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Impacts of Climate Change on Cassava Production and Farmers' Adaptation Practices: Evidence from Osun State, Nigeria

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Abstract: The study investigated the impacts of climate change on cassava production and the adaptation strategies employed by smallholder cassava farmers, using quantitative data collected from 190 respondents via an interview schedule and analysed using descriptive statistics and Pearson's Product-Moment Correlation. The findings revealed male dominance (72.2%) among the farmers, a mean household size of 5 ± 2 members, a mean age of 52.17 ± 10.41 years, a farm size of 3.8 ± 2.2 hectares, and a mean farming experience of 23.7 ± 12.7 years. Deforestation (88.1%) and bush burning (85.6%) emerged as the primary causes of climate change, while retarded cassava growth (85.3%) and yield reduction (76.3%) were the most significant effects. Planting drought-resistant (mean = 2.23) and improved varieties (mean = 2.09) were the key adaptation strategies utilised, with 63.2% of farmers exhibiting high utilisation. Limited climate information (85.3%) and inadequate finance (82.6%) were the main barriers. Household size ($r = 0.351$, $p \leq 0.01$), farming experience ($r = 0.265$, $p \leq 0.01$), and information sources ($r = 0.396$, $p \leq 0.01$) positively correlated with adaptation strategies adopted, while age ($r = -0.145$, $p \leq 0.05$) was inversely related. These findings provide localised information on adaptive behaviour and socioeconomic drivers, underscoring the need for enhanced meteorological advisory services, subsidised inputs, and targeted financial support mechanisms to strengthen smallholder adaptation and sustain cassava production.

Keywords: Adaptation strategies; barriers to adaptation; climate change impact; cassava production; small-holder farmers; Osun State Nigeria; perceived causes of climate change; demographic influence; sustainable cassava farming; drought resistant varieties

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1. Introduction

Cassava is a major root tuber/cash crop and remains one of the cornerstones of Nigeria's agricultural economy. Its annual production is estimated at 60.83 million metric tonnes of tubers

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across 7,737,846 hectares (FAOSTAT, 2022). This accounts for one-fourth of the world's cassava production and confirms Nigeria as one of the leading producers of cassava worldwide (Danso-Abbeam, 2021; FAOSTAT, 2022; Omodara et al., 2023). Cassava production represents a significant portion of Nigeria's food production, which supports over 30 million smallholder farmers, where 80% is meant for local consumption while the remaining 20% is used for industrial use (International Trade Administration, 2025), thereby boosting food security and providing a stable source of income for both subsistence and commercial producers (Ikuemonisan et al., 2020; Camber Collective, 2024). Despite this agricultural dominance, significant vulnerabilities persist within Nigeria's production system. Recent modelling studies reveal substantial yield gaps with current yields of 8.9 t/ha falling considerably below the potential yield of 13.3 t/ha (Srivastava et al., 2023). This performance deficit is attributed to poor agricultural practices and climate-related stressors. This productivity shortfall presents challenges for meeting Nigeria's projected cassava starch demand, anticipated to exceed 10 million tons by 2024 (AgroNigeria, 2025; Ezui et al., 2018; Business Wire, 2019, as cited in Amelework et al., 2021).

Climate change significantly increases these agricultural risks and has emerged as one of the most pressing challenges facing global food security, with cassava production in sub-Saharan Africa bearing a disproportionate burden of these impacts (Yakubu et al., 2020; Okoronkwo et al., 2024). Human-induced factors, such as widespread deforestation, uncontrolled bushfires, improper waste disposal practices, and the overuse of agrochemicals, are the primary drivers of these environmental alterations. These human activities fundamentally alter regional precipitation patterns and trigger environmental disturbances that exacerbate existing biotic stressors, such as whitefly population outbreaks (Atobatele et al., 2023; File et al., 2021; Omodara et al., 2023). Although cassava exhibits remarkable natural tolerance to drought and low soil fertility, providing some resilience against environmental stressors (Eze et al., 2019), the increasing severity of climate extremes continues to pose significant challenges to crop performance. Increasingly unpredictable rainfall patterns, extended drought periods, and extreme temperature events result in retarded plant development, characterised by stunted vegetative growth and poor root development. These climatic stressors have been documented to cause substantial yield losses of 10-40% across major staple crops, including cassava, maize, and rice (Ilesanmi et al., 2020; Adu, 2020; Manuel et al., 2021; Oluwatimilehin & Ayanlade, 2023). Current research advances validate these multidimensional climate impacts in Nigeria's agricultural landscape: increasing ambient temperatures and intensified pest pressures contribute to environmental degradation and biodiversity loss, while extreme hydrological events (flooding and drought) severely disrupt agricultural production cycles (Adeodun, 2024). These climate-induced disruptions disproportionately affect smallholder farming operations within the derived savanna ecological zones, where agricultural vulnerability is predominantly pronounced (Akinkuolie et al., 2025; Osuji et al., 2023; Nwaobiala et al., 2021).

Researchers have responded with comprehensive adaptation strategies for smallholder farmers. These strategies include cultivating early maturing varieties, practising crop rotation, and adopting climate-smart agricultural innovations that focus on resilience and productivity. For instance, the use of drought-tolerant and pest-resistant cultivars helps maintain stable yields under changing climates and reduces reliance on chemical inputs (Yakubu et al., 2020; Osuji et al., 2023; Omodara et al., 2023; Idiong et al., 2025). Additionally, soil moisture conservation techniques, such as mulching and organic manure application, further enhance crop resilience. Diversification strategies, like intercropping cassava with nitrogen-fixing legumes, help reduce production risks and improve food security (Masete et al., 2022). These adaptation practices are particularly beneficial in regions vulnerable to both flooding and drought (Agboola et al., 2024; Legide et al., 2024; Okoronkwo et al., 2024).

Multivariate statistical analyses reveal significant socioeconomic determinants of adoption patterns: younger farmers with higher educational attainment, larger household sizes, and enhanced access to credit facilities demonstrate a greater propensity to implement these adaptation practices, resulting in higher productivity ranging from 20 to 30 per cent (Omodara et al., 2023; Declaro-Ruedas, 2020; Olutumise et al., 2024; Akpabio et al., 2025). Modern adaptation frameworks now combine indigenous knowledge with formal institutional support, such as community-based initiatives in Southeastern Nigeria that incorporate meteorological services and subsidised agricultural inputs (Okeke, 2024). This integrated approach promotes systemic agricultural resilience that aligns with United Nations Sustainable Development Goals 2 (Zero Hunger) and 13 (Climate Action) (Akinkuolie et al., 2025; Okoronkwo et al., 2024).

Despite these advances, there is still inadequate region-specific data on climate adaptation strategies, especially for cassava farmers in Osun State. This gap justifies the study. Specifically, the study profiled respondents' demographic features, identified perceived causes of climate change, assessed the effects of climate change on cassava production, and determined the extent of adaptation strategy use and the constraints limiting their use in the study area.

2. Materials and Methods

2.1. Sampling procedure

The research was conducted between January and November 2023 in Osun State, Nigeria. The state has three Agricultural zones with thirty Local Government Areas (LGAs). They are: Osogbo Agricultural zone (13 LGAs), Iwo Agricultural zone (7 LGAs), and Ife-Ijesha Agricultural zone (10 LGAs). Smallholder cassava farmers constitute the study population. A multistage sampling procedure was used to select the sample size. At the first stage, 2 out of the 3 agricultural zones were randomly selected. The selected agricultural zones were Iwo and Ife-Ijesha. At the second stage, Ife East and Atakumosa West LGAs from Ife-Ijesha zone, and Iwo LGA from Iwo zone, were purposively selected because these LGAs are known for high cassava production in Osun State. Five per cent of the communities in the chosen LGAs were randomly selected, resulting in 17 communities in the third stage. At the last stage, out of the list of cassava farmers in each of the selected LGAs obtained from Osun State Agricultural Programme headquarters, the Yamane's (1967) formula was used to arrive at the sample size of 190, which is higher than the minimum sample size of 188.82

Yamane's Formula = $n=N/(1+N(e^2)$

Where: n = Sample size;

N = Population size of registered cassava farmers;

e = Level of precision.

Using N as 5,250 registered cassava farmers obtained from the Osun State Agricultural Programme headquarters, and

e as 7.23% margin of error at a 95% confidence,

$$n = \frac{25250}{1 + 25250(0.0723)^2} = 188.82$$

2.2. Measurement of variables

The dependent variable was captured as the utilisation of adaptation strategies. Adaptation strategy use was measured on a four-point Likert-type scale ranging from 0 (never utilised) to 3 (always utilised). This is consistent with the methodological approach employed by Adisa et al. (2022) and Agboola et al. (2024). Respondents' responses were summed up to form the utilisation score. The maximum score was 48, and the minimum was 0. The respondents' utilisation of the adaptation score was later categorised into two categories using an equal-interval approach. Any respondent with a utilisation score of 24 or below was categorised as having low utilisation, while respondents with a utilisation score above 24 were categorised as having high utilisation of adaptation strategies. For perceived causes, cassava farmers were asked to list them, and each was scored 1 point. The effects of climate change on cassava production were captured by asking cassava farmers to list them, and each was assigned 1 point. Also, cassava farmers were asked to indicate the constraints that hinder the full implementation of adaptation strategies on cassava production. Option "yes" was scored 1, while "no" was scored 0.

The primary data were collected from the sampled respondents using a structured interview schedule with closed-ended questions aligned with the set objectives. Data were analysed using descriptive statistics, including frequency counts, percentages, means, and standard deviations, while Pearson Product-Moment Correlation (PPMC) was used to determine the relationship between utilisation of climate change adaptation strategies and other independent variables. In this research, it is assumed that Likert data is treated as interval, that is why PPMC a parametric statistic was used to analyze Likert data (ordinal scale of "never used, rarely used, often and always") was treated as interval scale based on the following assumptions (i) it is assumed that the psychological distance between each response option (never used and rarely used) is equal. (ii) by assigning numerical values to each Likert response option ("never used=0, rarely used =1, often=2 and always=3") and ensuring the numerical values reflect the intended order as operationalized in this research; and (iii) the numerical values of all relevant Likert items for each respondent are summed up to form composite score, and the composite score is then treated as interval scale used as dependent variable (utilisation score) in this research. Since the summed scales are justified as interval-level, parametric methods can be used after confirming these assumptions (Elst, 2013)

The research instrument used for this study was a well-structured interview schedule containing open- and closed-ended questions to elicit quantitative data from respondents in line with the set objectives. It was developed by the researchers based on past empirical literature. Out of many adaptation strategies documented in literature (Hood et al., 2023; Eze et al., 2019; Kalu and Mbanasor, 2020; Henri-Ukoha, 2020; Omodara et al., 2023; Nwankwo et al., 2023), only sixteen adaptation strategies that are peculiar to the study area were adapted for this study. Content validity and construct validity were established through expert review. The research instrument was reviewed by experts from the Department of Agricultural Extension and Rural Development, as well as specialists in Geography and the Institute of Ecology, to critically examine and determine the appropriateness of the questions used to measure the study's variables. Their suggestions, corrections, and ideas were incorporated into the instrument prior to the field survey. This was initially prepared in English and translated into the local indigenous language for illiterate cassava farmers. To assess the instrument's reliability and standardisation and ensure consistent results, a test-retest reliability assessment was conducted. The instrument was pretested in Oriade Government Area (LGA), an area excluded from the main study, to evaluate its consistency without influencing the primary sample. The interview schedule was administered to ten cassava farmers at the Ijeda-Ijesa community at a two-week interval to allow researchers to gauge the clarity and understanding of the questions before it was used for actual data collection. The two test scores were correlated using Spearman's Rank-Order correlation, and the pretest showed a reliability coefficient of 0.91, significant at the 0.01 probability level. According to Bryman (2004), a reliability coefficient of 0.80 or higher indicates a satisfactory level of internal reliability

3. Results and Discussion

3.1. Demographic features of cassava farmers

The results presented in Table 1 show that the majority (72.1%) of the respondents were male, while 27.9% were female. This finding reveals that the majority of cassava farming activities were carried out by males, suggesting that male dominance in cassava farming is due to the tedious nature of cassava production, which requires physical strength. This agrees with the findings of Omodara et al. (2023) and Akpabio et al. (2025), who reported that males dominate cassava farming in Southern Nigeria. The results in Table 1 show that the mean age of the farmers was 52.2 ± 10.4 years, implying cassava farmers are experienced but becoming ageing with high awareness of climate change and adaptation strategies to mitigate climate change impact on cassava production (Afolabi et al., 2025; Famakinwa et al., 2023), but partly align with results of Idiong et al. (2025) who reported a mean age of 48 years. About 78% of the cassava farmers were married, with a mean household size of 5 ± 2 members, contradicting that of Afolabi et al. (2025), who reported a mean household size of 8 members. This moderate household size implies access to family labour, which will help cassava farmers adopt adaptation strategies. This aligns with the assertions of Idiong et al. (2025) and Famakinwa et al. (2023) that household size influences the adoption of climate change adaptation strategies, as family members serve as a source of labour for farm work. The larger proportion (54.7%) engaged in cassava farming as their primary occupation, while a few (21.1% and 17.4%) were traders and artisans, respectively. This implies that many of them rely on cassava farming as the primary source of livelihood in the study area. The mean years of experience in cassava farming were 23.4 ± 10.3 years, which aligns with the findings of Afolabi et al. (2025). This implies that the cassava farmers have sufficient experience in cassava production, suggesting that cassava production is a sustainable business. Years of farming experience can enhance smallholder farmers' resilience to climate change impacts, enabling them to adopt new strategies (Adeagbo et al., 2025). The result is consistent with that of Okoronkwo et al. (2024), and Omodara et al. (2023) reported that cassava farmers have many years of experience in farming, which could enhance resource use and the efficient management of farm activities.

The mean farm size of cassava farmers was 8.3 ± 5.4 acres, which is approximately 3.3 ± 2.2 hectares. This finding confirms the smallholding status of cassava farmers who operate their farming enterprises at a subsistence level (Kehinde & Olatidoye, 2019). Smallholder farming limits the adoption of climate change adaptation strategies because of restricted access to resources, inadequate capital, and limited access to inputs such as fertilisers and improved varieties. This hinders farmers' ability to invest in climate-resilient practices, thereby increasing vulnerability (Adeagbo et al., Alemu et al., 2022; Manda et al., 2024). This is consistent with Famakinwa et al. (2023) and Idiong et al. (2025), who reported that the majority of farmers operate at the subsistence level. The mean annual income was N1,081,578.9 ± N779,000. This implies that farmers realised moderate income from cassava production with a growing economic base (Ogunleye et al., 2025). As cassava production is gradually becoming a profitable farming enterprise, the income realised by cassava farmers can be used to mitigate the effects of climate change on their crops through investments in adaptation strategies such as fertiliser application and the use of resistant varieties (Nwaobiala et al., 2023). The result reveals that the majority (78.9%) were aware of climate change through personal observation, reflecting farmers' direct experience with climate impacts, such as retarded growth and yield losses, which can enhance the likelihood of adopting various adaptation strategies to mitigate the effects of climate change on cassava production. Famakinwa et al. (2023), Omokaro (2025), and Nwaobiala et al. (2023) reported that farmers were aware of climate change based on their observations and past experiences, which increased the likelihood of adopting adaptation strategies to cushion its effects. This is because farmers' decision to adopt adaptation solutions is usually based on awareness and knowledge of climate change impact (Danso-Abbeam et al., 2021; Trisos et al., 2022).

Table 1. Demographic features of cassava farmers

Variables	Frequency	Percentage	Mean ± SD
Sex			
Male	137	72.1	
Female	53	27.9	
Age (years)			
>30	33	17.5	52.2 ± 10.4
30-45	67	35.1	
46-60	52	27.4	
61+	38	20.0	
Marital status			
Single	6	3.2	
Married	149	78.4	
Divorced	14	7.4	
Widow/widower	11	5.8	

Separated	10	5.3	
Primary Occupation			
Farming	104	54.7	
Trading	40	21.1	
Artisan	33	17.4	
Teaching	8	4.2	
Civil service	5	2.6	
Years of Farming Experience (years)			
1-15	46	24.2	23.4 ± 12.7
16-30	96	50.5	
31-45	48	25.3.	
Household Size (years)			
1-4	64	33.6	
5-8	112	59.1	5.4 ± 2.3
9-12	14	7.3	
Farm Size (acres)			
<2-5	35	19.3	8.3±3.8
6-10	106	58.9	
10-15	49	25.8	
Annual Income (N)			
< 100,000,000	127	66.8	1,081,578.9± 2667,72.1
1,000,000-3,000,000	55	29.0	
3,000,001-5,000,000	8	4.2	
*Sources of Awareness			
Friends	37	19.5	
Internet	13	6.8	
Observation	150	78.9	
Social media	2	1.1	
Radio	21	11.1	
Television	24	12.6	
Past Experience	25	13.5	
Extension Agents	17	8.9	

*Multiple responses

3.2. Perceived causes of climate change

Entries in Table 2 reveal that cassava farmers identified deforestation (88.1%), bush burning (85.6%), excessive use of agrochemicals and fertilisers (83.2%) as primary causes of climate change, as well as cultural beliefs like divine curses from God (71.6%) as a result of loss of traditional values and norms. The results imply that human activities such as unsustainable agricultural practices and other related livelihood activities like felling of trees, slashing, bush burning, excessive use of agrochemicals and fertilisers dominate perceived drivers of climate change, followed by cultural attributions like divine curses from God as a result of gross disrespect for traditions, values, and norms. The cultural belief that God's curses cause climate change suggests a cultural lens in which environmental degradation is linked to the loss of traditional values, influencing perceptions and potentially adaptation priorities. This finding reflects a blend of agricultural and environmental factors that informs farmers' understanding of their local context and informs their adaptation strategies. This finding is in tandem with File et al. (2021), who observed unsustainable practices (deforestation, slash and burn, burning of crop residue, poor disposal of livestock wastes, and excessive use of agrochemicals and fertilisers) and divine curses from God are the key contributors to climate variability, altering rainfall patterns and triggering environmental degradation.

Table 2. Perceived causes of climate change

*Perceived Causes	Frequency	Percentages
Deforestation/tree felling	167	88.1
Bush burning	163	85.6
Excessive of agrochemicals and fertilisers	158	83.2
Curses from God resulting from loss of traditional values and norms	136	71.6
Indiscriminate mining activities	112	58.9
Burning of coal	106	56.8
Industrial activities	101	53.2
Car exhaust	91	48.1
Burning of fossil fuel	82	42.9
Urbanization	70	36.9
Raising of livestock	47	24.6
Volcanic eruption	24	12.5

*Multiple responses

3.3. Climate change effects on cassava production

The result in Table 3 shows that retarded growth of cassava (85.3%), reduction in cassava yield due (76.3%), altered growing season (75.8%) were the prime effects of climate change on cassava production, closely followed by increased production cost (74.7%), outbreak of pests and diseases (74.7%), and loss of young cassava plant (74.2%). The results suggest that although cassava demonstrates remarkable natural tolerance to drought conditions, the increasing severity of climate extremes such as prolonged drought and extreme heat continues to pose significant challenges to crop performance in terms of stunted growth, poor root production and development, and poor yield (Adu, 2020; Manuel et al., 2021; Okonkwo et al., 2025). Furthermore, rising soil temperature increases whitefly infestations, a vector of brown streak and mosaic diseases (Osuji et al., 2023). These biophysical and economic stressors can have devastating effects on cassava production, food security, and the livelihoods of farmers who depend on this crop. The finding aligns with the observations of Osuji et al. (2023) and Fidelis (2025) that climate change reduces yields, causes biodiversity loss, infestation by diseases and pests, loss of soil fertility, and cassava failures in Nigeria.

Table 3. Effects of climate change on cassava production

*Effects	Frequency	Percentages
Retarded growth of cassava due to drought	162	85.3
Reduction in cassava yield due to drought	145	76.3
Change in growing season	144	75.8
High infestation of pests and diseases	142	74.7
Wilting or death of young cassava	141	74.2
Reduced crop quality	140	70.5
Increased cost of production	131	68.9
Increased weed control measures	121	63.7
Loss of soil fertility	105	55.3

*Multiple responses

3.4. Adaptation strategies utilised by cassava farmers

The results in Table 4 reveal that planting drought-resistant varieties ($\bar{x}$ = 2.23), planting of improved varieties ($\bar{x}$ = 2.09), change in planting and harvesting dates ($\bar{x}$= 2.06), mixed cropping ($\bar{x}$ =1.98), planting of pests and disease resistant varieties ($\bar{x}$ =1.96), praying for rain ($\bar{x}$ =1.91), and use of weather information ($\bar{x}$ = 1.87) among others were the major adaptation strategies used by cassava farmers to reduce the adverse impacts of climate change on cassava production. Use of drought-resistant varieties to withstand water scarcity during prolonged dryness, planting of improved varieties, and use of pest and disease-resistant varieties have been found to be prominently used by farmers, because these varieties have been bred for resilience to varying weather conditions; have the ability to maintain optimum yield under harsh weather conditions, and also resistance to pests and diseases (Kalu and Mbanasor, 2020; Henri-Ukoha, 2020;Yakubu et al., 2020; Olutumise et al., 2024; Damilola et al., 2023; Fidelis, 2025). Besides, regular adjustments in planting and harvesting dates by cassava farmers to accommodate varying weather conditions and avoid crop failure are another key strategy adopted (Fidelis, 2025; Henri-Ukoha, 2020; Osuji et al., 2023). This is because early planting helps avoid drought periods, while late planting can mitigate risks associated with extreme rainfall or temperature fluctuations (Adeagbo et al., 2025). The use of mixed cropping was also a common practice because planting different crops rather than relying on cassava alone would reduce vulnerability to climate-related risks, promote resilience, and ensure food security in the event of crop failure (Agboola et al., 2024; Legide et al., 2024).

Apart from these, praying for rain and good weather is another traditional and cultural strategy utilised. This result suggests that farmers employ a diverse set of strategies to adapt to these challenges, prioritising planting drought-resistant and improved varieties, adjusting planting and harvesting dates, and adopting mixed cropping. Besides, they combine cultural practices, such as praying for rain, that rely on traditional beliefs and practices, with modern approaches, including using weather information to make informed decisions. This integration of traditional and modern strategies reflects farmers' adaptability and resourcefulness in responding to climate variability. These findings are similar to the observations of Eze et al. (2019), Kalu and Mbanasor (2020), Henri-Ukoha (2020), Damilola et al., (2023), Omodara et al. (2023), Nwaobiala et al. (2024), Olutumise et al. (2023) Olutumise et al. (2024), Osuji et al. (2024),Akpabio et al. (2025) and Fidelis, (2025) that reported that cassava farmers used various strategies to mitigate the effects of climate change which include mulching/cover cropping, livelihood diversification, planting drought resistant varieties, intensive use of organic manure, and mixed cropping among others.

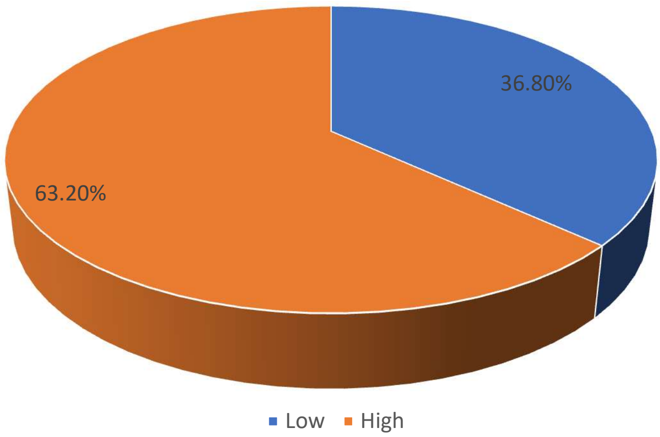
Table 4. Adaptation strategies used by the respondents

Adaptation strategies	**Mean**
Planting drought resistant crop varieties	2.23*
Planting of improved varieties	2.09*
Change in planting, weeding and harvesting date	2.06*
Mixed cropping	1.98*
Crop diversification	1.97*
Planting of pest and disease resistant varieties	1.96*
Praying for rain	1.91 *
Use of weather information	1.87 *
Regular weeding	1.77 *

Practice of crop rotation	1.71 *
Cover crop planting	1.65 *
Fertiliser application/organic manure	1.58*
Use of pesticide	1.48
Use of irrigation	1.46
Construction of drainages	1.42
Diversification to non-farm work	1.21

3.4.1. Levels of utilisation of these adaptation strategies

Figure 1 shows that the majority (63.2%) of cassava farmers highly utilised adaptation strategies to reduce the impact of climate change on cassava production, while 36.8% utilised them to a lesser extent. The high level of utilisation of adaptation strategies is attributed to high knowledge and awareness of the impact of climate change on cassava production and possible adaptation solutions. (Emmanuel et al., 2023) This prompted the farmers to urgently adopt multiple adaptation strategies to secure food in a changing climate. This is consistent with Damilola et al. (2023), Danso-Abbeam et al. (2021) and Trisos et al. (2022), who state that farmers' decisions to adopt adaptation strategies can be influenced by knowledge and awareness of climate change and possible adaptation solutions.



3.5. Constraints to the utilisation of climate change adaptation strategies

The results in Table 5 reveal that the majority (85.3%) of the respondents indicated a lack of climate forecasting information as the foremost barrier to the utilisation of adaptation strategies. This could be related to the paucity of climate data, which hinders informed decision-making and adaptation options, and to the country's limited number of meteorological stations, as reported by Adeloye et al. (2024) and Olutumise et al. (2024). Therefore, having access to weather forecast information will help guide against unforeseen circumstances on the farms. This is similar to Famakinwa et al. (2023), who argued that access to timely and reliable weather data is a crucial asset for farmers to plan ahead and reduce the shocks of climate change. Also, inadequate access to finance (82.6%) was considered another major barrier to the usage of climate adaptation strategies. This is because insufficient funds restrict farmers' ability to invest in adaptation strategies, such as improved cassava varieties, fertiliser, and agrochemicals, that would enhance their use. This is similar to the findings of Olutumise et al. (2024), who reported that cassava farmers have low access to funds. Other major constraints that limit the use of adaptation strategies as identified were limited access to resources (75.3%), such as land, water, and equipment, constrain farmers' adaptive capacity; inadequate extension personnel (73.2%) also limit farmers' access to expert advice and support which hampers farmers' ability to adopt new strategies, and high cost of inputs (72.1%) such as high costs of seeds, fertilisers, and other inputs limit farmers' ability to implement adaptation measures on their farms. The results reveal systemic challenges of informational and economic access, hindering effective strategy implementation. These interconnected barriers underscore the need for comprehensive solutions addressing informational, economic, and institutional constraints to support farmers' adaptation efforts.

Table 5. Constraints to the utilisation of adaptation strategies

*Constraints	Frequency	Percentages
Lack of climate forecasting information	162	85.3
Inadequate access to finance	157	82.6
Limited access to resources (improved varieties of cassava, fertilisers and agrochemicals)	143	75.3
Inadequate contact with extension personnel	139	73.2
High cost of inputs	137	72.1
Inadequate technological knowledge	136	71.6
Inadequate government intervention	133	70.0
Inadequate farm labour	128	67.5
Poor potential for irrigation	118	62.1
Shortage of farmland	113	59.5

*Multiple responses

3.6. Relationship between adaptation strategies and demographic features

The result in Table 6 shows that only age (r=-0.145) was negatively and significantly related to the utilisation of adaptation strategies on cassava production; while household size (r=0.351), years of experience in farming (r=0.265), and number of sources of information on adaptation strategies (r=0.265) were significantly correlated with adaptation strategy usage among cassava farmers. The negative correlation between age and the use of adaptation strategies among cassava farmers indicates that younger farmers are more likely to utilise adaptation strategies compared to their older counterparts (Adeloye et al., 2024). This is because younger farmers are more likely to have received formal education and modern agricultural training, thereby enhancing their receptivity to new technologies such as drought-resistant varieties and weather information systems. Additionally, younger farmers may have greater physical capacity to take risks and implement strategies such as mixed cropping or irrigation. This result aligns with global trends in youth adoption of climate-smart practices (Declaro-Ruedas, 2020; Alabi et al., 2023; Famakinwa et al., 2023; Omodara et al., 2023; Aroyehun et al., 2024; Olutumise et al., 2024; Idiong et al., 2025). Recent studies highlight that younger farmers in Nigeria are increasingly adopting digital tools and climate-resilient technologies. This suggests that policies should target youth engagement in agriculture through incentives such as subsidies for young farmers, tailored training programmes for younger demographics, and access to modern agricultural technologies. Apart from these, younger farmers are more likely to be open to experimenting with drought-resistant varieties or weather information tools, so extension services could prioritise youth-focused workshops to enhance adoption rates (Camby, 2024). However, household size, years of experience, and the number of sources of information on adaptation strategies were positively related to the utilisation of adaptation strategies (Adeloye et al., 2024). The positive correlation between household size and utilisation implies that larger households are associated with higher utilisation of adaptation strategies, likely due to increased availability of family labour. This is because larger households can provide a ready labour pool for labour-intensive adaptations, such as regular weeding and drainage construction. This can reduce reliance on hired labour, which is constrained by inadequate financing and can hinder broader strategy adoption. Apart from this, cassava farmers with larger households may be encouraged to diversify tasks among family members, integrating labour-intensive adaptation practices such as mixed cropping and regular weeding into their routines to enhance resilience.

A positive correlation between years of experience of Cassava farmers and the utilisation of adaptation strategies suggests that more experienced farmers are more likely to employ adaptation strategies, reflecting their accumulated knowledge and skills. Experienced farmers might be motivated to share best adaptation practices (such as adjusting planting dates) within their communities with other farmers, thereby fostering a culture of knowledge exchange to improve overall adaptation. This result is in tandem with the submissions of Famakinwa et al. (2023) that years of engagement were positively correlated with adaptation strategy usage, and is supported by Idiong et al. (2025), who found that farmers with over 20 years of experience are more likely to adopt pest-resistant varieties due to practical expertise. The number of sources of adaptation information is positively related to the utilisation of adaptation strategies, indicating that farmers with access to multiple information sources (such as observation, radio, and extension agents) are more likely to utilise them. This underscores the importance of policy interventions to expand information dissemination channels, such as investing in rural meteorological stations, mobile-based weather alerts, or community radio programmes. For farmers, actively seeking diverse information sources could enhance their decision-making, encouraging behaviours like using weather forecasts to time planting or adopting pest-resistant varieties based on expert advice (Adeloye et al., 2024). Recent literature from 2024 highlights the impact of multi-channel information, with Olutumise et al. (2024) reporting an increase in the use of adaptation strategies among farmers who accessed both extension services and digital platforms, reinforcing the need for integrated approaches.

Table 6. Relationship between selected demographic features and adaptation strategies

Socio-economic variables	**Correlation coefficient**	**p-value**
Age in years	-0.145*	0.042
Household size	0.351**	0.000
Income	0.054	0.475
Farm size	0.064	0.382
Duration of stay in locality	0.201	0.108
Number of sources of information	0.396**	0.001
Years of schooling	0.054	0.417
Years of farming experience	0.265**	0.000

*P ≤ 0.05, **P≤0.01

4. Conclusion

The findings of this study indicate that a majority of cassava farmers in Osun State, Nigeria, have adopted multiple adaptation strategies at a high level to mitigate the adverse effects of climate change, whereas a minority have implemented these strategies at a low level. Furthermore, human activities, including deforestation and uncontrolled bush burning, have been identified as primary contributors to climate change, with significant impacts on cassava production. These impacts have prompted farmers to employ diverse adaptation measures, such as drought-resistant varieties, improved varieties, adjustments in planting and harvesting dates, mixed cropping, and pest- and disease-resistant varieties. Despite the potential of these strategies to cushion the effects of climate change, their full implementation is constrained by pervasive constraints, including informational deficits, economic limitations, and policy neglect. These include the lack of climate forecasting information, inadequate financial resources, restricted access to inputs, insufficient extension personnel, high input costs, and limited technological knowledge.

Additionally, the study highlights that age, household size, years of farming experience, and the number of information sources significantly influence the utilisation of adaptation strategies. Specifically, younger farmers, those with larger households, individuals with extensive farming experience, and those with access to credit facilities, financial resources, and diverse weather information are more likely to adopt these strategies. Based on these findings, several recommendations are proposed. To address the critical barrier of limited climate forecasting information, governments at all levels should recruit and train more extension agents. These agents should prioritise the dissemination of localised, real-time weather data to farmers through mobile applications or SMS alerts, thereby equipping them with the technical knowledge necessary to mitigate climate change impacts. Furthermore, both government and non-governmental organisations (NGOs) should establish a low-interest microcredit programme, providing revolving loans tailored to low-income farmers and offering higher loan amounts to those with greater experience to facilitate the adoption of strategies such as fertiliser application and the use of drought-resistant and improved cassava varieties. In addition, subsidies on inputs such as fertilisers and pesticides should be provided directly to farmers to alleviate financial constraints.

To support ageing farmers, the government should promote research and policy initiatives by collaborating with research institutions such as the Institute of Agricultural Research and Training (IAR&T) and the International Institute of Tropical Agriculture (IITA). These institutions should develop user-friendly, low-tech cassava varieties and integrate them with an extension programme that utilises simplified visual aids tailored to older farmers. Moreover, extension agents and NGOs are encouraged to engage younger farmers as peer trainers to facilitate knowledge transfer to their older counterparts. Finally, to address the interconnected barriers identified, a collaborative framework involving meteorological stations, financial institutions, and extension services is essential. This collaboration should focus on creating integrated platforms that bundle weather information with subsidised inputs, distributed through extension agents, to enhance the high-utilisation rates of adaptation strategies. Such measures are critical for ensuring sustainable cassava production and bolstering food security in Nigeria.

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