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Farmers' Perceptions Of Climate Change Effects On Groundnut Farming In The Sahelian Zone: Evidence From Yusufari Lga, Yobe State, Nigeria

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Abstract: *Climate change poses a significant threat to agricultural productivity in the Sahelian zone of Nigeria, particularly for rain-fed crops such as groundnut (Arachis hypogaea). This study examined farmers' perceptions of climate change and its effects on groundnut yield in Yusufari Local Government Area (LGA), Yobe State, Nigeria. A descriptive survey research design was adopted, targeting male and female groundnut farmers with a minimum of five years of farming experience. Using a multistage sampling technique, data were collected from 150 respondents through structured questionnaires. Descriptive statistics, including frequencies and percentages, were used to analyze farmers' socio-economic characteristics, perceptions of climate change, and perceived effects on groundnut farming. The results revealed that farmers were highly aware of climate change, with the majority perceiving irregular rainfall (70%), increased temperature (63.3%), delayed onset of rains (56.7%), and shorter rainy seasons (50%). These perceptions align with documented climatic trends in the Sahelian region. Findings further showed that climate change has had predominantly negative effects on groundnut production, with low yield identified as the most significant impact (63.3%), followed by increased pest and disease incidence (53.3%), drought (46.7%), and delayed planting (43.3%). Although soil erosion and flooding were perceived as less frequent, they remain important long-term threats to land productivity. The study concludes that climate change is undermining groundnut productivity and rural livelihoods in Yusufari LGA, while farmers' adaptive capacity remains constrained by limited access to climate information, extension services, and improved inputs. The study recommends the promotion of climate-smart agricultural practices, improved climate information delivery, integrated pest management, livelihood diversification, and youth- and gender-inclusive agricultural policies to enhance resilience and sustain groundnut production in semi-arid northern Nigeria.*

Keywords: Climate change; Farmers' perceptions; Groundnut farming; Sahelian zone; Climate variability; Nigeria

INTRODUCTION

Climate change has emerged as one of the most critical environmental challenges confronting agricultural systems worldwide, with particularly severe implications for arid and semi-arid regions such as the African Sahel. The Intergovernmental Panel on Climate Change (IPCC, 2022) reports that the Sahelian region is experiencing rising temperatures, increasing rainfall variability, and a growing frequency of extreme climate events, notably droughts and floods. These climatic changes pose serious threats to rain-fed agriculture, which remains the primary livelihood activity for rural populations across the Sahel. In Nigeria, the northeastern region where Yobe State is located lies within the Sahelian ecological belt and is among the most climate-vulnerable areas in the country. Recent climate records indicate increasing mean temperatures, delayed onset and early cessation of rainfall, prolonged dry spells, and advancing desertification processes in the region (Nigerian Meteorological Agency [NiMet], 2023; Oloruntade et al., 2021). Such climatic stresses have negatively affected agricultural productivity and heightened food insecurity among smallholder farming households. Groundnut (Arachis hypogaea) is one of the most important cash and food crops cultivated in the Sahelian zone of Nigeria. It contributes significantly to household income, nutritional security; livestock feed supply, and soil fertility improvement through biological nitrogen fixation (Food and Agriculture Organization [FAO], 2021). In Yobe State, particularly in Yusufari Local Government Area (LGA), groundnut production is predominantly rain-fed and undertaken by smallholder farmers with limited access to irrigation and modern agricultural inputs. This production system makes groundnut yield highly sensitive to climate variability. Empirical studies have shown that changes in rainfall distribution, increased temperature extremes, and soil moisture stress significantly influence groundnut growth, flowering, pod formation, and final yield (Ahmed et al., 2020; Ajetomobi & Abiodun, 2019). In the Sahel, shortened rainy seasons, heat stress, and erratic rainfall have been associated with declining groundnut yields and increased risk of crop failure (Sultan et al., 2020; Traore et al., 2021).

Beyond objectively measured climatic trends, farmers' perceptions of climate change constitute a critical dimension of agricultural vulnerability and yield outcomes. Perception refers to farmers' awareness, understanding, and

interpretation of long-term changes in climate variables based on lived experience, indigenous knowledge, and socio-economic context (Maddison, 2007; Deressa et al., 2009). In northern Nigeria and across the Sahel, studies consistently report that farmers perceive rising temperatures, increasing rainfall unpredictability, delayed rainfall onset, and more frequent droughts (Abid et al., 2019; Ayanlade et al., 2022). These perceived changes often align with meteorological evidence and directly influence farmers' production decisions, including crop choice, planting dates, and input use. Farmers' perceptions are particularly important because they shape responses to climate risks and ultimately affect crop yield outcomes. Where farmers correctly perceive climate change and its effects, they are more likely to adopt yield-enhancing and risk-reducing practices such as adjusting planting dates, using improved or drought-tolerant groundnut varieties, practicing soil and water conservation, and diversifying income sources (Below et al., 2012; Bryan et al., 2013). Conversely, inadequate awareness or misinterpretation of climate signals may increase exposure to climate shocks, resulting in reduced yields and income losses.

In Yusufari LGA, where farming is largely subsistence-oriented, declining groundnut yields due to climate stressors have direct implications for household welfare and food security. The vulnerability of groundnut farmers in Yusufari LGA is further explained by the interaction of exposure to climate hazards, sensitivity of the rain-fed farming system, andlimited adaptive capacity. According to the IPCC (2022), adaptive capacity in many Sahelian communities is constrained by poverty, limited access to credit and extension services, inadequate infrastructure, insecurity, and weak institutional support. In Yobe State, these challenges exacerbate the negative effects of climate change on groundnut yield, making farmers more susceptible to production shocks (Ogunniyi et al., 2021; World Bank, 2023). Despite the economic and livelihood importance of groundnut in the Sahel, empirical studies that specifically examine farmers' perceptions of climate change and its effects on groundnut farming in northeastern Nigeria particularly at the local government level remain limited. Existing research has largely focused on cereal crops such as millet and maize or has assessed climate impacts at broader regional scales without sufficient crop- and location-specific analysis (Sultan et al., 2020; Traore et al., 2021). This gap limits the formulation of targeted, evidence-based adaptation strategies for groundnut farmers. Against this backdrop, this study investigates farmers' perceptions of climate change and its effects on groundnut yield in the Sahel, using evidence from Yusufari LGA, Yobe State, Nigeria. By analyzing perceived climatic changes and their implications for groundnut production, the study provides location-specific insights to inform climate-responsive agricultural policies, strengthen extension services, and enhance the resilience of groundnut-based farming systems in the Sahelian zone of Nigeria.

STATEMENT OF THE RESEARCH PROBLEM

Climate change poses increasing threats to agricultural productivity in the Sahel, particularly for climate-sensitive crops such as groundnut that are cultivated under rain-fed conditions. In Yusufari Local Government Area of Yobe State, rising temperatures, erratic rainfall, delayed onset of rains, and frequent dry spells have been widely reported, yet their specific effects on groundnut yield remain inadequately documented. Although groundnut is a major source of income and food security for smallholder farmers in the area, empirical evidence linking farmers' perceptions of climate change to observed yield outcomes is limited. This knowledge gap constrains the design of effective, location-specific adaptation strategies and climate-responsive agricultural policies. Several empirical studies in Yobe State provide important background evidence on climate change and agricultural production, though with notable limitations. A study conducted in Machina Local Government Area of Yobe State by Abdullahi et al. (2023) employed a cross-sectional survey of sesame farmers using structured questionnaires and descriptive statistics; the findings revealed that farmers perceived rising temperatures, delayed rainfall onset, and frequent droughts as major constraints to crop productivity, and the study concluded that climate variability was negatively affecting crop yields, recommending improved extension services and access to climate-resilient inputs, but it did not examine groundnut production or yield impacts. Similarly, Yusuf and Mustapha (2024) investigated farmers' perception and adaptation to climate change among smallholder crop farmers in Bade LGA, Yobe State, using questionnaire surveys and frequency analysis; the study found widespread awareness of climate change manifested through irregular rainfall and increased heat stress, and concluded that farmers' adaptive capacity was low due to poverty and limited institutional support, recommending government intervention and climate information dissemination, yet the study focused on mixed cropping systems without crop-specific yield analysis. Using remote sensing and GIS techniques, Mohammed et al. (2022) analyzed land degradation and vegetation dynamics across northern Yobe State, including Yusufari axis, and found significant vegetation loss and desertification linked to prolonged dry spells and temperature rise; the study concluded that these environmental changes threaten agricultural productivity in the Sahelian belt of Yobe State, recommending land restoration and sustainable land management practices, but did not incorporate farmers' perceptions or assess impacts on specific crops such as groundnut. At the community level, Adamu et al. (2023) examined climate change perception and livelihood impacts among rural households along the Komadugu-Yobe Basin, using household surveys and descriptive analysis; the findings showed that respondents perceived increased drought frequency and reduced agricultural output, and the study concluded that climate change was undermining rural livelihoods, recommending livelihood diversification, though the research was livelihood-oriented and did not analyze crop-specific yield outcomes.

More closely related, Garba et al. (2024) assessed climate variability and crop production challenges among rain-fed farmers in northern Yobe State, using structured questionnaires and mean score ranking; the findings indicated that erratic rainfall and high temperatures were perceived as major causes of low crop yield, and the study recommended adoption of drought-tolerant varieties, but it aggregated crops and did not isolate groundnut yield or focus specifically on Yusufari LGA. Although existing studies in Yobe State and its Sahelian LGAs document farmers' awareness of climate change, environmental degradation, and general impacts on agriculture, there is a clear lack of empirical research that specifically links farmers' perceptions of climate change to observed effects on groundnut yield in Yusufari Local Government Area. Most available studies are either non-crop-specific, focused on other crops such as sesame, or conducted at broader regional scales, thereby limiting crop- and location-specific understanding. This gap underscores the need for the present study, which focuses explicitly on perception and effects of climate change on groundnut yield in Yusufari LGA, to support targeted adaptation strategies and evidence-based policy formulation.

OBJECTIVES OF THE STUDY

The aim of the study is to examine farmers' perceptions of climate change and assess its effects on groundnut yield in Yusufari Local Government Area, Yobe State, Nigeria. The specific objectives are to: identify and analyze farmers' perceptions of climate change in Yusufari LGA, determine the perceived effects of climate change on groundnut production and yield in the study area.

MATERIALS AND METHODS

Yusufari Local Government Area is located between latitude $12^0$55'03"N to $13^0$28'03"N of the equator and longitude $10^0$15'0"E to $11^0$23'0"E of the Greenwich meridian time. The Local Government shares local boundaries with Yunusari Local Government to the east, Karasuwa and Bursari Local Government Areas to the south, Nguru Local Government Area to the west and international boundary with Niger Republic to the north. It has an area of about 3,928Km^2 (1,517 sq. mi) (Figures 1). The climate is semi-arid, characterized by low annual rainfall amount of less than 400mm with 60 days growing season (July-August) (Maigari, 2000).

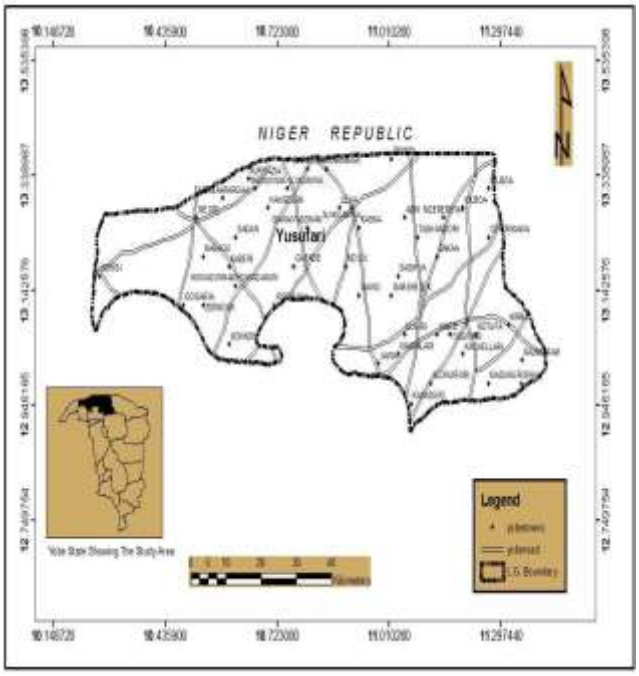

Figure 1: The Study Area
Source: modified and Adopted from the Administrative map of Nigeria

The area falls within those severely affected by the droughts of the seventies and eighties. The length of the dry season exceeds eight months (October to June) (ibid). Air is partially dry except for about two months in the middle of the very brief wet season. (Maigari, 1996; 2000). Potential evapotranspiration rates range between 6.9mm to 8.5mm per day (Maigari, 2000). The mean rainfall of the region is about 443.94mm. The average mean daily temperature is about 25^0 C and the monthly mean temperature is about 27^0 C. However, mean maximum temperature for the hotter months reaches 40^0 C in April, May and June (Jajere and Baka, 2010 in Jajere, 2014).

3. METHODOLOGY

This study employed a descriptive survey research design to examine the perception of climate change and its effects on groundnut farming among farmers in Yusufari Local Government Area (LGA) of Yobe State. The survey design was deemed appropriate because it allows for the collection of quantitative and qualitative data on farmers' socio-economic characteristics, perceptions, and experiences, while providing the basis for generalization to the broader population (Creswell & Creswell, 2018). The target population consisted of all male and female groundnut farmers in Yusufari LGA who has been actively engaged in farming for at least five consecutive years. This inclusion criterion ensured that respondents had sufficient experience to provide informed perspectives on climate variability, cropping patterns, and associated challenges.

According to the Yobe State Agricultural Development Programme (YSADP, 2023), agriculture is the primary livelihood in Yusufari, with groundnut cultivation constituting

a major source of income and sustenance. A total of 150 respondents were selected using a multistage sampling technique. The sample size was considered adequate for statistical representation, as recommended by Yamane (1967) for populations with moderate variability. This size also facilitated manageable data collection and analysis within the study's logistical constraints. A multistage sampling procedure was adopted for this study. First, purposive sampling was used to select the major groundnut-producing wards in Yusufari LGA. Second, stratified sampling was applied within the selected wards to ensure proportional representation according to the estimated farming population. Finally, simple random sampling was employed to select individual respondents within each ward, ensuring that every eligible farmer had an equal chance of inclusion (Etikan & Bala, 2017). Data were collected on three main areas. First, socio-demographic characteristics of respondents were captured, including age, marital status, education, occupation, years of residence, and farming experience. Second, respondents' perceptions of climate change were assessed, focusing on irregular rainfall, rising temperatures, shortened rainy seasons, and delayed rains. Third, the effects of climate change on groundnut farming were examined, including low yield, pest and disease incidence, soil erosion, delayed planting, drought, and flooding. Descriptive statistics such as frequencies, percentages were employed to summarize respondents' socio-economic characteristics, perceptions, and reported effects of climate change. Findings were interpreted in sentence form with supportive literatures.

RESULTS AND DISCUSSION

SOCIO-ECONOMIC CHARACTERISTICS OF RESPONDENTS

Figure 2 show that male respondents comprised 80% of the sample, while females represented only 20%, indicating a significant gender imbalance in agricultural participation within the study area. This pattern reflects the male-dominated household structures typical of rural northern Nigeria, where men are generally the primary decision-makers in farming and community affairs, and women often assume supportive roles in production, processing, and household management (Ekeleme & Olatundun, 2022; FAO, 2011, 2025).

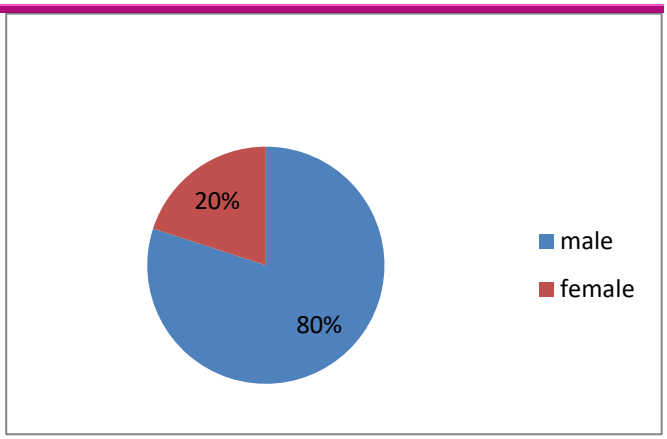

Figure 2. Sex of the Respondents
Source: Field Survey, 2025

Globally and across sub-Saharan Africa, women contribute substantially to agricultural labor often between 60% and 80% but face constraints in land ownership, access to credit, inputs, and extension services (FAO, 2011; FAO, 2025). In Nigeria, women farmers frequently produce lower yields per hectare than men due to unequal access to productive resources (World Bank & ONE Campaign, 2014; Uwadie et al., 2019). In Yobe State, studies have similarly documented limitations on women's participation in agriculture. Tijani and Tijjani (2019) reported that in Damaturu LGA, women's engagement in productivity is restricted by limited land access, financial constraints, and lack of decision-making authority. SWOFON (2021) noted that women farmers often cannot independently rent or inherit land and have minimal access to inputs like seeds and fertilizers. Recent studies on climate change adaptation in Yobe State further indicate that cultural norms, low literacy, and socio-economic inequalities hinder women's active involvement in agricultural innovation (Madaki et al., 2024; Umar et al., 2023). For instance, male cattle farmers in Yobe and Bauchi States owned, on average, 20 cattle, compared with only 2 for females, highlighting stark gender disparities in resource ownership. These findings underscore that, while women actively contribute to farming and processing activities in Yusufari and Yobe State, their roles are undervalued and constrained, leaving agricultural decision-making and adaptation strategies largely male-driven (FAO, 2020; World Bank & ONE Campaign, 2014). The gender imbalance observed in the study highlights the need for gender-sensitive agricultural policies that empower women, enhance access to land, credit, and training, and promote equitable participation in decision-making. Closing the gender gap in agriculture has the potential to increase productivity, strengthen household food security, and improve resilience to climate change in northern Nigeria (FAO, 2025; World Bank, 2014).

Table 1 show that most respondents (36.7%) are aged 36–45 years, followed by 26–35 years (23.3%) and 46–55 years (23.3%). Only 6.7% are below 25 years, while 10% are above 55 years. This indicates that the majority of farmers in the

study area are in their prime working and economically active ages, which is particularly important for labour-intensive activities such as groundnut farming. The small proportion of youth suggests limited engagement of younger generations in agriculture, reflecting broader national trends in youth employment in rural farming (Omoju et al., 2023). The dominance of the middle-aged group (26–55 years) is favorable for adopting improved farming practices, managing labour-intensive operations, and implementing climate adaptation strategies. In contrast, the presence of older farmers (above 55 years) highlights potential challenges related to succession planning, generational renewal, and the physical demands of farming. Similar patterns have been observed in Yobe State; for example, a study of sesame farmers in Machina LGA reported an average age of 42 years, with most respondents clustered in the 25–35 and 36–46 age brackets (Tafida, Nazifi, & Muhammad, 2024).

The age distribution implies that interventions to sustain agricultural productivity and climate resilience should focus on: (i) encouraging youth participation through mentorship and training, and (ii) designing extension services, credit schemes, and adaptation programs that accommodate both middle-aged and older farmers. Overall, the age profile underscores the active, experienced workforce in Yusufari while highlighting the need for generational renewal and strategies to engage younger farmers in agriculture for long-term sustainability. Table 1 shows that the majority of respondents (76.7%) are married, while 10% are single, and 6.7% each are widowed or divorced. This predominance of married individuals reflects a stable, family-oriented social structure, where household labour can be pooled for farming and other livelihood activities. Shared responsibilities and joint decision-making between spouses can enhance productivity, improve labour allocation, and facilitate risk-sharing during challenges such as pest infestations or irregular rainfall (Galadima, 2014; A Socio-economic Impact Assessment, 2017).

Table 1: Age, marital status, education, occupation and farming experience of Respondents

Age	Freq.	%
Below 25	10	6.7
26-35	35	23.3
36-45	55	36.7
46-55	35	23.3
Above 55	15	10.0
Marital status		
Single	15	10.0
Married	115	76.7
Widowed	10	6.7
Divorced	10	6.7
Education		
No formal Edu.	35	23.3
Primary	45	30.0
Secondary	50	33.3
Tertiary	20	13.3
Occupation		
Full-time farmer	105	70.0
Part-time farmer	30	20.0
Others	15	10.0
Years of farming		
Less than 5 years	15	10.0
5-10 Years	40	26.7
11-20 years	60	40.0
Over 20 years	35	23.3

Source: Field Survey, 2025

Such a pattern aligns with regional observations in Yusufari LGA and broader Yobe State, where rural households typically exhibit high proportions of married members, reflecting traditional family structures that underpin agricultural production in semi-arid northern Nigeria (Galadima, 2014). Married households are better positioned to mobilize family labour for planting, weeding, harvesting, and post-harvest activities, reducing dependence on hired labour and promoting coordinated responses to climatic or economic shocks. However, the relatively small proportion of single, widowed, or divorced respondents highlights potential vulnerabilities. These households may face constraints in accessing labour, credit, land, and other agricultural resources, making them more susceptible to productivity and livelihood challenges (IFAD-related assessments in Yobe; Galadima, 2014). Consequently, agricultural policies, extension services, and adaptation programs should be designed to be inclusive, ensuring that non-married and vulnerable households are supported to access inputs, information, and climate-smart strategies. Addressing these gaps can enhance overall resilience, equitable resource distribution, and sustainable agricultural development in Yusufari and similar semi-arid communities. Table 3 shows that 33.3% of respondents attained secondary education, 30% had primary education, 23.3% had no formal education, and only 13.3% reached tertiary education. This indicates a moderate level of literacy among farmers, with a fair proportion able to read and write, while a considerable number lack formal education. Such a distribution is consistent with findings from Yobe State and

other parts of northeastern Nigeria, where access to schools, poverty, and cultural factors often limit educational attainment, and livelihood activities take precedence over formal schooling (Galadima, 2014; Nwajiuba et al., 2019). Research in Yusufari LGA and surrounding communities further confirms that most adult farmers possess only primary or Quranic education, with few reaching secondary or tertiary levels. The predominance of farmers with basic education suggests that many can interact with extension services, follow radio agricultural programmes, and adopt simple climate-smart practices. However, limited formal education may hinder understanding of technical or scientific information required for advanced farm innovations (Ajao et al., 2020). The low proportion of tertiary-educated respondents also reflects limited exposure to employment opportunities beyond agriculture, reinforcing reliance on subsistence and small-scale commercial farming typical of semi-arid northern Nigeria (Adamu & Hassan, 2019). Education constraints in rural settings can affect the adoption of modern technologies, record-keeping, and the capacity to adapt to changing climatic conditions, as higher education has been shown to enhance farmers' decision-making, access to information, and responsiveness to extension services (FAO, 2022).

Therefore, improving literacy and educational attainment among farmers in Yusufari and Yobe State is critical for enhancing human capital, agricultural productivity, and the effective implementation of sustainable farming and climate adaptation strategies. The Table indicates that 70% of respondents are full-time farmers, 20% engage in farming part-time, and only 10% are involved in other occupations. This distribution demonstrates that agriculture constitutes the principal livelihood activity in Yusufari LGA, reflecting the heavy reliance of rural households on farming for both income and food security. Such a pattern aligns with previous studies in Yobe State and other semi-arid regions of northeastern Nigeria, where agriculture remains the backbone of local economies despite increasing climate variability and declining rainfall (Audu & Barde, 2018; Galadima, 2014). In Yusufari specifically, the predominance of full-time farmers is linked to the area's longstanding engagement in rainfed crop production, particularly millet, sorghum, groundnut, and cowpea, under traditional farming systems that rely primarily on family labour and limited mechanization (Yobe State Government, 2022). The relatively small proportions of part-time farmers (20%) and those in other occupations (10%) highlight limited livelihood diversification, which increases vulnerability to climatic and economic shocks. Research shows that rural communities with narrow livelihood bases are more exposed to income instability and food insecurity when faced with adverse weather events such as drought or delayed rainfall (Audu & Barde, 2018; FAO, 2021). In arid LGAs like Yusufari and Yunusari, the reliance on full-time farming is further compounded by limited access to off-farm employment and underdeveloped non- agricultural sectors (Aliyu & Saidu, 2020). This dependence restricts farmers' capacity to adopt adaptive technologies or diversify into livestock, irrigation, or small-scale trading, limiting resilience to climate change. The findings underscore the importance of livelihood diversification programmes, skill development initiatives, and access to microfinance as strategies to strengthen rural household resilience. Promoting alternative income-generating activities such as agro-processing, trading, and handicrafts can reduce vulnerability, alleviate poverty, and enhance adaptive capacity to climate-related risks (FAO, 2022).

Furthermore, creating opportunities for youth and women in non-farm enterprises can reduce pressure on land, improve household welfare, and support sustainable agricultural livelihoods in Yusufari and other agrarian communities in Yobe State. The data in Table 2 reveal that 40% of respondents have been farming for 11–20 years, 26.7% for 5–10 years, 23.3% for over 20 years, and only 10% have less than five years of farming experience. This indicates that the majority of respondents possess substantial agricultural experience, with over two-thirds engaged in farming for more than a decade. Such long-term involvement suggests that these farmers have accumulated considerable indigenous knowledge of local agro-ecological conditions, including soil fertility management, crop rotation practices, and adaptation to seasonal rainfall variability, all of which are essential for effective farm management and climate change adaptation (Aliyu & Saidu, 2020; Yusuf & Ibrahim, 2021). In Yobe State, farming remains the primary livelihood for most households, and long-term engagement reflects a strong reliance on traditional rainfed agricultural systems. Studies in semi-arid northern Nigeria, including Yusufari LGA, indicate that experienced farmers often depend on indigenous weather forecasting techniques and traditional coping mechanisms to address challenges such as drought, delayed rainfall, and pest infestations (Audu & Barde, 2018; Mustapha et al., 2018). The notable proportion (23.3%) of farmers with over 20 years of experience highlights the presence of an aging but knowledgeable farming population that preserves local agricultural practices, though their adoption of modern technologies may be limited. As reported by Adamu and Hassan (2019), these experienced farmers possess practical expertise but may face challenges such as limited formal education, declining physical capacity, and reduced willingness to adopt new innovations. Conversely, the relatively small proportion (10%) of respondents with less than five years of farming experience reflects low youth participation in agriculture. This is consistent with findings from FAO (2022) and Nwajiuba et al. (2019), which show that rural youth in northern Nigeria increasingly migrate to urban centers or pursue non-agricultural livelihoods due to decreasing profitability in farming, harsh climatic conditions, and insufficient government support. This trend poses a potential threat to the sustainability of agriculture in the region, as the aging farmer population may not be adequately replaced by younger, technologically skilled individuals. Consequently, policies and interventions designed to encourage youth engagement through improved access to land, credit facilities,

and training in climate-smart agricultural practices are crucial for revitalizing the agricultural workforce and ensuring long-term resilience in Yusufari and similar agrarian communities in Yobe State.

PERCEPTION OF CLIMATE CHANGE BY RESPONDENTS

Understanding farmers' perceptions of climate change is critical for assessing their awareness of environmental variability and for designing appropriate adaptation strategies. Table 2 summarizes respondents' views on key indicators of climate change in Yusufari LGA. A substantial proportion of respondents (70%) perceived rainfall as irregular, indicating that farmers in Yusufari LGA are keenly aware of changes in precipitation patterns that affect their agricultural planning and productivity.

Table 2: Perception of climate change by Groundnut farmers

	Agree		Undecided		Disagree			
Perception	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**	**Total**	**%**
Irregular rainfall	105	70.0	16	10.7	29	19.3	150	100
Increase in temperature	95	63.3	15	10.0	40	26.7	150	100
Shorter rainy season	75	50.0	60	40.0	15	10.0	150	100
Delayed rains	85	56.7	43	28.7	22	14.6	150	100

Source: Field Survey, 2025

This perception aligns with findings from other rural farming contexts in Nigeria and across Africa, where smallholder farmers frequently identify erratic rainfall including unpredictable onset, uneven distribution, and altered intensity as a primary indicator of climate change (Ayanlade et al., 2017; Audu et al., 2020). For example, a study in southwestern Nigeria demonstrated that farmers perceive recent rainfall patterns as increasingly unreliable, with noticeable fluctuations in both early and late rainy seasons and reduced predictability compared to past decades, mirroring actual climatological variability in rainfall trends (Olaniyi et al., 2016). Similarly, research in northern Nigerian rural communities showed that farmers are sensitive to variations in rainfall onset, duration, and distribution, linking these irregularities with adverse agricultural outcomes such as crop stress, drought episodes, and yield reduction (Adewuyi et al., 2017). This awareness is consistent with broader evidence from African smallholder settings including Uganda and the Sahel where the majority of farmers report decreasing trends in rainfall amount and intensity, along with unpredictable precipitation patterns that disrupt planting calendars and increase vulnerability to droughts and dry spells (Nkomwa et al., 2022). These perceptions are important because farmer awareness of rainfall variability often reflects long-term local experience of climatic change and can inform adaptation strategies. Farmers' local climate knowledge has been shown in multiple studies to correspond with meteorological data, even where formal climate services are limited, and farmers rely on seasonal cues from years of observation to adjust cultivation practices (Ayanlade et al., 2017; Olaniyi et al., 2016). In summary, the high level of agreement on irregular rainfall among respondents in Yusufari is consistent with empirical findings from Nigeria and other African agricultural contexts, reinforcing that irregular precipitation is widely recognized by smallholder farmers as a salient and impactful dimension of climate change. Such perceptions shape adaptive behavior including altered planting periods and use of drought-tolerant varieties and highlight the need for improved climate information services and extension support (Adewuyi et al., 2017; Nkomwa et al., 2022).

About 63.3% of respondents reported an increase in temperature, reflecting farmers' recognition of rising heat levels that affect crop growth and productivity. This perception aligns with studies indicating that smallholder farmers across Nigeria and other African countries are aware of increasing temperature trends and their negative effects on agriculture (Ojo et al., 2022; Akinbile & Oluwatayo, 2021). For instance, research in Lagos State showed that over half of farmers perceived warmer conditions affecting crops, including increased pest pressure and reduced yields (Olaniyi et al., 2019). Similarly, studies in Nigerian dry agro-ecological zones found that farmers observed significant temperature increases over the past decade, linking the warming trend to reduced growing periods, heat stress on crops, and declining productivity (Akinbile & Oluwatayo, 2021; Audu et al., 2020). Beyond Nigeria, evidence from Eastern Africa indicates that the majority of small-holders farmers perceive rising temperatures, with 76.6% of respondents in Kenya acknowledging warmer conditions over time that affect crop performance and planting schedules (Nkomwa et al., 2022). These local perceptions are supported by meteorological data documenting rising temperatures in West Africa, which influence photosynthesis, plant water stress, and overall crop productivity (Ayanlade et al., 2017). In summary, the observation of increased temperature by Yusufari farmers is consistent with both local experiences and broader empirical evidence of regional warming trends, highlighting the critical need for heat-tolerant crop varieties and climate adaptation strategies (Ojo et al., 2022; Olaniyi et al., 2019; Nkomwa et al., 2022). Half of the respondents (50%) observed a shortening of the rainy season, while 40% were undecided, indicating some uncertainty likely caused by inter-annual variability in rainfall patterns. This perception is consistent with studies in northeastern Nigeria, where farmers report that both the onset and cessation of rains have become less predictable, leading to shorter effective growing periods and disrupted cropping calendars (Abdulkadir et al., 2021; Sani et al., 2022). Research in the Sahel and other semi-arid regions of Nigeria similarly shows that smallholder farmers experience reductions in the length of the rainy season, which negatively

affects soil moisture availability, crop development, and harvest timing (Ayanlade et al., 2017; Audu et al., 2020). Farmers often adjust their practices by adopting early-maturing crop varieties, adjusting planting dates, and diversifying crops to cope with these shortened and unpredictable rainy seasons (Akinbile & Oluwatayo, 2021; Olaniyi et al., 2016).

Moreover, meteorological studies corroborate these local perceptions, documenting trends of earlier cessation and delayed onset of rainfall across northeastern Nigeria, resulting in a reduced duration of the rainy season (FAO, 2021; Nkomwa et al., 2022). This alignment between farmer observations and scientific data underscores the reliability of indigenous knowledge in recognizing climate change impacts and guiding adaptation strategies in smallholder farming systems. In conclusion, the perception of a shorter rainy season among Yusufari farmers highlights the challenges posed by reduced and unpredictable rainfall, emphasizing the need for timely climate information, extension support, and adaptive agricultural practices to sustain groundnut production in the region (Abdulkadir et al., 2021; Sani et al., 2022; Ayanlade et al., 2017). More than half of the respondents (56.7%) reported a delay in the onset of the rainy season, reflecting farmers' awareness of shifts in seasonal patterns that disrupt agricultural planning. This perception is consistent with studies in northern Nigeria, where smallholder farmers frequently identify delayed rains as a major climate change indicator affecting planting schedules and crop performance (Ayanlade et al., 2017; Audu et al., 2020). Research in the Sahelian regions of Nigeria also showed that farmers perceive late onset of rains as a recurrent issue that shortens the effective growing season, leading to reduced yields and increased risk of crop failure (Abdulkadir et al., 2021). Similar findings have been reported in other African countries, including Uganda and Kenya, where farmers link delayed rains with diminished water availability, soil moisture stress, and higher incidence of drought (Nkomwa et al., 2022; Sani et al., 2022). Furthermore, farmers' perceptions of delayed rainfall often correspond with meteorological records showing increasing variability in seasonal onset dates and irregular precipitation patterns across the Sahel and northeastern Nigeria (FAO, 2021; Olaniyi et al., 2016). Such local knowledge plays a critical role in adaptation planning, as farmers adjust planting dates, employ early maturing or drought-tolerant varieties, and diversify crops to cope with unpredictability in rainfall (Akinbile & Oluwatayo, 2021; Audu et al., 2020). In summary, the recognition of delayed rains by Yusufari farmers reflects both lived experience and documented climatic changes, emphasizing the importance of timely climate information and extension support to enhance agricultural resilience (Ayanlade et al., 2017; Nkomwa et al., 2022).

IMPACT OF CLIMATE CHANGE ON GROUNDNUT YIELD BY RESPONDENTS

Figure 3 illustrates farmers' perceptions of the impact of climate change on groundnut yield in Yusufari Local Government Area. A majority of respondents clearly indicate that groundnut yields have decreased under changing climatic conditions, with far fewer farmers reporting an increase or expressing uncertainty about the direction of yield changes. Specifically, a large proportion perceive that yields have declined, while only a minority believe yields have increased or are unsure of the impact.

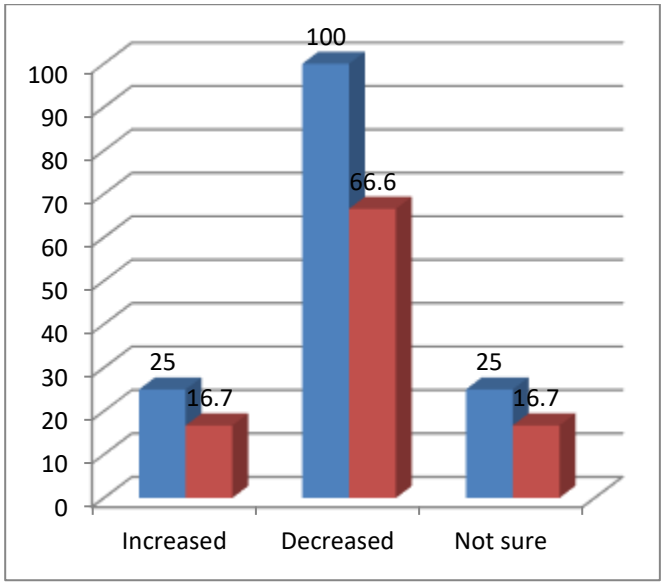

Figure 3: Perceived impact of climate change on groundnut yield
Source: Field Survey, 2025

The dominance of the "Decreased" category suggests that most groundnut farmers associate climate change with adverse production outcomes. This finding aligns with numerous studies in semi-arid regions indicating that climate variability especially erratic rainfall, prolonged dry spells, and rising temperatures negatively affects crop productivity. For example, Traore et al. (2021) found that increasing temperature extremes and erratic rainfall patterns in the Sahel have contributed to reduced productivity of rain-fed crops, including legumes. Similarly, Ahmed et al. (2020) reported that heat stress and moisture deficits during critical phenological stages (flowering and pod filling) significantly reduce groundnut yield, reinforcing the perception that climate change depresses output. Climatic stressors such as drought are often highlighted by smallholder farmers as the primary drivers of reduced yields. In their study of northern Nigerian farmers, Abid et al. (2019) observed that most respondents perceived reductions in crop yields due to increased drought frequency and rainfall unpredictability.

This corresponds with the high proportions in your dataset who attribute lower groundnut yield to climate change conditions. Moreover, Ajetomobi and Abiodun (2019) found that groundnut yields in Nigeria are especially sensitive to variability in rainfall distribution and temperature fluctuations, conditions frequently exacerbated under contemporary climate change scenarios. On the other hand, the relatively low number

of farmers reporting increased yields suggests that any potential benefits of climate variability (for example, occasional enhancements in soil moisture or extended growing seasons) are rare or insufficient to offset negative effects in this region. This echoes findings by Sultan et al. (2020), who noted that while some farmers may sporadically experience favorable conditions, the overall trend in the Sahel remains toward yield declines due to adverse climate shifts. The category of respondents who are "Not sure" highlights limitations in climate awareness or the ability to attribute yield changes directly to climatic factors. Such uncertainty is common in farming communities where access to formal climate information and extension support is limited. According to Deressa et al. (2009), uncertainty in farmers' perceptions is often associated with lower access to climate information services and limited understanding of complex climatic interactions, which inhibits farmers' capacity to distinguish between weather variability and long-term climate change. Overall, the distribution of responses in the chart underscores a predominantly negative perception of climate change impacts on groundnut yield among farmers in Yusufari LGA. This perception is consistent with documented evidence from the broader Sahel and northern Nigeria, where climate change has been linked to reduce yields of rain-fed crops and increased agricultural vulnerability (IPCC, 2022; Abid et al., 2019; Traore et al., 2021). The findings suggest that farmers in the study area are not only experiencing climatic stressors but also associating them with tangible decreases in groundnut productivity.

EFFECT OF CLIMATE CHANGE ON GROUNDNUT FARMING BY RESPONDENTS

Climate change significantly impacts groundnut production by altering environmental conditions that affect crop growth, yield, and farm management practices. Table 3 presents respondents' perceptions of how climate variability influences groundnut farming in Yusufari LGA. A majority of respondents (63.3%) reported experiencing low yields, indicating that reduced productivity is one of the most immediate and noticeable effects of changing climatic conditions on groundnut farming in Yusufari LGA. This perception reflects the reality that climate variability directly influences crop performance, especially in rain-fed agricultural systems where farmers rely heavily on the timing and amount of rainfall for successful crop growth. Erratic rainfall patterns including unpredictable onset, uneven distribution, and prolonged dry spells reduce soil moisture during key crop growth stages, impairing germination, root development, and grain filling, ultimately lowering productivity (Olaniyi et al., 2016; IIARD International Journal of Geography & Environmental Management, 2025). For example, inconsistent rainfall has been shown to significantly disrupt traditional farming cycles in Nigeria, leading farmers to experience reduced yields for staple crops and vulnerable cash crops such as groundnut and maize (Olaniyi et al., 2016).

Table 3: Effect of climate change on groundnut farming

Effect	Freq.		Freq.		Total	
	Yes	%	No	%	Freq.	%
Low yield	95	63.3	55	36.7	150	100
Pest and disease	80	53.3	70	46.7	150	100
Soil erosion	45	30.0	105	70.0	150	100
Delayed planting	65	43.3	85	56.7	150	100
Drought	70	46.7	80	53.3	150	100
Flood	20	13.3	130	86.7	150	100

Source: Field Survey, 2025

Rising temperatures exacerbate these effects: higher heat levels increase plant evapotranspiration the process by which water is lost from soil and plant surfaces resulting in moisture stress that further limits crop growth and reduces biomass accumulation (Olaniyi et al., 2016). High temperatures also accelerate plant development, shortening the growing period and leaving less time for crops to mature fully, which tends to lower final yields (Olaniyi et al., 2016). Empirical research in Nigeria and other parts of sub-Saharan Africa supports farmers' perceptions that climate change is linked to declining agricultural output. Smallholder farmers in regions like Kuje Area Council perceive temperature increases and rainfall variability as major factors contributing to lower crop productivity (Bako et al., 2022). Moreover, across multiple agro-ecological zones, farmers have reported that unpredictable weather reduces their ability to make effective planting decisions, further contributing to low yields). In addition to rainfall and temperature effects, climate variability can indirectly reduce yields through higher incidence of pests and diseases. Climatic stress weakens crop resilience and makes plants more susceptible to biotic pressures, compounding overall productivity losses (Olaniyi et al., 2016). Overall, the perception of low yield among Yusufari farmers aligns with both scientific evidence of climatic disruption to key agricultural processes and farmers' own observations of changing weather patterns that directly reduce output. This underscores the need for climate-smart interventions such as drought-tolerant varieties, improved water management, and timely weather information to help farmers maintain productivity under changing conditions. More than half of the respondents (53.3%) reported that climate change has led to increased pest and disease outbreaks, making this one of the significant impacts on groundnut farming in Yusufari LGA. Farmers' perceptions are consistent with empirical research showing that rising temperatures, erratic rainfall, and prolonged dry spells create conditions conducive to the proliferation of pests and the emergence of crop diseases (Ojo et al., 2022; Olaniyi et al., 2019; Bachama Boyi Noel et al., 2020). Temperature increases accelerate insect metabolism and reproduction rates, allowing pests to complete life cycles more quickly and expand their geographic range. Combined with high humidity

or unpredictable rainfall, this can enhance the spread of fungal and bacterial pathogens, particularly in rain-fed crops such as groundnut (Bako et al., 2022). For example, studies in Nigeria have linked shifts in rainfall and temperature patterns with increased incidence of pests like pod borers, aphids, and leafhoppers, which directly reduce yields (Olaniyi et al., 2019). Moisture stress caused by drought or irregular rainfall further weakens plants, making them more susceptible to attack by pests and pathogens (Ayanlade et al., 2017).

Research in semi-arid regions of sub-Saharan Africa shows that pest outbreaks are often synchronized with periods of climatic stress, illustrating the interplay between climate variability and crop vulnerability (Madaki et al., 2023). Additionally, farmers report that sudden heavy rainfall events followed by dry periods can trigger fungal infestations, reducing crop quality and marketability (Bachama Boyi Noel et al., 2020). These findings highlight that climate-induced pest and disease pressures are a critical constraint to agricultural productivity. Farmers' awareness of these trends reflects local ecological knowledge and emphasizes the need for integrated pest management, disease-resistant crop varieties, and early warning systems to mitigate losses and maintain food security (Bako et al., 2022; Ojo et al., 2022).

Only 30% of respondents perceived soil erosion as a significant effect of climate change, suggesting that it may be less immediately noticeable compared to other impacts like low yield or pest incidence. Nevertheless, soil erosion is a critical long-term concern in semi-arid regions such as Yusufari LGA. Fluctuating rainfall intensity, prolonged dry periods, and strong wind events contribute to accelerated topsoil loss, which diminishes soil fertility, reduces water retention capacity, and ultimately lowers agricultural productivity (FAO, 2021; Olaniyi et al., 2016). Studies in northern Nigeria indicate that erratic and intense rainfall events lead to surface runoff, which washes away nutrient-rich topsoil, while extended dry seasons increase soil susceptibility to wind erosion (Ayanlade et al., 2017; Audu et al., 2020). Over time, this cumulative soil loss degrades land quality, reduces crop yields, and increases vulnerability to climate shocks. Although fewer farmers immediately associate soil erosion with climate change, its indirect effects on productivity and sustainability are well documented (Bako et al., 2022). Research also highlights that soil degradation interacts with other climate stressors. For instance, land affected by erosion is more vulnerable to drought and nutrient depletion, which exacerbates low yields and crop failure (Olaniyi et al., 2016; Madaki et al., 2023). Farmers' limited recognition of soil erosion may reflect the gradual nature of this effect, emphasizing the importance of soil conservation practices, such as mulching, contour farming, and agroforestry, to maintain long-term productivity in climate-stressed areas (FAO, 2021; Ayanlade et al., 2017). In conclusion, while only a minority of respondents reported soil erosion as a direct effect, scientific evidence confirms its significance, particularly in semi-arid zones where climate variability and land degradation intersect to threaten sustainable agriculture.

About 43.3% of respondents perceived delayed planting as a consequence of climate change, reflecting the disruptions in rainfall onset and duration that are increasingly common in Yusufari LGA. Rain-fed farmers often rely on the timing of the first rains to initiate sowing. When the onset of rainfall is unpredictable, farmers are forced to postpone planting until adequate soil moisture is available, which can disrupt cropping calendars and reduce productivity (Adewuyi et al., 2017; Sani et al., 2022). Delayed planting shortens the effective growing season, limiting the time crops have to develop fully before the end of the rains or the onset of dry conditions. This can lead to reduced germination, stunted growth, and lower yields, especially for short-cycle crops like groundnut (Ayanlade et al., 2017; Madaki et al., 2023). Farmers' observations in Nigeria and other semi-arid regions of sub-Saharan Africa consistently link delayed sowing with diminished crop performance and increased vulnerability to climatic stressors (Bako et al., 2022). Climatic factors such as erratic rainfall, prolonged dry spells, and temperature extremes are primary drivers of delayed planting. Research shows that unpredictable weather patterns not only affect the initial sowing date but also influence subsequent agricultural decisions, including fertilizer application, irrigation scheduling, and pest management (Olaniyi et al., 2016; Ojo et al., 2022). Farmers often attempt to cope with delayed planting by adopting early-maturing varieties, adjusting planting dates based on local weather cues, and diversifying crops to spread risk (Ayanlade et al., 2017; Madaki et al., 2023). However, these strategies are constrained by limited access to reliable climate information and extension services in rural areas, highlighting the need for timely meteorological data and adaptive agricultural support (Adewuyi et al., 2017). In summary, the perception of delayed planting among Yusufari farmers is both a direct and observable impact of climate variability. It demonstrates how shifting rainfall patterns can disrupt traditional farming practices and underscores the importance of interventions to mitigate risks associated with unpredictable weather. Nearly half of the respondents (46.7%) perceived drought as a significant effect of climate change, reflecting its direct impact on soil moisture, crop growth, and overall agricultural productivity. In semi-arid regions like Yusufari LGA, prolonged dry periods reduce available soil water, impair seed germination, stunt plant growth, and ultimately lower yields, particularly for rain-fed crops such as groundnut (Ayanlade et al., 2017; Nkomwa et al., 2022).

Drought in semi-arid zones is primarily associated with erratic rainfall, delayed onset of rains, shortened rainy seasons, and high temperatures that increase evapotranspiration (Akinbile & Oluwatayo, 2021; Olaniyi et al., 2016). These factors exacerbate water stress and can lead to crop failure if insufficient rainfall coincides with critical growth stages such as flowering or pod development. Farmers in drought-prone

areas often experience reduced groundnut yields and poor crop quality, which affects food security and household income. The cumulative effect of recurrent droughts also depletes soil moisture and organic matter, making subsequent cultivation more challenging (Bako et al., 2022; Audu et al., 2020). To cope with drought, farmers have adopted several adaptive measures, including early sowing to utilize residual soil moisture, crop diversification, planting drought-tolerant varieties, and soil moisture conservation techniques such as mulching and minimum tillage (Ayanlade et al., 2017; Madaki et al., 2023). However, access to timely weather forecasts and agricultural extension services remains limited, constraining effective adaptation in many communities (Sani et al., 2022).

In conclusion, the perception of drought among Yusufari farmers reflects both lived experiences and meteorological evidence, emphasizing the importance of targeted interventions to enhance resilience and sustain productivity under increasingly variable climatic conditions. Only 13.3% of respondents reported flooding as a significant effect of climate change, reflecting the semi-arid climate of Yusufari LGA, where intense rainfall events are infrequent. Despite its low occurrence, flooding can have severe localized impacts, including the washing away of crops, destruction of farm infrastructure, waterlogging, and nutrient leaching, which reduces soil fertility and hampers crop growth (Olaniyi et al., 2016; FAO, 2021). Studies in semi-arid regions of northern Nigeria indicate that when flooding occurs, it can exacerbate other climate-related stresses, such as erosion and post-flood pest infestations, further impacting agricultural productivity (Ayanlade et al., 2017). The response patterns indicate that the most immediate and pressing effects of climate change in Yusufari LGA are low yield, pest and disease outbreaks, drought, and delayed planting. These effects directly threaten crop productivity, food security, and livelihoods. In contrast, soil erosion and flooding are perceived as less frequent concerns, which align with the local semi-arid agro-ecological conditions (Ayanlade et al., 2017; Audu et al., 2020; Olaniyi et al., 2016). These perceptions highlight the need for climate-smart agricultural practices, including the adoption of drought-tolerant crop varieties, integrated pest and disease management, soil and water conservation measures, and access to timely meteorological information to support effective adaptation strategies (Bako et al., 2022; Madaki et al., 2023). Understanding farmers' experiences and perceptions is crucial for designing interventions that are context-specific, practical, and responsive to local climate realities, ensuring the resilience of smallholder farming systems in semi-arid regions.

CONCLUSION

This study examined farmers' perceptions of climate change and its effects on groundnut farming in Yusufari Local Government Area of Yobe State, Nigeria, using a descriptive survey research design. The findings reveal that farmers in the study area are highly aware of climate change and its manifestations, particularly irregular rainfall, rising temperatures, delayed onset of rains, and shortened rainy seasons. These perceptions reflect farmers' long-term lived experiences and align closely with empirical evidence and meteorological trends documented for the Sahelian and semi-arid regions of northern Nigeria. The study further established that climate change has had predominantly negative effects on groundnut farming in Yusufari LGA. Low yield emerged as the most significant impact, followed by increased pest and disease incidence, drought, and delayed planting. These effects are largely attributable to erratic rainfall patterns, prolonged dry spells, and rising temperatures, which disrupt planting schedules, reduce soil moisture availability, and increase crop vulnerability to biotic stresses. Although soil erosion and flooding were perceived as less frequent, they remain important long-term threats to land productivity and agricultural sustainability in the semi-arid environment. Socio-economic characteristics such as age, education level, farming experience, and occupation played an important role in shaping farmers' perceptions and adaptive capacity. The dominance of middle-aged and experienced farmers suggests a wealth of indigenous knowledge regarding climate variability, while the limited participation of youth and women highlights structural constraints that may undermine long-term agricultural resilience. The heavy reliance on full-time farming and limited livelihood diversification further increases vulnerability to climate-induced shocks. Overall, the study concludes that climate change poses a serious challenge to groundnut production and rural livelihoods in Yusufari LGA. Farmers are already experiencing tangible adverse impacts, yet their adaptive capacity remains constrained by limited access to climate information, extension services, improved inputs, and alternative livelihood opportunities. Addressing these gaps is critical for sustaining groundnut production, improving food security, and enhancing resilience to climate change in semi-arid northern Nigeria.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are proposed:

1. Strengthening Climate-Smart Agricultural Practices: Government agencies, research institutions, and development partners should promote the adoption of climate-smart agricultural practices, including drought-tolerant and early-maturing groundnut varieties, improved soil moisture conservation techniques (such as mulching and minimum tillage), and efficient water management practices. These measures can help farmers cope with erratic rainfall, rising temperatures, and shortened growing seasons.
2. Improving Access to Climate Information and Extension Services: Timely and location-specific climate information, including seasonal rainfall forecasts and early warning systems, should be made accessible to farmers through extension agents, radio programs, and mobile platforms.

Strengthening agricultural extension services will enhance farmers' understanding of climate risks and support informed decision-making on planting dates, crop choices, and farm management practices.

3. Integrated Pest and Disease Management: Given the increasing incidence of pests and diseases linked to climate variability, there is a need to promote integrated pest and disease management strategies. These include the use of resistant crop varieties, biological control methods, and farmer training on early detection and appropriate response to pest outbreaks, thereby reducing yield losses and dependence on chemical pesticides.

4. Enhancing Soil and Land Conservation Measures: Although soil erosion was perceived as a less immediate problem, its long-term impact on productivity warrants attention. Programs promoting soil conservation practices such as contour farming, agroforestry, cover cropping, and controlled grazing should be implemented to protect soil fertility and sustain groundnut production under changing climatic conditions.

5. Promoting Livelihood Diversification and Rural Economic Opportunities: To reduce vulnerability arising from heavy dependence on farming, policies should encourage livelihood diversification through agro-processing, small-scale trading, and non-farm income-generating activities. Access to microcredit, vocational training, and rural enterprise development can strengthen household resilience to climate-related shocks.

6. Youth and Gender-Inclusive Agricultural Policies: Targeted interventions are needed to encourage youth participation in agriculture by improving access to land, credit, training, and modern farming technologies. Similarly, gender-sensitive policies should address structural barriers limiting women's access to productive resources, extension services, and decision-making opportunities, thereby enhancing their contribution to climate adaptation and agricultural productivity.

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