertilizers and other indigenous startegies to improve and increase crop yields, plant varieties of crops, adopt new farming techniques, and practice mixed farming and irrigation as adaptation strategies. The study concludes that there is an urgent need for the government to build farmers' capacity for modern farming techniques. The study recommends the provision of necessary resources such as credit facilities, climate information, and training,

and the introduction of drought-resistant crop varieties as well as technologies to help farmers adapt to changes in climatic conditions.

Keywords: Climate change, adaptation, credit, crop yield, farming

Introduction

The term ‘climate change’ describes a persistent modification of a region's precipitation, temperature, and wind patterns that affect a wide range of ecosystems (Hatfield, Kimball, Wolfe, & Boote, 2011). Climate change is the largest environmental hazard to agricultural productivity globally (Wuyep, Arin, & Samuel, 2019). Crop production is significantly impacted by climate change, which in turn affects the yield and production capacity of agricultural products (Odewumi, Awoyemi, Iwara, & Ogundele, 2013). According to the (2007) Intergovernmental Panel on Climate Change (IPCC), weather has a significant influence on crop productivity. Climate change-related natural disasters are causing an increase in climatic parameter instability on a global scale. Research has demonstrated that climate change is happening and having an impact, with developing countries suffering the most (Asfaw, Suryabhagavan, & Argaw, 2018; Gupta et al., 2019; Omerkhil, Chand, Valente, Alatalo, & Pandey, 2020). Adaptation is the process of changing natural or human systems in response to current or projected climate stimuli or their effects to minimize harm or seize favorable possibilities, according to the Intergovernmental Panel on Climate Change (IPCC, 2007). Governments may facilitate adaptation through policies that encourage appropriate and workable adaptation strategies, or small-holder farmers might implement adaptation on their own (Smith & Wandel, 2006; International Indigenous People’s Forum on Climate Change (IIPFCC), 2009).

Farmers must accept that the environment has been altered, then come up with workable solutions and make the necessary alterations to enhance the laws designed to help farmers deal with the challenges that climate change brings (Maddison, 2006; Challinor et al. 2014). Farmers in Sub-Saharan Africa (SSA) are constantly adjusting their farming methods to mitigate the effects of climate change. In reaction to climate change, farm households have adopted a variety of methods, many of which rely on proven knowledge and technologies (Füssel, & Klein, 2006; Leclere et al., 2013; Khan et al., 2020). These farm-household initiatives have the potential to greatly mitigate the detrimental effects of climate change.

Jos-South Local Government Area is primarily dependent on agriculture, especially when it comes to creating jobs and producing food. Sadly, a sizable portion of those employed in the agriculture industry are

either ignorant about climate change or uninformed of how it affects agriculture since they are not aware of it. As a result, the study sought to evaluate how farmers in Plateau State's Jos-South LGA saw climate change and their plans for adapting to it. This is to offer constructive answers to the issues brought on by climate change. Given this, more research is needed to understand the current provisions of adaptation as this comprehension can improve, promote, and support already existing local initiatives. Moreover, such knowledge can be used as an entry point to initiate and speed up national climate adaptation action by ensuring that policies are aligned with the needs and priorities of farmers. Given this, the particular goals are to ascertain how farmers view climate change, examine how they obtain knowledge about it, and examine how they view the consequences of climate change and the methods they have used for adaptation.

Climate Change and Adaptation Strategies in Nigeria

According to the World Bank Nigeria will have a population of 211 million people in 2021, making it the most populous country in Africa (World Bank, 2022). Tens of millions of people are in danger of climate-related disasters because the nation is among the top ten most vulnerable to climate change. The most obvious effects of climate change in Nigeria include drought, flooding, rising sea levels, and erosion, which have negative effects on food production, poverty, forced migration, and conflicts (Butu, Okeke, & Okereke, 2022; Adelekan, Simpson, Totin, & Trisos, 2022). Similarly, Nigeria's adaptive capacities and susceptibility to climate hazards were evaluated in 2021 by the Notre Dame Global Adaptation Initiative (ND-GAIN), the country was placed 161 out of 182 countries (Verisk Maplecroft, 2016). In the recent past (1971–2000), Nigeria saw higher air temperatures. In Nigeria during this period, minimum temperatures increased more quickly—by 0.8 °C—than maximum temperatures, which increased by 0.5 °C (Abiodun, Salami &Tadross, 2011). Given that global warming is expected to reach 1.5 degrees Celsius between 2030 and 2052, this problem is made worse (IPCC, 2018). Variable precipitation combined with temperature changes may cause crops to produce less, and the impacts will exceed the production strategies that are used. Climate change will have differing effects on Nigerian regions and crops, both annual and perennial. Nevertheless, it will have an impact on all production systems to varied degrees. Agricultural systems typically rely on dependable water sources, and if the pattern and possible amount of precipitation changes are poorly understood, agriculture will become much more vulnerable and uncertain (Intergovernmental Panel on Climate Change (IPCC), 2007; Oluwagbemiga, Ojumu, & Kishwar, 2020).

The realization that scientific understanding is insufficient to address Nigeria's climate challenge has grown in recent years. Therefore, it has been acknowledged that the experience of the indigenous local farmers plays a significant role in mitigating the effects of climate change and informing policies to do so (Natural Sciences, 2012; Wuyep, Samuel & Yakubu, 2015). There is growing recognition of the significance of local and indigenous farmers' knowledge as a source of climate knowledge and adaptation techniques. By incorporating this indigenous expertise, it would be possible to encourage local involvement in the creation of cost-effective, sustainable methods for mitigating the effects of climate change and adapting to them, which would boost food security and be rich in local content (Natural Sciences, 2012, Simane et al., 2016). Maddison, (2006) showed that for farmers to adapt to climate change, they must first recognize that the climate has changed, then find practical adaptations and put those adaptations into practice. It is critical to understand farmers' perspectives on climate change, their preferences for adaptation strategies, and the obstacles that impede their ability to adapt to the changing climate to improve policy aimed at addressing the difficulties that farmers face. In this sense, adaptation seems to be a practical and effective means for farmers to lessen these adverse effects of climate change (Füssel, & Klein, 2006).

Theoretical Framework

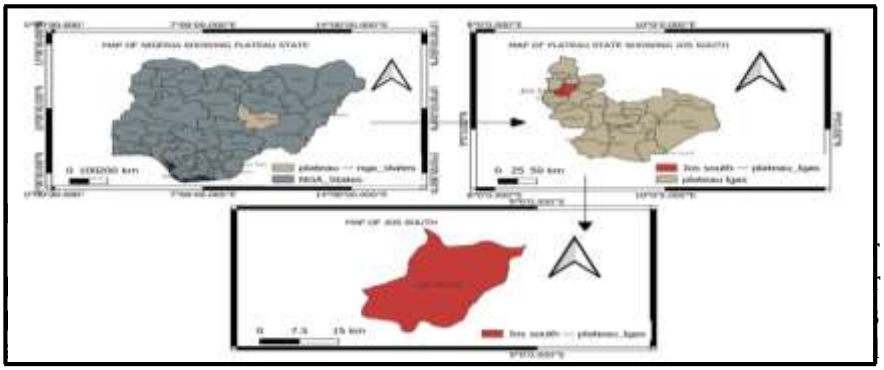
Numerous studies evaluated how climate change will affect agriculture, particularly how it might affect agricultural yield. These studies evaluated, measured, and simulated the effects of climate change on agriculture using various models and methodologies Smit, Ludlow, & Brklacic (1988) studied the effects of global climate change on agriculture using three primary approaches: agricultural systems analysis, spatial analysis, and crop yield analysis. Agronomic systems analysis evaluated the effects of climate change on various agricultural activities and the operation of the agricultural food sector, including prices, trade patterns, and employment. Crop yield analysis involves estimating the effects of changed environments on crop productivity levels. Spatial analysis investigated the implications of climate change on the regions and lands suitable for agricultural production. The effects of climate change on various agricultural activities and the operation of the agricultural food sector, including prices, trade patterns, and employment, were evaluated by agricultural systems analysis. The crop suitability technique, also known as the agroecological zoning (AEZ) approach, was created by the Food and Agriculture Organization (FAO) in 1996. It evaluated the suitability of different land types and biophysical characteristics for crop production. This method determined the suitability of crop production in different

places by taking into account soil and climate conditions, crop traits, and currently available technology.

Using a statistical model, Ajetomobi & Abiodun (2010) examined the relationships between temperature, precipitation, and time trend (a proxy for innovations and technological change) and cowpea (*Vigna unguiculata*) yield in the 20 states in Nigeria that produce the most cowpeas, from 1961 to 2006. The way that cowpea output responded to climate change differed depending on the region. Furthermore, in six states—five in the north and one in the south—the data showed a negative and substantial correlation between rising temperatures and cowpea yield. Similarly, in all but one of the northern states, there was a negative and substantial correlation between higher precipitation and yield. Additionally, the findings showed that while there was a positive link in the south with higher precipitation, there was a negative correlation in the north with cowpea output.

Research Methodology

Jos-South Local Government Area, found in north-central Nigeria, is located within the Northern Tropical Region of about Latitude 9°34'22" and 9°54'40"N and Longitude 8°39'55" and 8°59'13"E (Figure 1). It covers an area of 1,037 km^2 with an average elevation of around 1280m above sea level (Wuyep, Samuel & Yakubu, 2015). The study area is surrounded to the south by Barkin-Ladi, Riyom to the southwest, Jos-East to the east, and Bassa to the west. The area consists of five districts, viz., Vwang, Du, Gyel, Kuru, and Rantya, with Bukuru as the local government administrative center. Jos-South Local government area is one of the seventeen Local government areas in Plateau state of Nigeria (Wuyep, Zemba, & Jahknwa, 2013). According to the National Population Commission (2006), the local government has 650,835 residents. The climate of the Jos Plateau is dominantly influenced by its relatively high altitude and position along the Inter-Tropical Convergence Zone (ITCZ). It has an average height of about 1250m above mean sea level (Wuyep & Daloeng, 2020). The warmest months are March and April, while the coldest months are November and February. Mean rainfall falls between 1347.50 and 1460.00mm annually, with a minimum and maximum temperature of 16°C and 26°C respectively. Major crops such as maize, sweet potatoes Irish potatoes, beans, and vegetables such as carrots, cabbage, and cucumber are cultivated in the area (Wuyep, 2018). The soils of the area are generally said to be the product of the interaction of pedogenic factors (climate, biota parent material, topography, and time), which has produced a series of factors that reflect the particular influence of parent material (in terms of texture and nutrient status) and topography in terms of drainage (Dung-Gwom, Gontul, Baklit, Galadima, & Gyang, 2019).



method: a questionnaire and an interview. Interviews were conducted after prior informed consent was obtained from the respondents. A random sampling technique was used in selecting three districts (Vwang, Rantya, & Gyel) from the five (Du, Vwang, Gyel, Kuru, & Rantya) districts for this study. A purposeful sampling technique was used in selecting 120 respondents. The collected data were analyzed using simple descriptive, Linkert scale, and inferential statistics. The descriptive statistics used are simple percentages, while the analysis of variance (ANOVA) was used to test the hypothesis.

Results and Discussion

Table 1: Socio-economic and Demographic Characteristics of Respondents

Variables	Characteristics	Frequency	Percentage
Gender of Respondents	Male	72.0	60
	Female	28.0	40
Age	20-30 years	21.96	18.3%
	31-40 years	50.04	41.7%
	41- 50 years	30.99	25.83%
	51-60 years	12.0	10%
Marital Status	Married	65.04	54.2%
	Single	42.0	35%
	Divorced	6.0	5%
	Separated	2.04	1.7%
	Widow	5.04	4.2%
Level of education	Primary education	75.0	62.5%
	Secondary education	2.0	20%
	Tertiary education	15.0	12.5%
	No formal education	6.0	5%
		5.88	4.9%

		Qur'anic education		
Average Income	Monthly	less than N20.000,	26.04	21.7%
		N20,000 - N30,000	26.04	21.7%
			15.0	12.5%
		N31,000 - N40,000	9.24	7.7%
			8.04	6.7%
		N41,000-N50,000	45.0	37.5%
		N51,000 - N60,000		
		No information		

Socio-economic and Demographic Characteristics of Respondents

The gender of respondents as shown in Table 1, reveals that 60% of the respondents were male while 40% were female. This is indicative of the fact that males are associated with farming activities and are more capable of doing tedious work than females, particularly in rural areas. The result is in line with the findings of Wuyep (2021) that more males are into farming than females in Jos. Table 1 also reveals that ages between 31 and 40 years accounted for the highest percentage at 41.7%. This was followed by the ages between 41 and 50 years with 25.83%, while respondents between the ages of 20 and 30 years accounted for 18.3%. Furthermore, respondents between the ages of 51 and 60, and 61 and above had percentages of 10% and 4.17%, respectively. This implies that most of the farmers are of active and productive age, hence their involvement in farming activities. This has a direct bearing on the availability of able-bodied manpower for agricultural production, and age also influences the ability to seek and obtain off-farm jobs and income, which could increase (Wuyep, Samuel, & Yakubu, 2015; Daniel, 2018). Gbege, & Akubuiko (2013) acknowledged that the age of a farmer may positively or negatively influence the decision to adopt new technologies, as older farmers have more experience in farming and consequently have a higher probability of adopting modern technology than younger farmers. On respondents' marital status, as shown in Table 1, the married accounted for the highest percentage among respondents, with 54.2%, followed by 35% single, 5% divorced, 4.2% widowed, and 1.7% separated. This indicates that most respondents are married. This result agrees with the study by Umar, Isah, Bello, & Abubakar (2015) that the majority of the farmers (98.6%) in Sokoto State were married, hence responsible. On an educational level, Table 1 shows that primary education represents 62.5% of the respondents, secondary education represents 20%, 12.5% of the respondents had tertiary education, 5% had no formal

education, and 4.9% had Quranic education. This indicates that farmers in the study area are literate. The literacy level is high among farmers, which could have implications for agricultural production (Nwaru & Onuoha, 2010; Wuyep, Samuel, & Yakubu, 2015). The literacy level of farmers is an important factor that determines their ability to understand policies and programs relating to climate change (Alade, & Ademola, 2013; Wuyep, et al. 2015; Ojo, & Baiyegunhi, 2020). In addition, Table 1 also indicates that 37.5% of the respondents did not give information about their income level. 21.7% earn an average monthly income of between N20,000 and N30,000 and less than N20,000. 12.5% earn between N31,000 and N40,000, 12% earn less than N20,000, 7.7% earn between N41,000 and N50,000, and 6.7% earn between N51,000 and N60,000. The income level of respondents was below the minimum wage of 30,000 per month as recommended by the National Salaries, Income, and Wages Commission (NSWC, 2019).

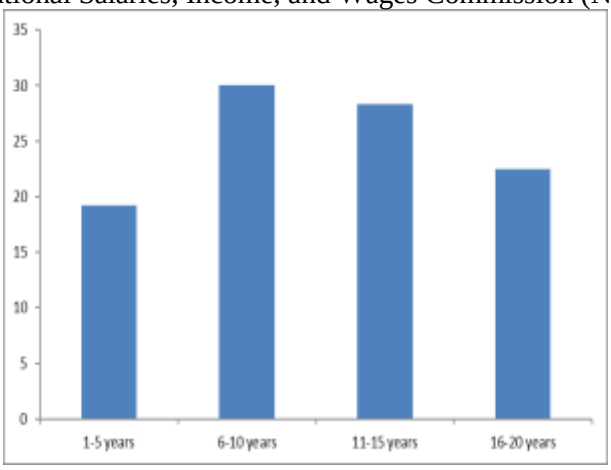


Figure 2: Years of Farming Experience

Years of Farming Experience

Respondents' years of farming experience, represented in Figure 2, shows that farmers with 6–10 years of farming experience have the highest percentage of 30%; those with 11–15 years accounted for 28.3%; 16–20 years accounted for 22.5%; and 1–5 years accounted for 19.2%. This implies that more than half of the respondents have been farming for over five years. The knowledge of the respondents on the effects of climate change that affect the growth and yield of agricultural products develops as they spend more years farming. They become more mature and conscious, thereby gaining more experience in understanding the environment (Alade, & Ademola, 2013; Wuyep et al., 2015). This statement corroborates the study of Boulding (1956), who suggested that over time, individuals

develop a mental impression of the world through their everyday contact with the environment.

Table 2: Farmer's Perception of Climate Change

S/N	Knowledge of Climate Change	A (%)	D (%)	UD (%)
1	Increase in temperature and high sunshine intensity	80.0	6.7	13.3
2	Increased rainfall and Change in rainfall pattern	70.0	21.7	8.3
3	Increased drought	49.2	34.2	16.7
4	Poor fertility of most soils	67.5	25.8	6.7
5	Flooding	60.4	18.2	21.4

A= Agree, D= Disagree and UD= Undecided

Farmer's Perception of Climate Change

Eighty percent (80%) of the respondents agree to have observed an increase in temperature and high sunshine, while 70% agree that increased rainfall and a change in rainfall pattern are signs of climate change (67.5%) (Table 2). Over 49% agree with increasing drought as a sign of climate change, and over 60% agree with the increase in the occurrence of flooding. This indicates that respondents in the surveyed communities know about climate change, with varying levels of perception of climate change. This finding is consistent with the findings of Ejeh (2014), who, in his studies, revealed that there has been an increase in the mean temperature over the past two decades. This result is also in agreement with the findings of Otitoju (2013), who reported that crop growers in south-west Nigeria perceived higher temperatures, lower rainfall, and delayed or erratic rainfall.

Table 3: Farmer's Source of Information on Climate Change

S/N	Sources of Information	A (%)	D (%)	UD (%)
1	Radio	80.8	15.0	4.2
2	Newspaper	63.3	32.5	4.2
3	Television	76.7	16.7	6.7
4	Extension personnel	53.3	36.7	10
5	Through experience	74.2	15.0	10.8

Farmer's Source of Information on Climate Change

Table 3 reveals that farmers in the study area have five major sources of information on climate change: 80.8% of the respondents obtain information through radio, 76.7% through television, 74.2% through experiences, 63.3% through newspapers, and 53.3% through extension personnel. However, this shows that the majority of respondents got information through radio, television, and personal experience. This finding corroborates the result of Ejeh (2014), who stated that farmers in Kano State received information on climate change primarily from radio and television, as agreed by 73.1% of his respondents. However, his findings disagreed with the assertion made by Umar (2015), who reported that 96% of farmers in Katsina State identified other farmers and extension workers as important sources of information about climate change. An interview was done with one of the respondents, as seen.

"How I wish there would be radio and television stations all over the world so that all farmers would adhere strictly to the instructions given to mitigate and cope with climate change to have a bumper harvest, April 5", 2023.

Table 4: Farmers' Perception of the Effects of Climate Change

S/N	Perception of Effects	A (%)	D (%)	UD (%)
1	Increase in rainfall	67.5	20	12.5
2	Decrease in rainfall	53.5	30.8	15.8
3	Due to climate change, there is an increased spread of agricultural pests, diseases, and weeds on farmland	70	20	10.8
4	There is a decrease in agricultural output due to climate change	69.2	22.5	7.5
5	There is an increase in the cost of food crops due to climate change	61.7	26.7	11.7
6	Climate change has led to an increased rate of erosion and flooding in many places	58.3	29.2	12.5
7	There have been increased incidences of drought due to climate change	58.3	29.2	12.5
8	Increase in daily temperature	65.8	18.3	15.8

Farmers' Perception of the Effects of Climate Change

Table 4 shows the results of farmers' perceptions of the effects of climate change. Seventy percent (70%) of the respondents perceived the

effects of climate change as increased spread of agricultural pests, diseases, and weeds on farmland, 69.2% as a decrease in agricultural output, 67.5% as an increase in rainfall, 65.8% agreed to an increase in daily temperature, 61.7% agreed to an increase in the cost of food crops, and 58.3% agreed to an increase in the rate of erosion and flooding. Similarly, 58.3% agreed to an increase in the incidence of drought due to climate change. About 62% agree that the increase in the cost of food crops is due to climate change. The increase in drought and floods as a result of climate change poses serious environmental problems and hence threatens the livelihood of farmers. This result agrees with the study of Adeshina & Odekunle (2011), who reported that environmental challenges arising from global warming are affecting crop yield through crop infestation by pests and crop diseases. The result conforms with the findings of Daniel (2018), who stated that climate change has led to an increase in pests and diseases in crops and livestock, as well as soil loss in Benin, Edo State. With climate change, crop diseases tend to spread to areas where they were previously unable to thrive. A good example is the spread of tsetse flies to the drier regions of northern Nigeria from the southern part as a result of the movement of cattle. This confirms the study of Audu, Bindol, & Gana (2013), which reported that the incidence of pests and diseases in Nigeria is very common and is becoming worrisome because the environment is becoming warmer, drier, and more conducive for them.

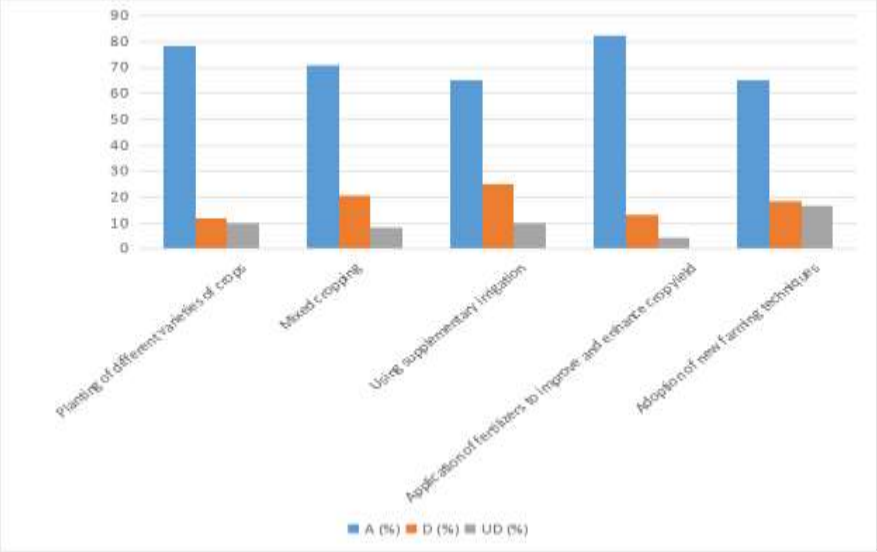


Figure 3. Indigenous Coping Strategies Due to Climate Change

Indigenous Coping Strategies Due to Climate Change

Figure 3 shows the strategies adopted by farmers in the study area due to climate change. About 83% of the respondents adopted the application of fertilizers to improve and enhance crop yield; 78.3% adopted the planting of different varieties of crops, probably because the different varieties of crops have different levels of tolerance for adverse effects of climate change. Over 70.8% of the respondents practiced mixed farming; 65% of the respondents used supplementary irrigation and also adopted new farming techniques. The following was reported by a respondent: "*For me, application of fertilizer to improve and also enhance my crop yield is the only strategy I use because most farmlands are not fertile", 19 May 2023.*

Table 5: Analysis of variance (ANOVA) for Farmer's Perception of Climate Change and Coping Strategies

	Sum of Squares	Df	Mean Square	P-value	Sig.
Between Groups	9938.000	2	4969.000	32.454	.000
Within Groups	1378.000	9	153.111		
Total	11316.000	11			

Analysis of variance (ANOVA) for Farmer's Perception of Climate Change and Coping Strategies

The ANOVA with a p-value of 32.454 showed that there is a significant relationship between the perceptions of climate change and coping strategies employed by farmers in Jos-south at a 95% confidence interval (Table 5). This implies that the coping strategies employed by farmers helped reduce the effects of climate change in the study area. Indigenous knowledge in coping with climate change is effective in reducing environmental challenges and, hence, enhancing the livelihood of farmers (Wuyep, Arin, & Samuel, 2019; Omerkhil, Chand, Valente, Alatalo, & Pandey, 2020**).**

Conclusion and Recommendations

The study assessed the indigenous climate change adaptation strategies among farmers in Jos South. The biggest environmental threat to agricultural productivity worldwide is climate change. This has a major impact on crop production; therefore, traditional knowledge exhibited by farmers in terms of adaptation practices helped farmers manage and adapt to the changing environment. Based on the mixed method used to elucidate

this study, it was observed that farmers in the study area have a good perception of climate change. On the sources of farmers' information on climate change, the study found that farmers obtained their information on climate change from radio, television, and personal experience. On the effects of climate change, there is an increase in the spread of agricultural pests, diseases, and weeds on farmland; there is also a decrease in agricultural output as well as an increase in rainfall and temperature. indigenous strategies adopted by farmers due to the changed climate include; adopting the application of fertilizers, planting of different varieties of crops, practicing mixed farming, using supplementary irrigation, and also adopting new farming techniques. The study recommends that to improve the indigenous climate change adaptation strategies among farmers in Jos South, there is an urgent need for agricultural extension workers to build farmers' capacity on modern farming techniques. Providing necessary resources such as credit facilities, climatic information, and training can significantly help to increase and sustain high levels of productivity among farmers by the government. However, research institutes should introduce drought-resistant crop varieties as well as provide irrigation technologies to farmers. Government policies need to support research and the development of appropriate technologies to help farmers adapt to changes in climatic conditions.

References

Abiodun, B.J., Salami, A.T., & Tadross, M., (2011). C*limate change scenarios for Nigeria: Understanding biophysical impacts. Ibadan, Nigeria*: Building Nigeria's Response to Climate Change (BNRCC) Project.

Adelekan, I. O., Simpson, N. P., Totin, E., & Trisos, C. H., (2022). *IPCC Sixth Assessment Report (AR6), Climate Change 2022 - Impacts, Adaptation and Vulnerability*: Regional Factsheet Africa. https://policycommons.net/artifacts/2264240/ipcc_ar6_wgiifactsheet Africa/3023294/

Adeshina, F.A., & Odekunle, T.O., (2011). C*limate change and adaptation in Nigeria; some background to Nigeria's response* III. International Conference on Environmental and Agriculture Engineering (IPCBEE) 15, 146-154.

Ajetomobi, J. & Abiodun, A., (2010). Climate Change Impacts on Cowpea Productivity in Nigeria. *African Journal of Food, Agriculture, Nutrition and Development, 10*(3), 12-19.

Alade, O. A., & Ademola, A. O., (2013). Perceived Effect of climate variation on poultry production in Oke-Ogun Area of Oyo State. *Journal of Agricultural Science*, 5(10), 176-182.

Asfaw, E., Suryabhagavan, K.V., & Argaw, M., (2018). Soil salinity modeling and mapping using remote sensing and GIS: the case of Wonji sugar cane irrigation farm, Ethiopia. *Journal of Saudi Society of Agricultural Science*, 17 (3), 250–258.

Audu, E.B., Audu, H.O., Bindol, N.I., & Gana, J.N., (2013). Climate change and Its implication on agriculture in Nigeria. *Abuja Journal of Geography and Development* (3) 2, 4-10.

Boulding, J., (1956). in Adebayo, A. A., (1989). *Man environment relations:* The Geographers new points, pp15 unpublished lecture notes.

Butu, H., M., Okeke, C., U., & Okereke, C., (2022). *Climate Change Adaptation in Nigeria: Strategies, Initiatives, and Practices.* Working Paper No. 3. APRI: Berlin, Germany.

Challinor, A.J., Watson, J., Lobell, D.B., Howden, S.M., Smith, D.R., & Chhetri, N., (2014). A meta-analysis of crop yield under climate change and adaptation. *National Climate Change*, 4 (4), 287. 296.

Daniel, C.C., (2018). Farmers perception and climate change adaptation in the West Africa Sudan Savannah: Reality check in Dassari, Benin, and Dano, Burkina Faso, J*ournal of Climate*, 6,44 available at (http://creativecommons.org/licenses/by/4.01).

Dung-Gwom, J.Y., Gontul, T.K., Baklit, G., Galadima, J.S., & Gyang, J.D., (2009). *A field guide manual of Plateau State, Nigeria*. Department of Geography and Planning, University of Jos, Nigeria.

Ejeh, U.I., (2014). *Assessment of Farmers' perception and adaptation strategies to climate change in Kano State, Nigeria*. An Unpublished Ph.D. Dissertation, Department of Geography, Ahmadu Bello University, Zaria, Nigeria.

Food and Agriculture Organization of the United Nations (1996). *Agro-ecological zoning: Guidelines, FAO soils bulletin, 73*, Rome, Italy.

Fussel, H.M., & Klein, R.J.T., (2006). Climate change vulnerability assessments: an evolution of conceptual thinking. *Climatic Change*, 75,301–329.

Gbegeh, B., & Akubuilo, C. (2013). Socio-economic determinants of adoption of yam Minisett by Farmers in Rivers State, Nigeria. *Wudpecker Journal of Agricultural Research*, (1), 033-038.

Gupta, A.K., Negi, M., Nandy, S., Alatalo, J.M., Singh, V., & Pandey, R., (2019). Assessing the vulnerability of socio-environmental systems to climate change along an altitude gradient in the Indian Himalayas. *Journal of Palaeosciences*, 106, 105-512.

Hatfield, R., Kimball, R.., & Wolfe, T., (2011). Climate Impacts on agriculture: Implications for crop production. *Agronomy Journa*l, 103(2), 351-370.

Intergovernmental Panel on Climate Change (IPCC) (2007). *Tide gauge measurements and satellite imagery suggest that sea level has risen. Recent climate change – sea level changes, climate, science*. The fourth assessment report of the IPCC. Cambridge University Press. London.

Intergovernmental Panel on Climate Change (IPCC), (2007). *Climate change: Impacts, adaptation and vulnerability, contribution of working group ii to the 84th assessment report of the intergovernmental panel on climate change.* Cambridge, UK: Cambridge University Press.

International Indigenous People's Forum on Climate Change (IIPFCC) (2009). *Policy paper on climate change.* A policy paper was finalized at the IIPFCC meeting in Bangkok, Thailand. September 26-27, 2009.

IPCC (2018) Global warming of 1.5 ℃ Geneva, Switzerland: Intergovernmental Panel on climate change.

Khan, I., Lei, H., Shah, I.A., Ali, I., Khan, I., Muhammad, I., & Javed, T., (2020). Farm households risk perception, attitude and adaptation strategies in dealing with climate change: promise and perils from rural Pakistan. *Land Use Policy*,91,104395.

Leclere, D., Jayet, P.A., & de Noblet-Ducoudr N., (2013). Farm-level autonomous adaptation of European agricultural supply to climate change. *Ecology Economy*, 87, 1–14.

Maddison, D., (2006). *The perception and adaptation to climate change in Africa. CEEPA.Discussion paper* No.10. Centre for Environmental Economics and Policy in Africa. Pretoria, South Africa, University of Pretoria.

National Population Commission (NPC), (2006). *Federal Republic of Nigeria; National Population Commission:* Abuja, Nigeria.

National Salaries, Income and Wages Commission (2019). N*ational Salaries, Income and Wages Commission Abuja, Nigeri*a. Available at: http://www.nsiwc.gov.ng.(Last accessed 13th, September 2019).

Natural Sciences (2012). *Turning tables on change: Indigenous assessments of impacts and adaptation*. http://www.unesco.org /new/en/natural sciences. Accessed 12/07/2017.

Nwaru, J. C., & Onuoha, R. E., (2010). Credit Use and technical change in smallholder food crop production in Imo State of Nigeria. *New York Science Journa*l, 3(11), 144-151.

Odewumi, S. G., Awoyemi, O. K., Iwara, A. I., & Ogundele, F. O., (2013). Farmer's perception on the effect of climate change and variation on urban agriculture in Ibadan Metropolis, South-western Nigeria. *Journal of Geography and Regional Planning*, 6 (6), 209-217.

Ojo, T.O., & Baiyegunhi, L.J.S., (2020). Determinants of climate change adaptation strategies and their impact on the net farm income of rice farmers in South-west Nigeria. *Land Use Po*licy, 95, 103946.

Oluwagbemiga, O., Ojumu, M. & Kishwar J., (2020). A Theoretical Framework for Assessing the Impact of Climate Change on Crop Yields. *International Journal of Management*, 14, *(*2), 65-87.

Omerkhil, N., Chand, T., Valente, D., Alatalo, J.M., & Pandey, R., (2020). Climate change vulnerability and adaptation strategies for smallholder farmers in Yangi Qala district, Takhar, Afghanistan. *Ecological Indicators*, 111, 105- 863.

Otitoju, M. A., (2013). *The Effects of climate change adaptation strategies on food crop production efficiency in South Western Nigeria.* A PhD Unpublished Dissertation, Department of Agricultural Economics, University of Nigeria, Nsukka.

Simane, B., Zaitchik, B.F. & Foltz, J.D., (2016). Agroecosystem specific climate vulnerability analysis: application of the livelihood vulnerability index to a tropical highland region. *Mitigating Adaptation Strategy Global Change*, 21, 39–65.

Smit, B., Ludlow, L., & Brklacich, M. (1988). Implications of global climatic warming for agriculture: A review and appraisal. *Journal of Environmental Quality, 17*, 519-27.

Smith, B. & Wandel, J., (2006). Adaptation, adaptive capacity, and vulnerability. *Global Environment Change,* 16, 251-282.

Umar, S. Jayet, P.A., & de Noblet-Ducoudr (2015). Awareness, manifestation, and information sources on climate change among. *Climate Change*, 6(19), 16-27.

Verisk Maplecroft (2016). *Climate Change Vulnerability Index. https://www.maplecroft. com/risk-indices/climate-change vulnerability-index/*

World Bank. (2022). Nigeria Overview. World Bank. https://www.worldbank.org/en/ Country/Nigeria/overview.

Wuyep S. Z., & Daloeng, H. M., (2020). Climate change, rainfall trends, and variability in Jos Plateau. *Journal of Applied Science*, 20, 76-82.

Wuyep S.Z., (2021). Improving Food Security, Employment, and income through dry season potato farming in the urban area of Jos, Nigeria. *Fudma International Journal of Social Sciences*, 3(1), 1-18.

Wuyep, S. Z., Arin, H. B., & Samuel, A. J. (2019). Assessment of indigenous climate change coping strategies among small-scale farmers in Jos East L.G.A, Nigeria. *Climate Change*, 5(19), 177-187.

Wuyep, S. Z., (2018). *An Assessment of Urban and Peri-Urban agriculture in Jos, Nigeria: Food security, employment and income generation.* Unpublished PhD Thesis, Department of Geography, Environmental Management & Energy Studies, University of Johannesburg, South Africa.

Wuyep, S. Z., Samuel, A. A., & Yakubu, P. M., (2015). Farmers' awareness of the effects of climate on growth and yield of potato (Solanum Tuberosum) in Jos-South Local Government Area of Plateau State, Nigeria. *Agriculture, Forestry and Fisherie*s, 4(4), 179-183.

Wuyep, S.Z., Zemba, A.A., & Jahknwa, C.J., (2013). Effects of precipitation effectiveness on the yield of Irish potato (Solanum Tuberosum) in Jos-Plateau, Nigeria. *Impact: International Journal of Research In Applied, Natural And Social Sciences,* 1(50), 27-32.