



**THE EXTREME VULNERABILITY OF SMALLHOLDER FARMERS OF
CHANGING CLIMATE ALONG WITH ITS EFFECT UPON THE PRODUCTION:
EVIDENCE FROM NIGERIA**

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ABSTRACT

The research examined the extreme vulnerability of smallholder farming households in Kwara State, Nigeria. Primary data were gathered and analyzed using descriptive statistics, multiple regression models, and a Likert-type scale. Findings indicate that 65.83% of the respondents were aged 50 years and above, 55.83% were male, and 59.17% had attained tertiary education. Furthermore, 74.17% of the participants reported being aware of the changing climate, 60.83% had individual experiences with it, and 59.17% had experienced flooding in their communities. The consequence of changing in climate on lower crop yields as part of productivity in agriculture (4.30), increased food shortages (4.14), pest infestations and disease outbreaks (4.13). Key factors significantly influencing farmers' vulnerability to climate change included age, education level, farm size and awareness of climate change were positively significant at 1%. While contact with extension agents, flooding experiences, and exposure to pests and diseases were negatively significant at 1% and 5% respectively. According to the survey, 48.33% of participants had a moderate level of climate change vulnerability. Coping strategies identified included tree planting to prevent flooding, obtaining farm insurance, constructing drainage systems, cultivating climate-resilient crops, and farmer sensitization programs. The study concludes that majority of smallholder farming households in study arear are susceptible to climate change. It recommends that agricultural extension agents be thoroughly educated on climate change and its effect on farming to be able to effectively disseminate relevant details to farmers.

Keywords: Awareness, Climate, Change, Coping, Strategies, Flooding, Vulnerability

INTRODUCTION

Climate change and variability pose significant risks to agricultural production, particularly for smallholder farmers who rely heavily on natural resources but often lack the capacity to respond effectively to climate shocks (Olagunju, 2015). These farmers, who form the backbone of Nigeria's agricultural system, are highly vulnerable due to their dependence on rain-fed agriculture, limited access to infrastructure, and inadequate adaptation resources. Globally, climate change has already contributed to an estimated 1–5% decline in agricultural productivity over the past decade. Forecasts suggest that without effective intervention, agricultural production in many parts of Africa could decline by 10–50% by 2050 under current farming practices (Adishi and Oluka 2018). This presents a serious threat not only to agricultural livelihoods but also to broader development goals such as poverty alleviation, food security, and sustainable economic growth (Adishi & Oluka, 2018). Climate change adaptation refers to adjustments in systems, processes, or practices to minimize the adverse effects of climate variability. In agricultural contexts, adaptation strategies may include crop diversification, irrigation development, planting of drought-tolerant varieties, and improved access to climate information (Ayinde, 2011). These strategies are increasingly vital in regions such as Africa and Asia, where climate change impacts are most severe and adaptive capacity is often low.

In Nigeria, the agricultural sector is dominated by smallholder farmers who live in rural areas with limited access to modern farming inputs, infrastructure, and extension services. Their dependence on seasonal rainfall makes them especially susceptible to erratic weather patterns, prolonged droughts, and flooding. These challenges are compounded by the broader socio-economic vulnerabilities that



characterize rural communities. As noted by Ayo *et al.*, (2014), climate change threatens not only the sustainability of agriculture but also the very foundation of human existence. Its effects include reduced crop yields, water scarcity, soil degradation, pest and disease outbreaks, and food insecurity. In turn, these impacts lead to diminished livelihoods for farming households and increase the risk of food-related health issues. Despite some government and international efforts—such as the Structural Adjustment Program (SAP) and various donor-led interventions—agriculture’s contribution to Nigeria’s GDP remains suboptimal. There is a noticeable gap in localized research that examines the specific impacts of climate change on agricultural production and farmer responses in Nigeria. The specific objectives include; determine the level of farmers’ awareness of climate change, assess effect of climate change on agriculture production, examine farmer’s vulnerability to climate change and evaluate the coping strategies to agricultural risks in climate change towards production

MATERIALS AND METHODS

Study Area

This study was conducted in **Kwara State**, located in the North-Central geopolitical zone of Nigeria. The state was created on May 27, 1967, and has Ilorin as its capital and administrative headquarters. Kwara State comprises 16 Local Government Areas (LGAs), which are further subdivided into districts and villages (KWADP, 2016). According to the National Population Commission (NPC, 2021), the state has a population of approximately **3,192,893** people, with an average population density of **74.6 persons per square kilometer**. Geographically, the state lies between **latitude 7° 45’ and 9° 30’ N** and **longitude 2° 30’ and 6° 25’ E**, covering a total land area of **3,682,500 hectares**, representing about **3.5%** of Nigeria’s total landmass. Of this, **25%** is estimated to be under agricultural use. The state's climate is humid tropical, characterized by two distinct seasons: the wet season (April–October) and the dry season (November–March). Annual rainfall ranges between **1,000 mm and 1,500 mm**, while average temperatures range from **30°C to 35°C** (KWADP, 2016). Vegetation is predominantly wooded savanna, with some forested regions in the south. Kwara State is primarily agrarian, with vast expanses of arable land and fertile soil. Common cropping systems include **maize-based, yam-based, cassava-based, and rice-based systems** (particularly along the River Niger). Major crops cultivated include **yam, maize, cassava, groundnut, cowpea, sorghum, melon, okra, pepper**, and various leafy vegetables.

Sampling Technique

The sample households for this study were selected using a multi-stage sampling procedure. The first step was the purposeful selection of Zone C and Zone D among Kwara State's four Agricultural Development Project (ADP) zones. In the second stage, Local government areas were selected randomly from each ADP zone, 4 villages were also chosen at random from each local government areas in each ADP zone in the third stage. While the last stage, involve random selection of 10 households from each village, making a total of 120 households.

Data Collection

Analytical Techniques

The study employed both **descriptive** and **inferential statistical tools** for data analysis. **Descriptive statistics** such as frequencies, percentages, mean values, graphs, and Likert-scale rankings were used to summarize the socio-economic characteristics and responses of the farmers. **Inferential statistics**, specifically the **multiple regression analysis**, was used to identify the factors influencing the vulnerability of smallholder farmers to climate change.

RESULTS AND DISCUSSION

As shown in Table 1, the mean age of respondents was 52 years, indicating that most farmers were in their middle age and still active in agricultural activities. This suggests a potentially high level of productivity, as the farming population consists of individuals who are physically capable of engaging in labor-intensive work. The result showed that 55.83% of the respondents were male, while 44.17% were female. Although male farmers constituted the majority, a significant proportion of women were also actively involved in farming activities. This underscores the important role women



play in agriculture within the study area. The result depicted that more than half of the respondents (51.67%) were married, which supports the findings of Osayinlusi *et al.* (2017), who suggested that married individuals, particularly men, dominate farming due to its physically demanding nature. The result in Table 1 further revealed that the modal family size was between 4 and 6 members, representing 60.83% of respondents. Family size is a key factor in determining available farm labor, particularly for smallholder farmers who often rely on household members for agricultural work. Educational levels among respondents varied. Majority of the respondents (59.17%) had attended tertiary education, while 24.17% had completed secondary education. Only 11.67% had primary education, and 5.00% had no formal education. These results indicate a relatively educated farming population, which may enhance the adoption of new technologies and innovations in agricultural practices. In addition, the findings revealed that 55.83% of respondents were members of one form of association or cooperative society, while 44.17% were not affiliated with any group. Membership in associations is beneficial as it often facilitates access to loans, subsidized inputs, and shared knowledge. Furthermore, 52.50% of the farmers had access to credit, while 47.50% did not. Access to credit is essential for increasing investment in farm inputs, which can boost productivity. Access to agricultural extension services was relatively balanced, with 49.17% of respondents having access, while 50.83% did not. Among those with access, most (49.17%) reported receiving between 1 and 5 visits from extension agents during a farming season. Regular contact with extension officers enhances farmers' knowledge about improved practices, government support programs, and new technologies. The results also revealed that majority (70.00%) of respondents indicated that farming was their primary occupation, while 30.00% engaged in farming as a secondary activity. In terms of income, 65.00% of respondents earned between ₦500,000 and ₦1,000,000 per farming season, reflecting the economic significance of farming in the area. Respondents reported considerable experience in farming. Less than half 45.00% had been farming for over 20 years, while the second-highest group had between 11 and 20 years of experience. This long-term engagement in farming reflects a high level of expertise and resilience within the farming community. As shown in Table 1, landholding sizes also varied. A majority (55.00%) of respondents cultivated between 1 and 5 hectares of land, while 10.00% farmed on less than one hectare. These findings indicate that farming is a dominant livelihood in the area, supported by relatively substantial land access and years of accumulated farming knowledge. Finally, 55.83% of respondents belonged to cooperative societies. These organizations play a critical role in improving members' access to farm inputs, credit, subsidized food items, and collective bargaining power.



Table 1: Distribution of Respondents According to Socio-economic Characteristics

Variables	Frequency	Percentage (%)
Age		
30-40	12	10
41-50	29	24.17
Above 50 years	79	65.83
Mean	52	
Household head		
Yes	62	51.67
No	58	48.33
Gender		
Male	67	55.83
Female	53	44.17
Marital Status		
Single	35	29.17
Married	62	51.67
Divorced	7	5.83
Widow	16	13.33
Household size		
1-3	35	29.17
4-6	73	60.83
7-10	10	8.33
Above 10	2	1.67
Mean	5.0	
Farm size (ha)		
<1	12	10
1-5	66	55
6-10	32	26.67
Above 10	10	8.33
Mean	3.0	
Primary Occupation		
Farming	84	70
Non farming	36	30
Income per season		
30,000-100,000	1	0.83
100,000-500,000	4	3.33
500,000-1,000,000	78	65
Above 1,000,000	37	30.83
Mean	7500000	
Access to extension agent		
Yes	59	49.17
No	61	50.83
Extension Agent Contact		
No visit	61	50.83
Once a month	59	49.17
Access to credit		
Yes	63	52.50
No	57	47.50
Farming Experience		
1-10	16	13.33
11-20	50	41.67
Above 20	54	45.00
Mean	10.30	



Cooperative membership		
Yes	67	55.83
No	53	44.17
Level of Education		
No formal education	6	5.00
Primary education	14	11.67
Secondary education	29	24.17
Tertiary education	71	59.17

Source: Field Survey, 2023

The Awareness and Perception about Climate Change

Table 2 presents respondents’ levels of awareness and perception regarding climate change in the study area. A significant majority (74.17%) of the respondents indicated that they were aware of climate change, while 25.83% reported no knowledge of it. Regarding sources of information, 60.83% had personally experienced the effects of climate change, 15.83% became aware through social media, and 23.34% learned about it through other means. When asked about specific climate-related events, 65.00% of respondents reported being affected by early onset of rainfall, while 35.00% stated otherwise. Additionally, 59.17% confirmed being impacted by late cessation of rainfall, with the remaining 40.83% reporting no such effect. Flooding was also reported as a major issue, with 59.17% of respondents experiencing flooding in their communities, compared to 40.83% who had not. These findings align with the observations of Ojo and Adebayo (2012), who noted that areas once considered well-drained agricultural plains are now prone to flooding, and that increasing aridity in the Sahel and Sudan savannah regions continues to negatively impact agricultural productivity. Furthermore, 65.83% of respondents indicated they had been affected by extreme temperatures, while 34.17% reported no such experience. These results suggest a high level of exposure to climate-related stressors and highlight the need for improved climate change awareness and capacity-building initiatives among smallholder farmers in the region.

Table 2: Awareness and Perception about Climate Change

	Frequency	Percentage
Awareness and Perception		
Yes	89	74.17
No	31	25.83
Extent of awareness		
Experience	73	60.83
Social media	19	15.83
Others	28	23.34
Affected by early rainfall		
Yes	78	65.00
No	42	35.00
Affected by late cessation of rainfall		
Yes	71	59.17%
No	49	40.83%
Experienced flood in your community		
Yes	71	59.17
No	49	40.83
Affected by extreme temperature		
Yes	79	65.83
No	41	34.17

Source: Field Survey, 2023



Climate Change Impact on Farmers' Productivity

The techniques farmers use to lessen the negative consequences of climate change are greatly influenced by their understanding of the phenomenon. Among the various impacts identified, the most significant is the **reduction in crop productivity**, which is closely tied to land size and yields. This decline implies that the output from farming activities may not be proportional to the labor and resources invested, thereby reducing overall productivity.

As shown in **Table 3**, the **reduction in crop productivity** had the highest mean score of **4.30**, with **62%** of respondents strongly agreeing that their productivity had been negatively impacted. Another prominent effect noted was the **general impact of climate change**, with **67%** of farmers reporting that they were seriously affected overall. Furthermore, **61%** strongly agreed that **pest infestation and disease outbreaks** had increased, largely due to prolonged dry spells and inadequate rainfall.

The perception of **food shortages** as an effect of climate change yielded a mean score of **3.49**, with **52%** of respondents remaining neutral on the issue—indicating a more mixed or less direct experience with this impact. The most alarming consequence of climate change, however, was **flooding**, with **81%** of respondents strongly agreeing that it had **displaced their farmlands and destroyed crops**.

Pest infestation and disease outbreak ranked third among the effects, with a high mean score of **4.13** and **44%** of respondents strongly agreeing that these challenges were now common in the area. Additionally, **45%** of respondents agreed that **reduced rainfall** had a direct effect on crop growth due to insufficient water after planting, reflected in a mean score of **3.29**.

Frequent flooding and the associated **land displacement** have also contributed to **rural-urban migration**, as a large number of impacted farmers move to cities in pursuit of better living and infrastructure. This emphasizes how urgently rural farming communities require infrastructure improvements and climate adaption techniques.

Table 3: The Impact of Climate Change on the Productivity of Farmers

Perception	Mean score on likert scale	Majority of respondents	Percentage (%)	Rank
Reduction in crop productivity	4.30	SA	62	1 st
Delay in rainfall	3.83	SA	45	7 th
Increase in rise of food price	4.03	A	56	4 th
Rise in food shortage	4.14	A	67	2 nd
Pest infestation and disease outbreak	4.13	SA	61	3 rd
Reduction in livestock productivity	3.22	N	54	11 th
High mortality rate of livestock	2.95	N	72	13 th
High occurrence of flood	3.86	SA	81	6 th
Reduction in amount of rainfall	3.29	A	45	9 th
Reduction in crop production	3.18	A	56	12 th
High temperature	3.98	A	64	5 th
Rural urban migration	3.23	A	58	10 th

Source: Field survey, 2023; Key: N (Neutral), A (Agree), and SA (Strongly Agree)

Factors Affecting the Climate Change Vulnerability of Smallholder Farmers

Table 4 presents an examination of the variables influencing smallholder farmers' susceptibility to climate change. The association between a few socioeconomic factors and climate sensitivity was evaluated using a multiple regression model. The model produced an R2 value of 0.625, meaning that the independent factors in the model account for about 62.5% of the variation in the farmers' susceptibility to climate change.

Regression results show that several variables significantly influence vulnerability levels. These include **age, education level, extension agent contact, farm size, climate change awareness,**

flooding experience, and pest/disease outbreaks, all of which were significant at either the **1% or 5% levels**. At the 1% level, age had a positive and substantial impact, indicating that farmers' awareness and perception of the effects of climate change improve with age, possibly lowering their vulnerability. This implies that **younger farmers tend to be more vulnerable**, possibly due to less experience in coping with climatic shocks. This result is consistent with a similar association noted by Onuoha. and Ezirim (2010). With a coefficient of 0.051, education also demonstrated a favorable and substantial impact at the 1% level. This implies that greater perceived vulnerability is linked to higher educational attainment, probably because educated farmers report higher sensitivity due to their increased awareness of the concerns connected with climate change.

Furthermore, education may expose farmers to more information and modern innovations, increasing their recognition of potential climate threats. Farmers who use extension services more regularly tend to be more conscious of climate threats and hence perceive themselves as more vulnerable, as evidenced by the positive significance of extension agent contact at the 5% level. Access to extension services increases exposure to information about climatic variability and adaptation strategies. With a coefficient of 0.3019, farm size had a favorable and significant effect at the 5% level. This implies that because they are more exposed to climate-related hazards like drought and flooding, farmers with larger landholdings feel more vulnerable. Larger farms require more inputs and management, making them more susceptible to climatic stressors. **Climate change awareness was positively significant at the 1% level**, indicating that increased awareness correlates with increased vulnerability. This could be because knowledgeable farmers are more aware of the long-term risks that climate change poses to their means of subsistence. On the other hand, flooding experience demonstrated a negative and significant connection at the 1% level, indicating that farmers who have experienced floods frequently in the past may have developed coping mechanisms that lessen their risk now. Farmers who have previously adapted may be better prepared for future events. Lastly, **pest infestation and disease outbreaks were negatively significant at the 5% level**, implying that while these factors reduce overall yields, farmers experiencing them may perceive lower vulnerability due to the adoption of disease and pest management practices. However, these problems continue to be major risks to food security and productivity (Oerke 2006), estimated that plant diseases alone can result in up to **15% losses in global crop yields**, highlighting the critical need for robust pest and disease control strategies.

Overall, the results imply that a complex interaction of socioeconomic traits, experience, and awareness levels shapes sensitivity to climate change. In order to mitigate these risks, targeted measures that increase farmers' capacity for adaptation such as education, disaster preparedness, and access to extension services are crucial.

Table 4: Factors Influencing Small-scale Farmers' Vulnerability to Climate Change

Output	Coefficient	T	P> t
Age (Year)	0.026***	2.73	0.007
Household size	0.011	0.65	0.517
Level of education	0.051***	3.10	0.002
Cooperative membership	0.031	1.06	0.293
Access to extension agent	-0.064**	-2.04	0.044
Access to credit	-0.027	-0.84	0.403
Farm size (ha)	0.302***	3.23	0.002
Farming experience (yr)	-0.007	-0.58	0.563
Awareness of climate change	0.182***	5.71	0.000
Experience flood	-0.220***	-8.86	0.000
Changes in length of Temperature	-0.024	-0.80	0.423
Delay in rainfall	-0.008	-0.49	0.623
Pest and disease Outbreak	-1.998***	-2.57	0.011
Constant	0.817***	5.37	0.000

Source: Field Survey, 2023



Vulnerability Status

The distribution of respondents according to their degree of climate change vulnerability is shown in Table 5. According to the findings, 48.33% of farmers were classified as moderately vulnerable. Furthermore, 40.00% of respondents were categorized as extremely vulnerable, indicating that a sizable segment of the farming community is significantly impacted by unfavorable weather. These results highlight the necessity of proactive and focused efforts to lower the risks and possible effects of climate change on agricultural output. However, just 11.67% of respondents were classified as low vulnerable, meaning that they had little or no exposure to the detrimental consequences of climatic variability in the research area.

Table 5: Farmers' Level of Climate Change Vulnerability

Vulnerability Status	Frequency	Percentage
Highly vulnerable	48	40.00
Low vulnerability	14	11.67
Moderately vulnerable	58	48.33

Source: 2023 Field survey

Coping Strategies

The coping mechanisms respondents used to deal with the effects of climate change are shown in Table 6. The total of **30.00%** of the farmers **strongly agreed** that **planting trees** helps prevent flooding, while a larger proportion (**64.17%**) **agreed** with the same strategy. Similarly, **63.03%** of respondents **agreed** that having **farm insurance** is essential, while **30.25%** **strongly agreed** with its importance. Regarding **drainage construction**, **54.17%** of the respondents **agreed** with its effectiveness in mitigating climate impacts, while **44.17%** **strongly agreed**. On **local risk management**, **59.17%** **agreed** that it is an important strategy, and **35.83%** **strongly agreed**.

When it comes to **capacity building**, **49.17%** **agreed** that increasing farmers' capacity is vital, and **44.17%** **strongly agreed**. Building capacity entails "strengthening the skills, abilities, processes, and resources that organizations and communities need to survive, adapt, and thrive in a fast-changing world," according to Wossen et al., (2018). " Capacity building in this sense refers to the adoption of sustainable agricultural practices and technologies. Ray (2012) emphasized that developing economies require capacity building to enable effective technological transfer, a view supported by CDP (2010) which highlights its importance in promoting sustainable development.

Furthermore, **59.17%** of respondents **agreed** with **planting tolerant crop varieties**, while **34.17%** **strongly agreed**. On the need for **farmer enlightenment**, **51.67%** **agreed** and **40.83%** **strongly agreed** on its importance in coping with climate risks. Concerning the **provision of infrastructure**, **52.50%** **agreed**, and **41.67%** **strongly agreed** that it would enhance their adaptive capacity.

As Uwazie, (2020) assert, knowledge is power—awareness of coping strategies and constraints is critical. Poorly informed coping mechanisms can compromise long-term livelihoods and reduce future adaptation options by misallocating resources or pursuing unsustainable practices.

Table 6: Farmers' Coping Strategies to Climate Change

Strategy	Frequency	Percentage
Planting Trees prevent flooding		
Strongly Agree	36	30.00
Agree	77	64.17
Neutral	7	5.00
Farm Insurance		
Strongly Agree	36	30.25
Agree	76	63.03
Neutral	6	5.04
Disagree	2	1.68
Drainage construction		
Strongly Agree	53	44.17
Agree	65	54.17
Disagree	2	1.68
Local risk management		
Strongly Agree	43	35.83
Agree	71	59.17
Neutral	6	5.0
Farmers capacity building		
Strongly Agree	53	44.17
Agree	59	49.19
Neutral	8	6.67
Planting of tolerant crops		
Strongly Agree	41	34.17
Agree	71	59.17
Neutral	7	5.83
Disagree	1	0.83
Enlightment of farmers		
Strongly Agree	49	40.83
Agree	62	51.67
Neutral	9	7.50
Provision of infrastructure		
Strongly Agree	50	41.67
Agree	63	52.50
Neutral	7	5.83

Source: 2023 Field survey

CONCLUSION AND RECOMMENDATION

The study's concludes that smallholder farmers in the region are particularly susceptible to the effects of climate change. Also age, education level, extension agent contact, farm size, climate change awareness, flooding experience, and pest/disease outbreaks were the factors influencing changing climates effects among the respondents in the study area.

The following recommendations were put forth to lessen smallholder farmers' susceptibility to climate change in light of the study's findings:

1. Extension agents should receive comprehensive training on the effects of climate change on agriculture, to enable them give appropriate training to farmers.
2. Farmers should be encouraged to cultivate drought-tolerant and early-maturing crop varieties, especially in areas prone to prolonged dry spells.
3. Awareness campaigns should be conducted by stakeholder to improve the understanding of local communities on how agricultural output and climate change are related.
4. Empowering farmers with knowledge enables them to adopt effective adaptation strategies.



5. The government should invest in the construction and maintenance of proper drainage systems in farming communities. This will significantly reduce the impact of flooding on farmlands and protect agricultural investments.
6. Farmers should be supported in exploring non-farming income-generating activities to enhance household resilience and reduce dependency on climate-sensitive agricultural production.

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