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Perceived Effects of Climate change on Farmer's Livelihood in North Western Nigeria

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Abstract— *Northwestern Nigeria has been identified as one of the most vulnerable regions to climate change in Nigeria. The study assessed the perceived effects of climate change on the farmer's livelihood. This study employed a combination of qualitative and quantitative analytical methods. Multi-stage sampling technique was used to select four local government areas (LGAs) from Kano State and random selection of 260 farmers from 52 cooperatives within these LGAs. The collected data were analysed appropriately to achieve the objectives of the results. The results indicate that 57.7% were aware of climate change and understood it through patterns of rainfall, temperature, and changes in yield. The majority of the farmers (84.2%) believed that climate change was responsible for an increase in the rate of diseases among the family members in the area and an increase in the distance travelled in search of drinking water. A reasonable percentage of farmers (62.7%) believed that the main road was eroding, making it difficult to get to the market, schools, and health centers. To cope with climate change, farmers used climate-sensitive varieties and crop diversification. In conclusion, climate change has had a real impact on resources like agriculture, water availability, family health, roads, and social networks. Therefore, we recommend providing farmers with technical training on the consequences of climate change and coping strategies.*

Keywords— ***Adaptation, Climate change, Effects, Farmers, Livelihood. Nigeria***

I. INTRODUCTION

Climate change is one of the most pressing concerns of our day, having far-reaching repercussions for the planet's ecosystems and human progress in all sectors. From the exacerbation of poverty to the breakdown of infrastructure, to the loss of environmental, political, economic, and social security, the impacts of climate change are extensive [1]. The United Nations Framework Convention on Climate Change (UNFCC) characterises climate change as the result of human activity altering the composition of the global atmosphere, along with natural climatic fluctuations observed over comparable time periods. People often refer to it as a long-term shift in weather data, including averages. Climate change has an impact on crucial components of farmers' livelihoods, such as water, food, farmland, and health. It influences the frequency of floods, erosion, droughts, and heat waves, as well as infectious diseases and other health issues. It also has an impact on livelihood opportunities, particularly seasonal ones, as well as those related to natural resources. Climate change

has become a reality for rural communities, especially those whose livelihoods are being washed away by floods and whose children's education is being truncated by the economic effects of climate change. According to [2], climate change will have an impact on crop and animal productivity, hydrologic balances, input supply, and other agricultural system components, as well as rural living standards in related developments. It is already affecting the lives and livelihoods of many communities in poor countries, such as Nigeria. As a result, no section of the nation is immune to the consequences of climate change. For example, desertification threatens more than two-thirds of the country. Nigerian states under threat, including Borno, Sokoto, Jigawa, Zamfara, Kebbi, Katsina, Yobe, Kaduna, Kano, Bauchi, Adamawa, and Niger, are vulnerable. [3]. Climate change has a significant influence on Nigeria, notably in agriculture, land use, energy, biodiversity, health, and water resources. Nigeria, like all Sub-Saharan African countries, is extremely sensitive to the effects of climate change [4]. Furthermore, about 67% of Nigeria's land cover is vulnerable to drought and desertification. Its water supplies are in jeopardy, posing a threat to electricity sources (such as the Kanji and Shiroro dams). Furthermore, rain-fed agricultural practices and fishing activities, on which the majority of Nigeria's population relies, are under serious threat, in addition to the high population pressures of 169 million people surviving on the physical environment through various activities within an area of 923,000 square kilometers. [2]. Northern Nigerian food crop farmers provide the majority of crops consumed locally and supplies to other regions of the country, and they are experiencing climate change even though they have not considered its implications, as evidenced by late rainfall and the drying up of streams and small rivers that normally flow year-round in the country [5].

Understanding climate change is one way to overcome this because local people perceive climate as having a powerful spiritual, emotional, and physical dimension. It is assumed that these communities possess innate, adaptive knowledge, enabling them to thrive in high-stress ecological and socioeconomic environments. Thus, knowing and measuring the effect of climate change on livelihoods, as well as the adaptation strategies utilised by them, is crucial.

1.1 Objectives of the Study

The broad objective of this study is to assess the perceived effects of climate change on the livelihood status of the farmers in the study area, The specific objectives were to:

1. Describe the perceptions of farmers about climate change.
2. Describe the impact of climate change on the livelihood of farmers. and
3. Identify the adaptive strategies used by the farmers in the study area to cope with climate change.

1.2 Conceptual Framework of the Study

The framework focuses on the effects climate change on livelihood strategies. Access to a range of livelihood resources, including natural, economic, human, physical, and social capital, enables the pursuit of various livelihood strategies. This includes agricultural intensification or reduction, livelihood diversification (Fig. 1). This study adopted and modified the Sustainable Rural Livelihood (SRL) framework approach to conceptualising the effect of climate change and understanding the diverse set of livelihood strategies pursued and their impacts on long term adaptation to climate change, as well as short-term coping mechanisms and/or responses. People's livelihoods' resilience depends on their ability to adapt to internal and external shocks and stress. The ability to adapt is largely dependent on the livelihood assets (natural, human, social, physical, and financial capital) that one has or can access, as well as how well these are utilized.

The institutions and processes operating from the household to the national level determine an individual's, a household's, or communities access to assets and livelihood options, thereby affecting their vulnerability to climate change impacts. Transforming the structures and processes of organisations that design and implement policies and legislation, deliver services, and perform other functions that affect livelihoods can reduce or worsen the effect of climate change on vulnerable people. These structures and processes form the link between individuals or households at the micro-level and national governments at the macro-level.

Livelihood strategies consist of a variety of activities that people engage in to achieve their livelihood goals. People choose different types of livelihood strategies (natural and/or non-natural resource-based activities) depending on the livelihood assets they have and the structures and processes that impact them under a given vulnerability context (climate change in this case). According to the SRL framework, understanding the diverse and dynamic rural livelihood strategies helps identify appropriate strategies for intervention to introduce new livelihood strategies and improve Numerous studies [6, 7] have identified numerous techniques for adapting to climate change in terms of livelihood. These strategies encompass modifications in crop variety and planting schedules, as well as crop diversification, irrigation development, water harvesting, tree planting, herd splitting, herd mobility, cattle breeding, and migration.

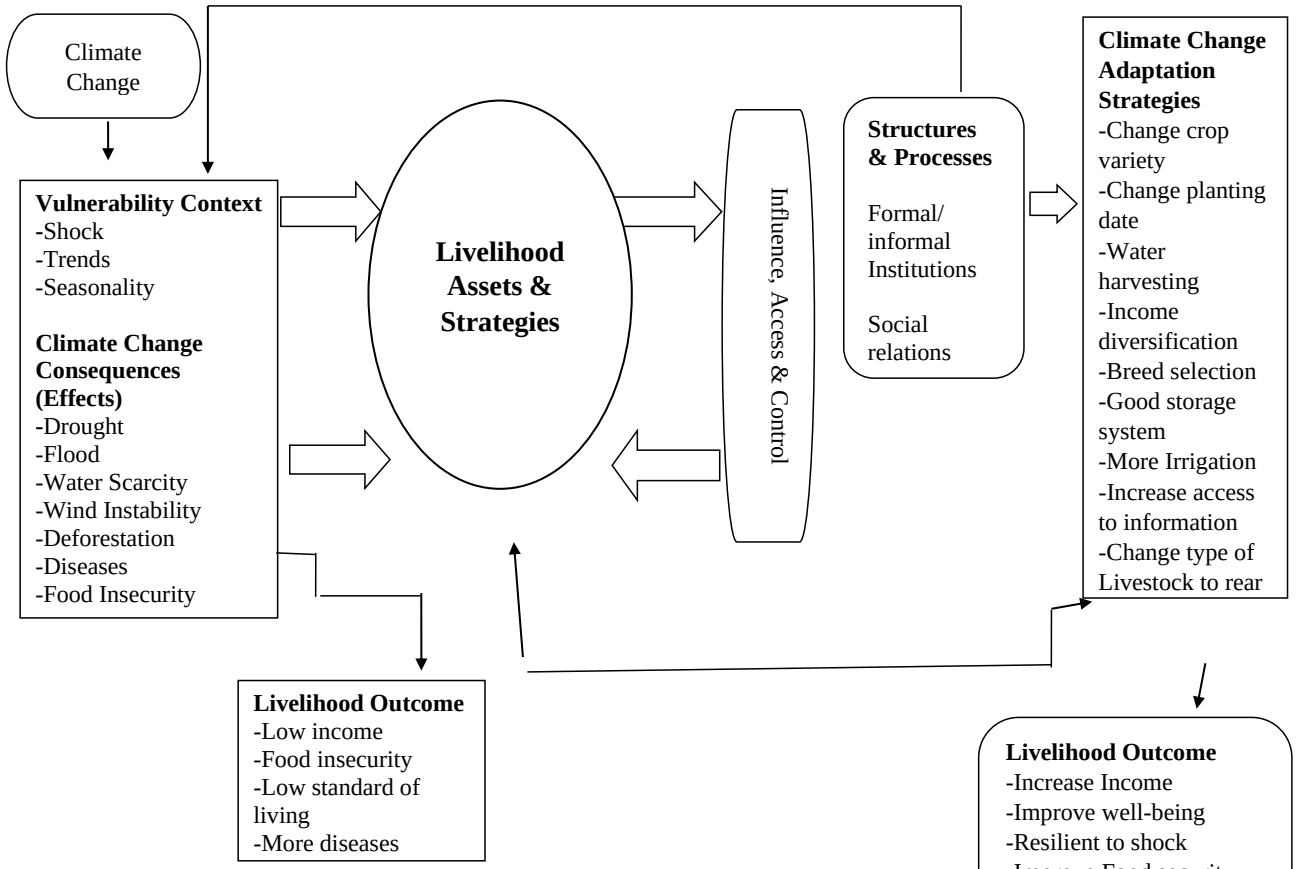

Fig.1: Effects of Climate Change on Livelihood and Adaptation Strategies Framework
Adopted and Modified from DFID Livelihood Framework

II. METHODOLOGY

2.1 Description of the Study Area

Kano State is situated in the Sudan Savannah Agro-Ecological Zone of Nigeria, ranging between latitudes 9^0 30' and 10^0 33' to 12^0 37' North and longitudes 7^0 34' to 9^0 25' East. The state has a total land area of 42,582.8 km^2. The states' borders are Katsina State to the west and northwest, Jigawa State to the east and northeast, Bauchi State to the south, and Kaduna State to the southwest [8]. The state has 44 local government areas with a total land area of 42,582.8 km^2, of which agricultural land is 30,684.8 km^2, and forest and grazing land is 11,898 km^2 [8]. More than half of the state's residents are farmers, cultivating legumes, grains, and vegetables. Livestock rearing and trading are also common in the state [9]. The National Bureau of Statistics (NBS) estimated the population of Kano State to be 15,462,200 in 2022. The climate of the study area is tropical dry, with a mono-modal rainfall distribution averaging 600mm per annum, with most rains occurring between May and September. Air humidity is high during the wet season and extremely low during the dry season. The average temperature is 29°C, with a minimum temperature of 15°C occurring from November to February and a maximum temperature of 39°C occurring from March to May [8]. Windblown sands, derived from acidic crystalline rocks in a basement complex, develop the main soil type. The soils are light, freely graining, and loamy, making them highly adaptable to intensive cultivation. Kano State typically reaches its highest elevation near its southwestern tip. It is about 1,200m above sea level; this decreases as one moves northward to 450m above sea level [9]. The state's natural vegetation is savannah, but this has given way to cultural vegetation.

2.2 Sample Procedure and Sample Size

This study employed a multi-stage sampling technique. There are 44 local government areas (LGAs) in Kano State and two agro-ecological zones: Sudan and the Northern Guinea Savannah. In stage one, three LGAs were randomly selected from the 42 LGAs that are situated in the Sudan Savannah. One LGA was selected from the two LGAs (T/Wada and Doguwa LGAs) that are located in the Northern Guinea Savannah; therefore, Doguwa LGA was selected as it encompasses the entirety of Northern Guinea. In Sudan Savannah, three LGAs were randomly selected from the three agricultural zones in Kano State. Kunchi from the Dabatta zone, Gwarzo from the Rano zone, and

Wudil LGA from the Gaya zone were selected. Giving a total of four LGAs for the study.

The second stage involves collecting a list of registered farmer groups from the KNARDA LGA office and using it for the random sampling procedure. In the four LGAs selected for the study, there were 1077 groups. A random sampling technique was used to select 4% of the total farmer group from each of the selected LGAs, giving a total of 43 cooperatives. Stage three involves the random selection of six farmers from each of the selected groups, making a total of 258 farmers in the study.

Table 1: Summary of the Sample Size of the Farmers' Co-operative Groups

Agro-ecological Zone	LGA	No. of Farmers Co-operative/LGA	4% of the association selected	No. of Farmers
Sudan Savannah				
	Kunchi	260	10	60
	Wudil	275	11	66
	Gwarzo	270	11	66
Northern Guinea Savannah				
	Doguwa	280	11	66
Total	**4**	**1077**	**43**	**258**

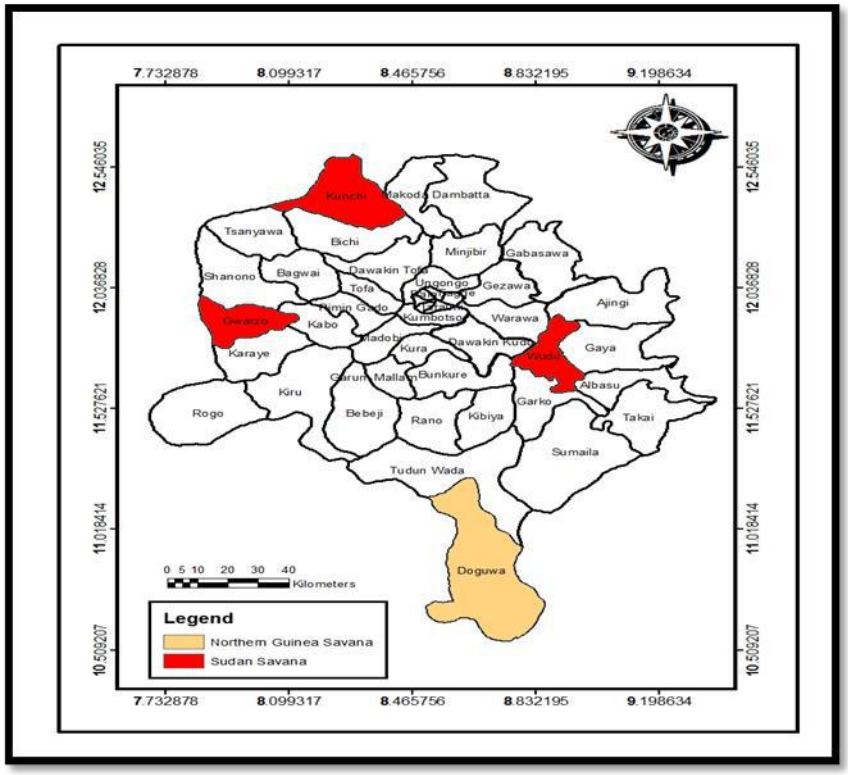

Fig. 2: Map of Kano State showing the Four LGAs Selected from the two agro-ecological zones

2.3 Method of Data Collection and Analysis

The primary data were collected through the use of a structured questionnaire and a semi-structured interview. The collected data were on farmers' socioeconomic characteristics, farmers' perceptions of climate change, climate change adaptive strategies, and the effect of climate change on the farmer's livelihood. The variables considered on the livelihood and effect of climate are affordability of health services, number of meals per day, source of water for domestic use, awareness of climate

change, changes in climate over 5 years, effects of climate change on health, water for domestic use, season road, farmland, farm production, and adaptive strategies used by the farmers. To achieve the study's objectives, we analysed the collected data using descriptive statistics such as mean, minimum, maximum, and charts.

III. RESULTS AND DISCUSSION

3.1 Farmers' Perception on Climate Change

Perception is the way in which farmers regard climate change, understand it, and become aware of its effect on their livelihood. This section of the study displays the results of farmers' perceptions of climate change. As shown in Table 2, 58.1% of farmers were aware of climate change. Extension agents also made farmers (41.5%) aware of climate change. This emphasizes the importance of sources of awareness in disseminating knowledge about climate concerns, as well as the significance of extension agents in exposing farmers to climate change issues. [10] (Simi and Chaminda) reported that the farmers in Shendam and Riyom were aware of the consequences of climate change, and extension agents play a vital role in enlightening the farmers about the situation.

Table 2: Farmers Awareness on Climate Change

Variables	Frequency	Percentage
Awareness of Climate Change		
Aware	150	58.1
Not Aware	108	41.9
***Sources of Awareness**		
Friends	84	27.9
Extension agent	125	41.5
Radio	84	27.9
Television	8	2.7
Total	**258**	**100**

*Multiple response

Fig. 2 reveals that 98.80% of farmers experienced a change in climatic conditions during the last five years. Over the past five years, they (94.70%) have witnessed climate change in crop and animal production. This is consistent with the findings of [11] (Mustapha *et al*.), who found that 61.25% of farmers in Borno State, Nigeria, believed that climate change had an impact on agricultural productivity. Figure 2 also shows that 97.70% of farmers experienced a long-term temperature variation. The shift in temperature pattern is a way of understanding climate change. This is in line with [12] (Falaki *et al.*), who found that farmers in north-central Nigeria detected a rise in temperature over time as a result of climate change. The study's findings also revealed that farmers (97.30%) experienced changes in rainfall distribution patterns over the last five years. The farmers were aware of climate change through productivity factors such as rainfall and how it changed over time. And it's in agreement with the findings of [13] (Sofoluwe *et.al.*), who discovered that the majority of farmers in Osun State experienced a shift in rainfall and precipitation patterns.

3.2 Effect of Climate Change on Livelihood

Climate change is emerging as a serious threat to progress in people's livelihoods; it is the greatest challenge facing mankind's existence on earth in this century. This section discusses the effects of climate change on farmers' livelihoods. Table 3 shows that climate change affects family education (71.7%). These changes in climate affect the education of the farmers' families, especially children, because of the nature of the rain variability and floods that led to increases in disease and the destruction of roads. The results also showed that illnesses like malaria, asthma, and diarrhoea impacted 55.4% of the farmers' families, negatively impacting their educational processes. Only 5.4% and 4.7% dropped out of primary and secondary schools, respectively. Climate change does not really have a direct effect on children dropping out of school, which is probably due to parents' understanding of the importance of education and the low participation of primary and secondary youth in seasonal agriculture and other income-generating activities. This aligns with the findings of [14] (William *et al*.), who reported that climate change affected the education of 64.0% of farmers' children. Table 3 further demonstrates the impact of climate change on

family feeding, with 76.7% of farmers acknowledging these changes. 44.2% of farmers claimed that a reduction in meal quality affected their family's feeding. Farmers' low income and low yields were also responsible for the reduction in quality meals consumed as a result of climate change. According to Giller *et al*. [15], households that rely solely on one form of farming activity are less food secure. Climate change also affected the health of farmers' families (Table 3), with 84.8% believing that it increased the incidence of diseases such as waterborne malaria, asthma, pneumonia, and diarrhoea. Farmer's family health is a very important aspect of livelihood; without good health, production and business activities can be seriously affected. 32.6% of farmers who changed their business types to increase returns reported a slight impact on their businesses. This suggests that farmers were diversifying their businesses beyond farming to enhance their living standards and offset the effects of climate change.

Table 3: Effect of Climate Change on Farmers' Livelihood (Natural capital)

Variables	Frequency	Percentage
Climate change affects family education		
Agree	185	71.7
Strongly agree	42	16.3
Very strongly agree	31	12.0
Effects on family education		
Low money to pay for school fees	86	33.3
Ill health	143	55.4
Destruction of road to school as a result of erosion	29	11.2
Children drop out from school as a result of climate change		
Primary	14	5.4
Secondary	12	4.7
None	232	89.9
Climate change affects family feeding		
Agree	198	76.7
Strongly agree	47	18.2
Very strongly agree	13	5.1
Effects on family feeding		
Reduction of number of meals	93	36.0
Reduction in quality of the meal	114	44.2
Inadequate cooking fuel	51	19.8
Effects on farmer's health		
Increase in diseases	219	84.8
Malnutrition	23	8.9
Death of some family members	16	6.2
Change of types of business		
Change business	84	32.6
Didn't change business	174	67.4
Total	**258**	**100**

Source: Field Survey, 2022

The farmers in the study area experienced changes (35.3%) in accessing available water for drinking and domestic use. This is due to an increase in the distance to search for water (55.1%), which invariably affects their schedule as presented in Table 4. Climate change has affected the majority of Ghanaian farmers in their search for domestic water, as reported by [14] (William *et al.*). The changes also had an impact on livestock production, with 55.4% of the farmers reporting a rise in livestock diseases. This is due to the high temperatures and drought in the study area, which affect livestock production. This is in line with [16] (Festus *et.al.*), who reported that the farmers in Ghana had lost crops or livestock production during the last few years due to the bad weather conditions. The climate variability significantly impacted farmers' farm production and farmland, resulting in low yields (79.60%). Moreover, erosion and flooding affected (46.50% and 53.50%) their farmland (Fig. 3), leading to the clearing of planted crops and nutrients and an increase in the rate of erosion.

Table 4: Effect of Climate Change on the Farmers' Livelihood (Natural capital)

Variable	Frequency	Percentage
Effects on the availability of water		
Not available	68	26.3
In adequate water	62	24.0
Available	91	35.3
Much available	37	14.3
Effects on distance to access water		
Increase distance	142	55.1
Increase in the depth of well	77	29.8
Ceased of the water from well and borehole	39	15.1
Effects on Livestock production		
Death of livestock	36	14.0
Low livestock reproduction	79	30.6
Increase in diseases	143	55.4
Total	**258**	**100**

Source: Field Survey, 2022

Table 5 exposed the consequences of climate change on seasonal roads, revealing that erosion (62.4%) and bridge breakage (7.8%) significantly impacted these roads. Farmers in remote areas had trouble getting in touch with neighbouring communities and getting their goods to market, which increased their profits from agricultural produce sold in main city markets. Furthermore, their communication network (28.3%) was poor, impacted their interactions with friends and family, and also limited their access to certain critical information. Heavy rainfall caused a decline in power supply (44.6%), leading to the destruction of electricity supply poles and wires. Climate change also affected the farmers' residences, another important resource (Table 5). A reasonable percentage (54.3%) of farmers experienced partial destruction of houses due to excessive rainfall that led to flooding, which damaged their homes and made it impossible for them to live in them. The distance to the market, children's school, and health centre were also part of the consequences of climate change felt by the farmers (Table 6). The majority of farmers (67.8%) agreed that the distance to market to sell their produce had increased. 69.4% of the farmers reported an increase in the distance to children's schools, while 65.1% reported a decrease in the distance to health centers. This is due to the increased distance; particularly in regions where the road has eroded and bridges have broken, the farmers have had to travel a considerable distance to their destination, which results in fatigue.

Table 5: Effect of Climate Change on Livelihood (Physical capital)

Variable	Frequency	Percentage
Effects of on the season road		
Erosion	161	62.4
Flood	77	29.8
Bridge Collapse	20	7.8
Effects on communication network		
Little	73	28.3
Much	54	20.9
Very much	44	17.1
No change	87	33.7
Effects on the electricity supply		
Increase	61	23.6
Decrease	115	44.6
No change	82	31.8
Effects on farmers' houses		
Flooding	28	10.9
Destruction of part of the house	140	54.3
Reduce the quality of the house	90	34.8
Effects on distance to market		
Affects the distance	175	67.8
Did not affects the distance	83	32.2
Effects on distance to children school		
Affects the distance	179	69.4
Did not affects the distance	79	30.6
Effects on distance to health center		
Affects the distance	168	65.1
Did not affects the distance	90	34.9
Total	**258**	**100**

Source: Field Survey, 2022

Table 6: Adaptive Strategies Used to Cope with Climate Change

Variables	Frequency	Percentage (%)	Rank
Use of climate sensitive varieties	200	18.0	1st
Crop diversification	180	16.2	2nd
Integrated farming	153	13.7	3rd
Planting date sensitive	122	11.0	4th
Income diversification	112	10.1	5th
Mixed cropping	103	9.2	6th
Improve irrigation efficiency	99	8.9	7th
Soil moisture conservation	65	5.8	8th
Planting/Replacement of trees	60	5.4	9th
Crop/Livestock insurance	20	1.8	10th

Source: Field Survey, 2022; *Multiple response

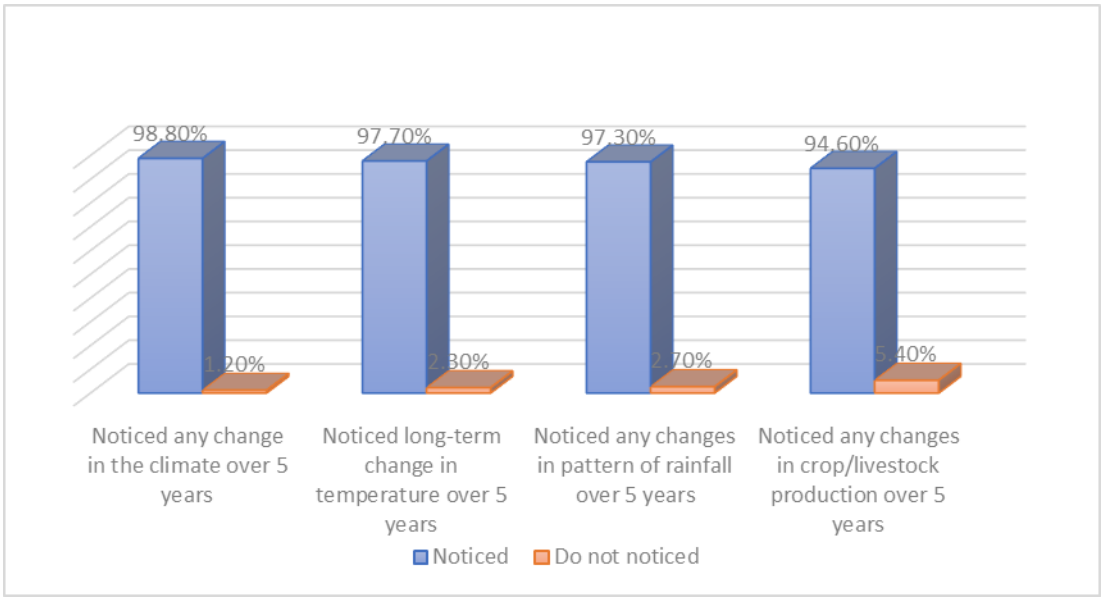

Fig. 3: Farmers' ability to Notice a change in climatic condition

Fig. 4 also presented the implications of climate change on farmers' livelihoods, as determined by the majority (70.0%). This was due to bridge failure and erosion, which made it impossible for farmers to attend meetings and other group gatherings to discuss production activities. Climate change also affected interrelationships with family and relatives (62.30%). Low technical support led to poor visitation (75.30%), which negatively impacted these relationships. Farmers experienced erosion and low yields, which negatively impacted their revenue. Fig. 5 delves into another impact of climate change: it significantly influenced farmers' yearly revenue, accounting for 40.80%. Low yields reduced the farmers' income, impacting their standard of living. Climate change also impacted access to credit, with only 32.7% remaining unaffected. The study area's increased demand for credit may have contributed to the difficulty farmers faced in acquiring financing.

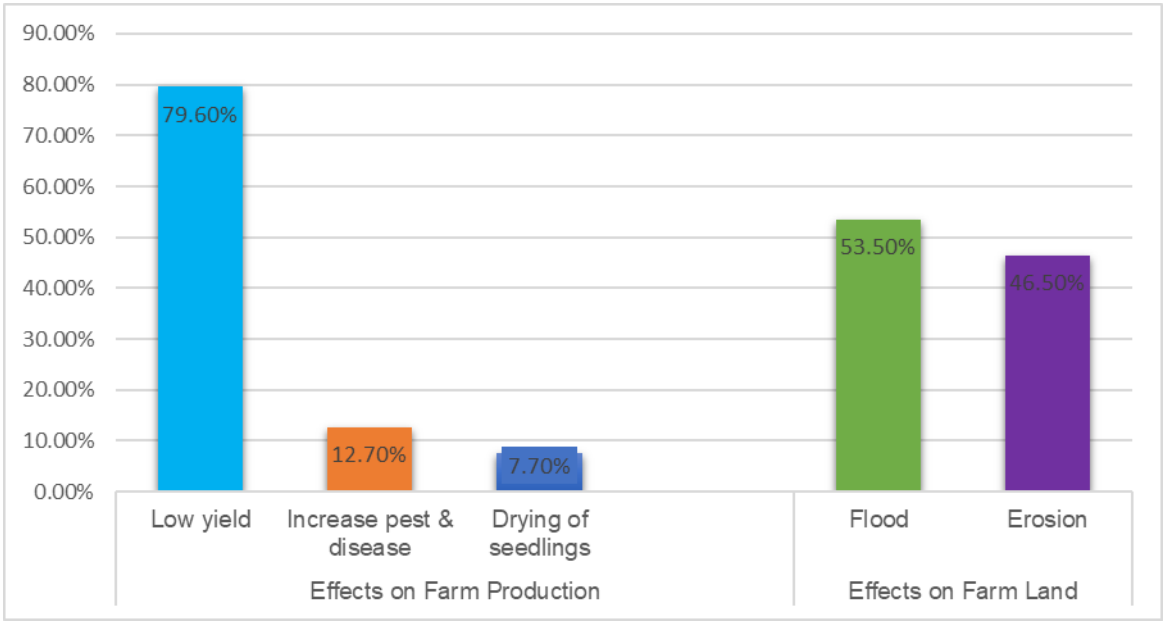

Fig. 4: Effects of climate change on farm production and farmland

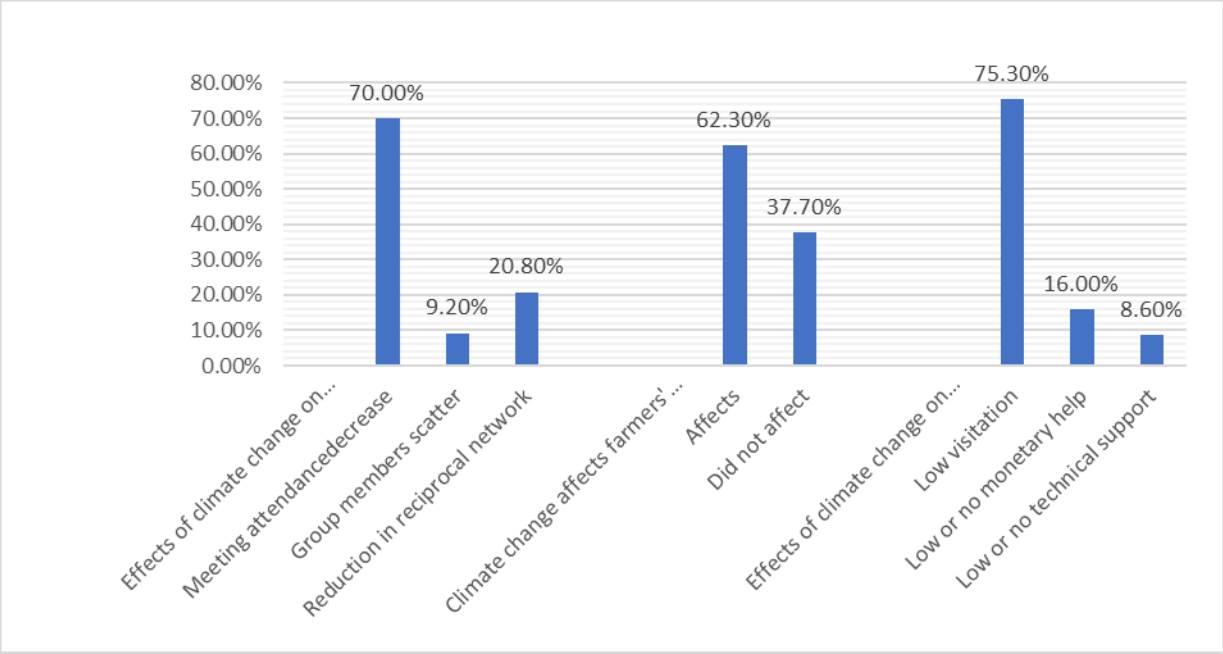

Fig. 5: Effects of Climate Change on Livelihood (Social Capital)

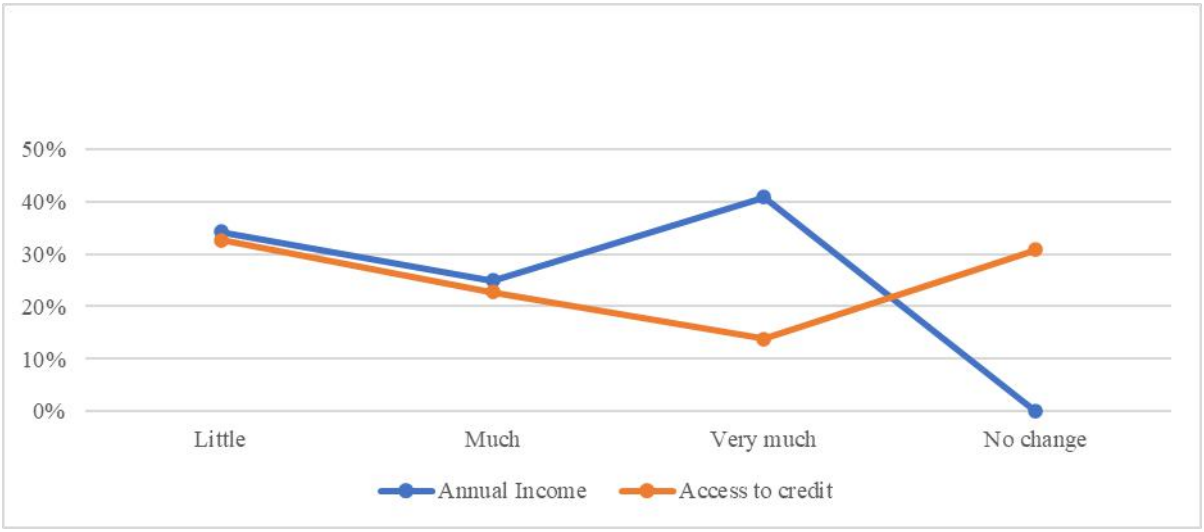

Fig. 6: Effects of climate change on Annual Income and Access to Credits

3.3 Adaptive strategies employed by farmers to cope with climate change

Adaptation is the ability to respond and adjust to the actual or potential impacts of changing climatic conditions in ways that moderate harm or take advantage of any positive opportunities that the climate may afford. The study discusses the results of adaptive strategies employed by farmers to cope with climate change. Table 6 presents the ranking of farmers' adaptation strategies to climate change, ranging from 1st to 10th position. Farmers prioritised using climate-sensitive varieties, ranking them first. Planting sensitive varieties, especially short-duration and drought-resistant crops, could help reduce the risk of vulnerability to climate change. The farmers employed crop diversification as their second adaptive strategy. Diversifying to high-value crops is a short- and long-term strategy to reduce the loss risk associated with monocultures in both non-irrigated and irrigated areas. The farmers identified integrated farming as the third strategy. An integrated farming system involves two or more enterprises that act symbiotically with one another. This is a system that is becoming more popular throughout the country because of its returns. Also, planting date-sensitive (4^{th}) was the next important strategy identified; the farmers became more sensitive to the date and time they needed to cultivate a particular crop at the right time, especially with

the short duration of rainfall and the intensity of the rain that most often led to flood issues. Farmers also used income diversification (5th) as an adaptation strategy, as it provides opportunities, particularly in rural areas, to reduce the risk of low income due to climate variability. Furthermore, the sixth, seventh, and eighth-ranked strategies identified by the farmers were mixed cropping, improving irrigation efficiency, and soil moisture conservation, respectively. Farmers in the study area have been planting trees such as mango, lime, lemon, and others as a way of adapting to the effects of climate change. The study ranked crop and livestock insurance as the least important adaptation strategy. This is likely due to a lack of awareness of the role of insurance in the farming business and good management, which leads to underwriting agriculture and offering farm-based insurance products.

IV. CONCLUSION AND RECOMMENDATIONS

Climate change has impacted farmers' livelihood resources, such as farmland, water, family health, children's education, roads, and social networks, with climate-sensitive varieties and crop diversification being the most important adaptation techniques adopted by farmers. Therefore, we recommend that the relevant agencies launch a sensitization campaign to increase awareness about the effects of climate change, and provide farmers with technical training on how to adapt to these changes in agriculture and the wider community.

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REFERENCES

[1] Zhang L, Xu M, Chen H, Li Y and Chen S (2022) Globalization, Green Economy and Environmental Challenges: State of the Art Review for Practical Implications. Front. Environ. Sci. 10:870271. doi: 10.3389/fenvs.2022.870271

[2] Intergovernmental Panel on Climate Change (IPCC) (2022). Climate change: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

[3] Farauta, B.K., Egbule C.L., Idrisa, Y.L., Agu V.C. (2011). Climate change and adaptation measures in Northern Nigeria: Empirical situation and policy implications. African Technology Policy Studies Network, Nairobi, Kenya.

[4] Okon, E.M., B.M. Falana, S.O. Solaja, S.O. Yakubu, O.O. Alabi, B.T. Okikiola , T.E. Awe, B.T. Adesina, B.E. Tokula , A.K. Kipchumba, A.B. Edeme (2021). Systematic review of climate change impact research in Nigeria: implication for sustainable development. Heliyon Journal, 2405-8440 © 2021 Published by Elsevier Ltd. https://doi.org/10.1016/j.heliyon.2021.e07941

[5] Fadairo, O., Olajuyigbe, S., Osayomi, T., Adelakun, O. Olaniyan, O., Olutegbe, S. and O. Adeleke (2021). Climate Change, Rural Livelihoods, and Ecosystem Nexus: Forest Communities in Agro-ecological zones of Nigeria. In: Oguge, N., Ayal, D., Adeleke, L., da Silva, I. (eds) African Handbook of Climate Change Adaptation. Springer, Cham. https://doi.org/10.1007/978-3-030-45106-6_155

[6] Gideon Danso-Abbeam, Temitope O. Ojo, Lloyd J.S. Baiyegunhi and Abiodun A. Ogundeji (2021) Climate Change Adaptation Strategies by Smallholder Farmers in Nigeria: Does Non-Farm Employment Play any Role? *Heliyon*. 2021 Jun; 7(6): e07162. Published online 2021 May 28. doi: 10.1016/j.heliyon.2021.e07162 PMCID: PMC8192565PMID: 34151036

[7] Hassan, B.A.; Knight, J. (2023). Adaptation to Climate Change and Variability by Farming Households in North-Central Nigeria. *Sustainability* 2023, *15*, 16309. https://doi.org/10.3390/su152316309

[8] Kano State (2019). Kano State Government Official Dairy Directorate of Information, Kano, Nigeria.

[9] Kano State (2020). Kano State Government Official Dairy Directorate of Information, Kano, Nigeria.

[10] Simi Goyal and Chaminda Pathirage (2018) Farmers Perceptions of Climate Change Related Events in Shendam and Riyom, Nigeria. *Economies*, *6*(4), 70; https://doi.org/10.3390/economies6040070

[11] Mustapha, S.B., Sanda, A.H. and Shehu, H. (2015). Farmers' Perception of Climate Change in Central Agricultural Zone of Borno State, Nigeria. *Journal of Environment and Earth Science.*www.iiste.org. ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online) Vol 2 (11).

[12] Falaki, A. A., J. A. Akangbe and O. E. Ayinde (2013). Analysis of Climate Change and Rural Farmers' Perception in North Central Nigeria. *Journal of Human Ecology*, 43 (2): 133-140. Kamla-Raj.

[13] Sofoluwe N.A., A. A. Tijani and O. I. Baruwa (2011). Farmers' perception and adaptation to climate change in Osun State, Nigeria. *African Journal of Agricultural Research* Vol. 6(20), pp. 4789-4794, Available online at http://www.academicjournals.org/AJAR DOI: 10.5897/AJAR10.935 ISSN 1991-637X. *Academic Journals*.

[14] William Adzawla, Solace Kudadze, Aminu Rashad Mohammed and Ismail Issaka Ibrahim (2019). Climate Perceptions, Farmers' Willingness-to-Insure Farms and Resilience to Climate Change in Northern Region, Ghana. Environmental Development, Vol. 32, 2019, 100466, ISSN 2211-4645, https://doi.org/10.1016/j.envdev.2019.100466.

[15] Giller, K.E., Delaune, T., Silva, J.V., Descheemaeker, K., Van de Ven, G., Schut, A.G.T., Wijk, M.V., Hammond, J.,

Hochman, Z., Taulya, G., Chikowo, R., Narayanan, S., Kishore, A., Bresciani, F., Teixeira, H.M., Andersson, J.A., and M. K. van Ittersum (2021). The future of farming: Who will produce our food? *Food Sec*. 13, 1073–1099 (2021). https://doi.org/10.1007/s12571-021-01184-6

[16] Festus Ugwoke Agbo, R. N. Arua and Eucharia Anulika Okonkwo (2015). Effects of climate variability on the choices of livelihood among farm households in Anambra State, Nigeria. *African Journal of Agricultural Research*. Vol. 10 (44), pp. 4134-4141. Article number: B97B2E256035. ISSN 1991-637X