# COPING STRATEGIES ON CLIMATE VARIABILITY AMONG COWPEA FARMERS IN KWARA STATE, NIGERIA †

# [ESTRATEGIAS DE AFRONTACIÓN A LA VARIABILIDAD CLIMÁTICA ENTRE LOS PRODUCTORES DE CAUPÍ EN EL ESTADO DE KWARA, NIGERIA]

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## SUMMARY

**Background.** The unstable climatic conditions can no longer be predicted by farmers. The unpredictability intensity of temperature and pattern of rainfall in cowpea production has affected the farmers' decision on production practices and general productivity. Therefore, farmers are beginning to improvise on management practices to avert the effects of climate change to remain relevant and profitable in the business of cowpea production. **Objective.** To examine the farmers' coping strategies used against the effects of climate variability for cowpea production in Kwara State, Nigeria. **Methodology.** A multistage sampling technique was used to select 120 cowpea-based farmers. A structured survey questionnaire was used to collect primary data. Data were analysed with frequency, percentage, mean, and standard deviation while Pearson Product Moment Correlation was used to ascertain the relationship between socioeconomic characteristics and copying strategies used by farmers. **Results.** Majority (79.2%) of the respondents experienced high adverse effects of climate variability including abnormal rise in temperature (76.7%), irregular/unpredictable rainfall patterns (51.7%), and excessive rainfall (37.5%) on cowpea crop. The leading coping strategies used by farmers were use of fertilizer ($\bar{x}$=2.73), herbicides ($\bar{x}$=2.72), and planting early maturing variety ($\bar{x}$=2.51). Farmers were mainly hindered by adequate irrigation facilities ($\bar{x}$=1.72), inadequate access to extension services ($\bar{x}$=1.66), and high cost of agrochemicals ($\bar{x}$=1.60). Result education, cowpea farm size, years of experience in cowpea farming, membership in farmers group, and additional sources of information on cowpea production showed a positive significant relationship with the choice of coping strategies employed by cowpea farmers against the effects of climate change experienced at $p<0.05$ level. **Implication.** The study showed that abnormal rise in temperature and irregular rainfall patterns are affecting cowpea production and thus, some socioeconomic attributes significantly supported farmers' choice of coping strategies employed against the effects of climate change and variability. **Conclusion.** The use of agrochemicals and cultivation of early maturing variety has played critical roles in coping with adverse effects of climate variability in cowpea production.
**Key words**: cowpea production; abnormal rise in temperature; irregular rainfall pattern; early maturing variety; socioeconomic attributes.

## RESUMEN

**Antecedentes**. Los agricultores ya no pueden predecir las inestables condiciones climáticas. La imprevisibilidad de la intensidad de la temperatura y el patrón de lluvias en la producción de caupí ha afectado la decisión de los agricultores sobre las prácticas de producción y la productividad general. Por lo tanto, los agricultores están comenzando a improvisar prácticas de gestión para evitar los efectos del cambio climático y seguir siendo relevantes y rentables en el negocio de la producción de caupí. **Objetivo.** Examinar las estrategias de afrontamiento de los agricultores utilizadas contra los efectos de la variabilidad climática para la producción de caupí en el estado de Kwara, Nigeria. **Metodología.** Se utilizó una técnica de muestreo de múltiples etapas para seleccionar 120 agricultores que cultivaban caupí. Se utilizó un cuestionario de encuesta estructurado para recopilar datos primarios.

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La información se analizó con frecuencia, porcentaje, media y desviación estándar, mientras que se utilizó la correlación momento-producto de Pearson para determinar la relación entre las características socioeconómicas y las estrategias de copia utilizadas por los agricultores. **Resultados.** La mayoría (79.2%) de los encuestados experimentó altos efectos adversos de la variabilidad climática, incluido un aumento anormal de la temperatura (76.7%), un patrón de lluvia irregular/impredecible (51.7%) y lluvias excesivas (37.5%) en el cultivo de caupí. Las principales estrategias de afrontamiento utilizadas por los agricultores fueron el uso de fertilizantes ($\bar{x}$=2.73), herbicidas ($\bar{x}$=2.72) y la siembra de variedades de maduración temprana ($\bar{x}$=2.51). Los agricultores se vieron obstaculizados principalmente por instalaciones de riego adecuadas ($\bar{x}$=1.72), acceso inadecuado a servicios de extensión ($\bar{x}$=1.66) y el alto costo de los agroquímicos ($\bar{x}$=1.60). Los resultados de la educación, el tamaño de las granjas de caupí, los años de experiencia en el cultivo de caupí, la membresía en un grupo de agricultores y las fuentes adicionales de información sobre la producción de caupí mostraron una relación significativa y positiva con la elección de las estrategias de afrontamiento empleadas por los agricultores de caupí contra los efectos del cambio climático experimentados ($P<0.05$). **Implicaciones.** El estudio muestra que el aumento anormal de la temperatura y el patrón irregular de lluvias están afectando la producción de caupí y, por lo tanto, algunos atributos socioeconómicos respaldaron significativamente la elección de las estrategias de afrontamiento empleadas por los agricultores contra los efectos del cambio y la variabilidad climática. **Conclusión.** El uso de agroquímicos y el cultivo de variedades de maduración temprana han desempeñado un papel fundamental para hacer frente a los efectos adversos de la variabilidad climática en la producción de caupí.
**Palabras clave:** producción de caupí; aumento anormal de temperatura; patrón de lluvia irregular; variedad de maduración temprana; atributos socioeconómicos.

## INTRODUCTION

Cowpea (*Vigna unguiculata L.*) is one of the important staple food crops and sources of livelihood for several members of farming households Nigeria (Murtala and Abaje, 2018). To achieve food security through plant-based protein crops, cowpea and soybean are highly recommended when compared to other grain legumes in the tropical and sub-tropical regions of the world, including in sub-Saharan Africa (SSA) (Franke *et al.*, 2018; Gerrano *et al.*, 2017). Cowpea cultivation is usually intercropped with cereals including sorghum, maize, roots and tubers such as yam sweet potatoes and cassava (Kolayemi, 2019). More than 95% of the global production is in Africa, especially in SSA, with Nigeria being the world's largest producer and consumer, followed by the Niger Republic and Burkina Faso (FAO, 2022; Boukar *et al.* 2019). The cultivation of cowpea is not exempted to climate change effects causing reduction in the overall production as productivity is determined by climatic condition and soil water availability (Rafaele *et al.*, 2022; Karim *et al.* 2018). Cowpeas are sensitive to water deficit, and this abiotic stress can also cause flower abortion, pod failure, and grain filling reduction (Mwale *et al.*, 2017). Therefore, studies have agreed that cowpea production is highly vulnerable to climate change shock (Arimi *et al.* 2020; Adusei *et al.*, 2023).

Climate change remains a global threat to humanity in the 21st century. It is a rapidly advancing phenomenon that threatens the livelihoods of smallholder farmers, the sustainability of the economy, and the wellbeing of humanity in general (Adeagbo *et al.*, 2021). Scholarly research has demonstrated rising temperature and variable rainfall at the global scale (Zhou *et al.*, 2021; Intergovernmental Panel on Climate Change (IPCC), 2022). Global temperature rose at alarming levels from 2009 to 2020, with the peak years reported in 2016, 2019, and 2020 (World Meteorological Organisation (WMO), 2021). Increased intensities of temperature and greenhouse gases have resulted in extreme climatic and weather situations (such as floods, drought, heat-waves and windstorms), which pose a significant threat to agricultural livelihoods, particularly in SSA (Agba *et al.*, 2017). For instance, the IPCC predicted that crop growing season in SSA will shrink by 20.0% on average by 2050, resulting in a 40.0% reduction in crop yields (IPCC, 2018). Many farmers in developing countries are vulnerable climate change impacts and could not accurately predict the future climatic condition (Asante and Amuakwa-Mensah, 2015). Vulnerability is the characteristics of an individual or group of people and their situation that weakly or negatively influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard. This conceptualization of vulnerability shifts attention to the role that social connections and supports play in buffering people, processes, and places when confronted with exposure to natural hazards (Collins *et al.*, 2017).

Studies have concluded similarly that poor yield of cowpea is directly linked to climate change phenomenon which include increase amount of rainfall, very high temperature, flood and infestation of pest and diseases (Yakubu *et al.*, 2021; Arimi *et al.*

2020; Murtala and Abaje, 2018). Experimental studies have shown that cowpea production increases at mild season than during the hot season and linear increase was observed with increase soil water availability (Rafaele *et al.*, 2022). It was specified that the temperatures of 29 ºC (day)/23 ºC (night) lead to a higher seed weight while the temperatures of 32 ºC (day)/29 ºC (night) lead to a greater flower abortion as increase of $CO_2$ leads to a higher number of pods and seeds and seed weight in cowpea production (Angelotti *et al.*, 2020). Survey studies further indicated negative significant relationship between rainfall pattern, relative humidity and area of land/ha, while a significant positive relationship existed between temperature intensity and cowpea yield over the period under study decade (Mohammed *et al.*, 2021).

Due to the adverse effects of climate change on cowpea, most farmers had highly employed climate change adaptation strategies for cowpea production (Arimi *et al.* 2020). The IPCC describe adaptation as the adjustment in human or natural systems through innovation or changing environment (IPCC, 2007). In other words, climate change adaptation (resilient building mechanisms) implies the ability of a system to cushion potential impacts of climate change and to cope with the outcomes (Ashfaq and Jan, 2019; Bolarin *et al.*, 2022). Some of the measures include: changing planting date, crop rotation, use of improved seed variety, fertilizer application, irrigation system, shifting cultivation, agricultural diversification and change in harvesting date (Yeleliere *et al.*, 2023). The utilization of these approaches or technologies is contingent upon the farmer's knowledge and attitude. This agrees with report stated by Mugandani and Mufongoya (2019) who averred that the decision to adopt a technology is associated with how the technology is perceived. Recent studies have confirmed that Africa is among the continents with the least ability to adapt to climate variability and weather variations (Fadina and Barjolle, 2018). While some mitigation measures have been implemented in response to the current climate variability, they may not be sufficient to adequately prepare for the effects of future climate change (Muller, 2021). However, it has been observed that the lack of predictability caused by climate variability hinders investment in and utilization of agricultural technologies and market opportunities (Autio *et al.*, 2021). Nigeria is responsible for the emission of 35 million metric tons of CO2 and 12 million metric tons of methane, both of which have a significantly increased warming potential compared to $CO_2$ (Watts, 2017). It is against this context that this research work tends to examine the knowledge, attitudes strategies on weather and climate variability by cowpea farmers in Irepodun and Ifelodun LGA, Kwara State, Nigeria. Findings from the study are expected to positively influence agriculture extension policy process to promote farmers adaptability capacity to mitigate the effects of climate change on cowpea production.

The broad objective of this study is to examine the knowledge, and attitude strategies on weather and climate variability by cowpea farmers in Irepodun and Ifelodun LGA, Kwara state, Nigeria. The specific objectives are to: (i) examine the farmers' knowledge of climate change and variability phenomenon, (ii) assess the effects climate change and variability on cowpea production, (iii) determine farmers' coping strategies for weather and climate variability in cowpea production, and (iv) identify the farmers' constraints to use coping strategies on weather and climate variability in cowpea production.

**Farmers' Socioeconomic Characteristics and Coping Ability to Climate Change and Variability**

The capability of small-scale farmers to cope with the effects of climate variability is influenced by several factors which include socio-economic characteristics of a household such as marital status, educational status, age, gender household size (IPCC, 2014; Mugi-Ngenga *et al.*, 2016). These factors vary between individuals and within communities, countries and regions (Eriksen *et al.*, 2011). In Pakistan, Qazlbash *et al.*, (2020) investigated the socioeconomic characteristics that determined climate change adaptation practices employed by farmers in flood-prone area using binary logistic regression model and found that sex, primary occupation, and level of education were factors that significantly influenced adaptability of the farmers to climate change effects. A study conducted in Ghana by Tangonyire and Akuriba (2020) on socioeconomic characteristics affecting smallholder farmers' adaptive practices to climate change effects found using Chi-square analysis showed that farmers' access to land, access to loan, gender and communal norms significantly affected the ways farmers interpret and respond to climate change. Study conducted in South Africa by Tshikororo *et al.*, (2021) using multinomial logistic regression model showed that farmers' socio-economic attributes such as household size, formal education, gender, farming experience, and age group significantly influenced farmers' selection of climate change adaptive strategies. Atube *et al.* (2021) found gender, farm income, farming experience, and household size as socioeconomic factors that determined farmers' adaptability to climate change in Uganda. Malaysia farmers' willingness to pay for climate adaptation

was reported to be influenced by their household size, farm size, education level and farm income (Al-Amin *et al.*, 2020). Study by Ihemezie *et al.* (2018) found that income, house ownership and house type are the main feature influencing individual and households' capacity to adapt favorably to the effects of climate change in Leeds, United Kingdom. Lal *et al.* (2011) indicated literacy, demography, earnings, occupations and poverty incidence as major farmers' determinants to adapt the effects of climate change in United States of America.

In Nigeria, several studies have investigated the influence of socioeconomic characteristics on the adaptability of smallholder farmers to adapt the effects of climate change on the production of rice (Bello *et al.*, 2023; Agyo and Ornan, 2021), maize (Adeagbo *et al.*, 2021), Soghum (Adedeji *et al.* 2017), yam (Bolarin *et al.*, 2021) and urban agriculture (Okunlola *et al.*, 2022) but none has investigated the influence in cowpea production, most especially in Kwara State. Related studies on cowpea focused on vulnerability of cowpea farmers to climate change in Oyo State (Arimi *et al.*, 2020), impact of climate change on cowpea production in Abuja (Ayanwuyi, and Akintonde, 2012; Ajetomobi and Abiodun, 2010). Null hypothesis: socio-economic attributes of cowpea farmers do not affect coping strategies employed against the effects of climate variability.

## MATERIAL AND METHODS

The study area is Kwara State and is located between latitudes 8o and 10o 041 N and longitudes 2º 451 E and 6º121E (Fig. 1). The state occupies an area of 36,825km$^2$ and shares boundaries with Niger State in the North, Kogi and Ekiti States at the East, Osun and Oyo States in the South and an international boundary with the Republic Environment 88 of Benin in the West. The State has sixteen Local Government Areas. Kwara State falls under a tropical climate with a distinct dry and rainy season. The dry season is about four months from November to February and sometimes times it may extend to early March. The rainy season on average lasts for nine months between March and October or sometimes early November with a mean annual rainfall of 1,000 to 1,500 mm. The natural vegetation consists broadly of rainforest and wooded savannah with sprouts of tall grasses. The relief of Kwara State ranges between 60 meters and 680 meters above mean sea level. The hinterland is undulating with the highest hills found mostly in Ifelodun, Irepodun, and Ilorin West Local Government Areas. The mainstay of the economy of the state is agriculture. More than 90 percent of the state's rural populations who form the bulk of the state's total population are engaged in farming. Food crops grown include maize, yam, guinea corn, sorghum, cassava, and sweet potato among others.

A multistage sampling technique would be employed to obtain data from the respondents. The first sampling stage is the purposive selection of Irepodun and Ifelodun local government areas. This selection is a result of the fact that the two (2) LGAs are one of the major rural areas where farming production and other primary activities are prevalent. Thereafter, a purposive selection of six (6) communities from each of the selected local government areas in the study area would be carried out. In the last stage, twenty (20) respondents would be randomly selected from each community to make up a sample size of 120 respondents.

A structured questionnaire was used to collect data from respondents. The instrument was subjected to content validity which was done by experts in the Department of Agricultural Economics and Extension Services, Kwara State University Malate, Nigeria. Experts' opinions were incorporated for necessary modification. Also, a pilot test and re-test was conducted on 20 cowpea farmers located outside the study area to ascertain reliability of the instrument. A Cronbach's alpha coefficient value of 0.89 was obtained, indicated that the instrument was reliable to collect primary data for the study.

Ethical approval to conduct the study was obtained from the Research Ethics Committee of Kwara State University (KWASU) Nigeria with reference number KWASU/CREDIT/REA/2023/006. Additionally, a letter of introduction and permission to collect data were obtained from the Department of Agricultural Economics and Extension Services, Malete, Nigeria. The introduction letter was presented to the heads of rural farming household cultivating cowpea and each members willing participate were recruited as part of the process of obtaining informed consent. Thereafter, the volunteers were provided with the questionnaire to fill. The majority of participants completed the questionnaire in 2–5 minutes. Subsequently, the questionnaire was retrieved and verified for completion. Upon successful completion, the questionnaire was given a unique numerical code, and a tag containing the code was provided to the surveyed respondent for retention. Respondents were asked to react to a set of statements indicating the knowledge strategies of cowpea farmers on weather and climate variability, high=2, Low=1, and No idea=0. Frequencies of occurrence of weather and climate variability were measured using a five-point Likert scale: always=3, sometimes=2, rarely=1, never=0. Effects of weather and climate variability

on cowpea production were measured as high=3, moderate=2, low=1. Coping strategies against weather and climate variability were measured as always=3, sometimes=2, rarely=1, never=0. Constraints to use of coping strategies were measured as very severe=3, severe=2, and not severe=1. Coded data were entered into Statistical Package for Social Science (SPSS) version 23. Analysis of specific objectives were performed and presented using frequency, percentage, mean and standard deviation while Pearson Product Moment Correlation (PPMC) analysis was performed to assess the stated hypothesis. PPMC model was adopted and expressed as follows:

$$\mathbf{r_{xr}}=\frac{n\sum xy-(\sum x)(\sum y)}{\sqrt{\{n\sum x^2-(\sum x)^2\}\{n\sum y^2-(\sum y)^2\}}}\ldots\ldots\ldots\ldots(1)$$

where;
r = correlation coefficient
y = dependent variable (coping strategies used against the effects of climate variability for cowpea production)
x = independent variables
$X_1$ = Age (years)
$X_2$ = Household size (persons)
$X_3$= Cowpea farm size (acres)
$X_4$= Years of experience in cowpea production (years)
$X_5$= Annual income (Naira)
$d_1$ = Sex (male=1, female =0)
$d_2$ = Marital status (dummy, married =1 otherwise 0)
$d_3$ = Educational Status (dummy, formal education=1 otherwise 0)
$d_4$ = Engagement in non-farming activities (dummy, yes=1 otherwise 0)
$d_5$ = Membership of farmers group/association (yes=1, no =0)
$d_6$ = Other sources of information (dummy, yes=1 otherwise 0)
n = total number of observation
$\sum$ =summation

## RESULTS AND DISCUSSION

Socio-economic characteristics of the respondents were presented in Table 1 and 2. A significant percentage (44.2 %) of the respondents were aged between 31–40 years, while the average age of all respondents was 39.7±9.28 years. Persons with average of 39 years old could be considered as youth, thus the cowpea farmers in the study area are young and are expected to have required strength to carry out strenuous activities involved in cowpea farming. On sex of the respondents, 70.8 percent were male, while 29.2 % were female. This shows that cowpea farming enterprise in the study is dominated by male folk. Further analysis revealed that 78.3% were married while 21.7 % were unmarried. The implication is that majority of cowpea farmers in the study area are married. Married farmers are expected to be more committed to cowpea production enterprise as source of income due to family responsibilities attached to the status (Sylla *et al.*, 2023). Regarding household size of the respondents, 48.3 percent indicated 5 persons or less, while the average household size of all respondents was 6±3.94 persons. Household with 6 persons could be considered as moderate considering the present economic situation of Nigeria. Nevertheless, these persons could be used as labour for cowpea farming, thereby reducing the expenditure in hiring labour. Further information in Table 2 indicated that only 30.5 % of the respondents had no formal education while the remaining larger percentage had one form of formal education including primary education (35.0 %), secondary education (17.5 %), and tertiary education (20.0 %). This implies that cowpea farmers in the study area are literate who are able read extension information for cowpea production as well as the ability to write extension organization/personnel on their challenges or needs for improved technology needs for cowpea production practices.

Table 2 further showed that majority (77.5 %) of the respondents had 5 acres or below size of farm land for the cultivation of cassava. The average farm size of all respondents was 2.7±1.67 acres. This average farm size could be considered as small. This shows that cowpea farmers in the study area were small scale farmers. Result on farmers experience indicated that majority (70.0 %) of the respondents had 10 years of experience or below. The average year of experience for all respondents was 8.2±7.6 years. This showed cowpea farmers in the study area had relatively long years of experience in cowpea production. This accumulated experience is expected to have given considerable knowledge on how the climate change is affecting cowpea crops in the study area. Considering the income earned by the respondents, 49.2 percentage earned ₦100,000 or below, while few number of farmers (29.2 %) earned between ₦100,001 – ₦200,000. The average income earned was ₦162,458.33±153264.47. If divided by 365 days, it shows that each cowpea farmers earned average of ₦881.84 per day. Considering the present economic situation of the country and price of commodity, the amount realized per day can only make the farmers to marginally escape hunger but still remain poor. Result on membership of farmers group indicated that 52.5 percent were members while 47.5 percent were non-members. Prominent

sources of information of the respondents were radio (49.2%), farmers group (21.7%) and extension agents (12.5%). This shows that radio, farmers group and extension are relevant information dissemination channels to reach cowpea farmers in the study area.

**Table 1. Socioeconomic characteristics of respondents (n=120).**

| Variables | Frequency (120) | Percentage | Mean | Standard dev. |
|---|---|---|---|---|
| **Age (years)** | | | | |
| Less than 30 | 20 | 16.7 | | |
| 31 – 40 | 53 | 44.2 | 39.7 | 9.28 |
| 41 – 50 | 31 | 25.8 | | |
| Above 50 | 16 | 13.3 | | |
| **Sex** | | | | |
| Male | 85 | 70.8 | | |
| Female | 35 | 29.2 | | |
| **Marital Status** | | | | |
| Married | 94 | 78.3 | | |
| Unmarried | 26 | 21.7 | | |
| **Household size (people)** | | | | |
| ≤ 5 | 58 | 48.3 | | |
| 6 – 10 | 50 | 41.7 | 6 | 3.94 |
| 11 and above | 12 | 10.0 | | |

Source: Field survey, 2023

**Table 2. Socio-economic characteristics of respondents (continue).**

| Variables | Frequency | Percentage | Mean | Std. Dev. |
|---|---|---|---|---|
| **Educational status** | | | | |
| None formal education | 33 | 30.5 | | |
| Primary education | 42 | 35.0 | | |
| Secondary education | 21 | 17.5 | | |
| Tertiary education | 24 | 20.0 | | |
| **Farm size (acre)** | | | | |
| ≤ 5 | 93 | 77.5 | | |
| 6 – 10 | 22 | 18.3 | 2.7 | 1.67 |
| 11 and above | 5 | 4.2 | | |
| **Farming experience (years)** | | | | |
| ≤ 10 | 84 | 70.0 | | |
| 11 – 20 | 26 | 21.7 | 8.2 | 7.65 |
| 21 and above | 10 | 8.3 | | |
| **Annual income (Naira)** | | | | |
| ≤ 100,000 | 59 | 49.2 | | |
| 100,001 – 200,000 | 35 | 29.2 | 162,458.33 | 153264.47 |
| 200,001 – 300,000 | 10 | 8.3 | | |
| Above 300,000 | 16 | 13.3 | | |
| **Membership of farmers group** | | | | |
| Yes | 63 | 52.5 | | |
| No | 57 | 47.5 | | |
| **Sources of information** | | | | |
| Radio | 59 | 49.2 | | |
| Extension agents | 15 | 12.5 | | |
| Farmers group | 26 | 21.7 | | |
| Newspaper | 5 | 4.2 | | |
| Journal | 3 | 2.5 | | |
| Internet | 12 | 10.0 | | |

Source: Field survey, 2023

Table 3 presents results on the farmers' knowledge of climate change and weather variability phenomenon and their frequency of occurrence. The majority of the cowpea based farmers were highly aware about the incidence of abnormal rise in temperature (76.7 %) while others above halve of the respondents (51.7 %) indicated their high knowledge about irregular/unpredictable rainfall pattern. Appreciable percentage of the respondents indicated high knowledge for flood (41.7 %), excessive rainfall (37.5 %) and incidence of drought (36.7 %). Ranking order of the farmers' knowledge of the phenomenon shows that abnormal rise in temperature (mean=1.68) ranked while degradation of farm land (mean=1.04) ranked seventh position as the least known climate change phenomenon.

Farmers' knowledge on the frequency of manifestation of weather and climate variability phenomenon in recent times indicate that climate change always manifest through excessive rainfall ($\bar{x}$=1.84) ranked first position, irregular/unpredictable rainfall pattern ($\bar{x}$=1.78) ranked second, abnormal rise in temperature ($\bar{x}$=1.66) ranked third position while Degradation of farm land ($\bar{x}$=1.30) ranked the least of frequency of occurrence of the climate change phenomenon (Table 4). Finding in this study affirmed previous studies that affirmed occurrence of climate change in Nigeria (Ogunleye *et al.*, 2021; Williams *et al.*, 2018). Table 5 and 6 further present results on unfavourable incidences experienced by cowpea based farmers on crops as a result of climate change phenomenon.

The ranking order of effects weather and climate variability on cowpea farm as indicated in Table 5 shows that large crops failure due to the variations in climates ($\bar{x}$=2.30), decrease in crop yields ($\bar{x}$=2.18), excessive rain hardly supports crops production ($\bar{x}$=2.07), reduced farm profit ($\bar{x}$=2.04), reduced farm income ($\bar{x}$=1.93), and reduced soil fertility ($\bar{x}$=1.83) ranked 1st, 2nd, 3rd, 4th, 5th, and 6th positions respectively. This finding implies that large crops failure, decrease in crop yields, excessive rain that hardly supports crops production were the leading effects experienced by cowpea farmers as a result of weather and climate change in the study area.

Individual grouping of cowpea farmers according to level of effects of climate change was performed and presented in Table 6. It was found that 20.8 percent of the respondents were grouped as low effect while 79.2 percent of the respondents were grouped as high effects. The implication of this result is that climate change has highly affects cowpea based farmers in the study area. This study is consistence with earlier studies that found that climate change effects highly affects farmers, most especially the smallholder farmers

**Table 3. Farmers' knowledge of weather and climate variability.**

| Weather and climate variability | Knowledge level | | | | |
|---|---|---|---|---|---|
| | High | Low | No idea | Mean(SD) | Rank |
| Abnormal rise in temperature | 92(76.7) | 18(15.0) | 10(8.3) | 1.68(.62) | 1st |
| Irregular/unpredictable rainfall pattern | 62(51.7) | 47(39.2) | 11(9.2) | 1.43(.65) | 2nd |
| Excessive rainfall | 45(37.5) | 61(50.8) | 14(11.7) | 1.26(.65) | 3rd |
| Incidence of drought | 44(36.7) | 57(47.5) | 14(11.7) | 1.21(.69) | 4th |
| Incidence of flooding | 50(41.7) | 41(34.2) | 29(24.2) | 1.18(.79) | 5th |
| Dryness of rivers/dam for irrigation | 46(38.3) | 34(28.3) | 40(33.3) | 1.05(.84) | 6th |
| Degradation of farm land | 30(25.0) | 65(54.2 | 25(20.8) | 1.04(.67) | 7th |

Source: Field survey, 2023

**Table 4. Knowledge of frequency of occurrence of weather and climate variability.**

| **Weather and climate variability** | **Frequency of occurrence** | | | | | |
|---|---|---|---|---|---|---|
| | Always | Sometimes | Rarely | Never | Mean(SD) | Rank |
| Excessive rainfall | 28(23.3) | 56(46.7) | 25(20.8) | 11(9.2) | 1.84(.88) | 1st |
| Irregular/unpredictable rainfall pattern | 11(9.2) | 78(65.0) | 25(20.8) | 6(5.0) | 1.78(.676) | 2nd |
| Abnormal rise in temperature | 13(10.8) | 66(55.0) | 28(23.3) | 13(10.8) | 1.66(.815) | 3rd |
| Incidence of flooding | 21(17.5) | 32(26.7) | 56(46.7) | 11(9.2) | 1.53(.88) | 4th |
| Incidence of drought | 13(10.8) | 54(45.0) | 37(30.8) | 16(13.3) | 1.53(.85) | 5th |
| Dryness of rivers/dam for irrigation | 16(13.3) | 45(37.5) | 30(25.0) | 29(24.2) | 1.40(.99) | 6th |
| Degradation of farm land | 15(12.5) | 26(21.7) | 59(49.2) | 20(16.7) | 1.30(.89) | 7th |

Source: Field survey, 2023.

**Table 5. Perceived effects of weather and climate variability on cowpea farm.**

| Effects | High | Moderate | Low | Mean(SD) | Rank |
|---|---|---|---|---|---|
| Large crops failure due to the variations in climates | 45(37.5) | 66(55.0) | 9(7.5) | 2.30(.60) | 1st |
| Decrease in crop yields | 29(24.2) | 83(69.2) | 8(6.7) | 2.18(.52) | 2nd |
| Excessive rain hardly supports crops production | 27(22.5) | 74(61.7) | 19(15.8) | 2.07(.61) | 3rd |
| Reduced farm profit | 27(22.5) | 74(61.7) | 19(15.8) | 2.04(.71) | 4th |
| Reduced farm income | 14(11.7) | 83(69.2) | 23(19.2) | 1.93(.55) | 5th |
| Reduced soil fertility | 21(17.5) | 57(47.5) | 42(35.0) | 1.83(.70) | 6th |

Source: Field survey, 2023

**Table 6. Level of Effects of weather and climate variability on cowpea farm.**

| Level | Score range | Frequency | Percentage | Mean |
|---|---|---|---|---|
| Low adverse effects | 1 – 9 | 25 | 20.8 | 12.35±1.91 |
| High adverse effects | 10 – 18 | 95 | 79.2 | |
| Total | | 120 | 100 | |

Source: Field survey, 2023

who are the largest producers of staple food in Nigeria (Bolarin *et al.*, 2022; Mkwambisi *et al.*, 2021). This is because crop production in the tropical region as Nigeria are rain-fed production that highly dependent on natural environmental conditions, including climate (Dhanya *et al.*, 2022; Santos *et al.*, 2022). Table 7 presents results on the choice of coping strategies to use for weather and climate variability effects on cowpea farm.

As shown in Table 7, coping strategies used by cowpea farmers were increase use of soil fertilizer ($\bar{x}$=2.73) ranked first, increase use of herbicides ($\bar{x}$=2.72) ranked second, planting early maturing variety ($\bar{x}$=2.51) ranked third, planting of resistance to diseases crop ($\bar{x}$=2.47) ranked fourth, increase use of pesticides ($\bar{x}$=2.41) ranked fifth, listening to early warning information ($\bar{x}$=2.38) ranked sixth, planting cover cropping ($\bar{x}$=2.36) ranked seventh, mulching to preserve soil moisture ($\bar{x}$=2.26) ranked eighth, use of drought-tolerant crop varieties ($\bar{x}$=2.09) ranked ninth, doing of small scale irrigation ($\bar{x}$=2.02) ranked tenth position as the least choice of coping strategies employed by the farmers. This finding implies that increase use of soil fertilizer, increase use of herbicides, and planting early maturing varieties were the topmost coping strategies used by cowpea farmers to adapt to effects of weather and climate variability in the study area. The coping strategies found in this study confirmed the adaptation and mitigation practices reportedly common among crop farmers in North-central Nigeria (Bakare, Ogunleye & Kehinde, 2023; Jug *et al.*, 2018).

Table 8 presents detailed results on the constraints facing constraints facing the cowpea based farmers on the choice of coping strategies to use for weather and climate variability effects on cowpea farm. Lack of adequate irrigation facilities ($\bar{x}$=1.72) ranked first, inadequate extension officers ($\bar{x}$=1.66) ranked second,

**Table 7. Coping strategies against weather and climate variability.**

| Adaptation Strategies adopted | Always | Sometimes | Rarely | Never | Mean(SD) | Rank |
|---|---|---|---|---|---|---|
| Increase use of soil fertilizer | 94(78.3) | 20(16.7) | 6(5.0) | 0 | 2.73(.54) | 1st |
| Increase use of herbicides | 86(71.7) | 34(28.3) | 0 | 0 | 2.72(.45) | 2nd |
| Planting early maturing variety | 64(53.3) | 53(44.2) | 3(2.5) | 0 | 2.51(.55) | 3rd |
| Planting of resistance to diseases crop | 63(52.5) | 50(41.7) | 7(5.8) | 0 | 2.47(.60) | 4th |
| Increase use of pesticides | 57(47.5) | 58(48.3) | 2(1.7) | 3(2.5) | 2.41(.65) | 5th |
| Listening to early warning information | 73(60.8) | 22(18.3) | 22(18.3) | 3(2.5) | 2.38(.87) | 6th |
| Planting cover cropping | 60(50.0) | 46(38.3) | 11(9.2) | 3(2.5) | 2.36(.75) | 7th |
| Mulching to preserve soil moisture | 55(45.8) | 49(40.8) | 8(6.7) | 8(6.7) | 2.26(.85) | 8th |
| Use of drought-tolerant crop varieties | 42(35.0) | 52(43.3) | 21(17.5) | 5(4.2) | 2.09(.83) | 9th |
| I do small scale irrigation | 43(35.8) | 47(39.2) | 19(15.8) | 11(9.2) | 2.02(.94) | 10th |
| Construction of local dam | 25(20.8) | 65(54.2) | 27(22.5) | 3(2.5) | 1.93(.73) | 11th |

Source: Field survey, 2023

**Table 8. Constraints to use of coping strategies against weather and climate variability.**

| Constraints | Very severe | Severe | Not severe | Mean(SD) | Rank |
|---|---|---|---|---|---|
| Lack of adequate irrigation facilities | 85(70.5) | 33(27.5) | 2(1.7) | 1.72(.54) | 1st |
| Inadequate extension officers | 83(69.2) | 26(21.7) | 9(7.5) | 1.66(.65) | 2nd |
| Shortage and high cost of acquired farm inputs | 81(67.5) | 27(22.5) | 12(10.0) | 1.60(.70) | 3rd |
| Lack of knowledge on appropriate adaptation strategies | 47(39.2) | 73(60.8) | 0 | 1.39(.49) | 4th |
| Unpredictable weather and climate condition | 49(40.8) | 67(55.8) | 4(3.3) | 1.38(.55) | 5th |
| Lack of information about potential climate variability | 43(35.8) | 72(60.0) | 5(4.2) | 1.32(.55) | 6th |
| Inadequate government support | 53(44.2) | 52(43.3) | 15(12.5) | 1.32(.68) | 7th |

Source: Field survey, 2023

shortage and high cost of acquired farm inputs ($\bar{x}$=1.60) ranked third, lack of knowledge on appropriate adaptation strategies ($\bar{x}$=1.39) ranked fourth, unpredictable weather and climate condition ($\bar{x}$=1.38) ranked fifth, lack of information about potential climate variability ($\bar{x}$=1.32) ranked sixth, while inadequate government support ($\bar{x}$=1.32) ranked seventh position as the least constraints facing the cowpea based farmers on the choice of coping strategies to use for weather and climate variability effects on cowpea farm. This finding implies that lack of adequate irrigation facilities, inadequate extension officers and shortage and high cost of acquired farm inputs were the foremost constraints facing the cowpea based farmers on the choice of coping strategies to use for weather and climate variability effects on cowpea farm. Results in Table 9 showcase the statistical relationship between socio-economic characteristics of cowpea based farmers and their coping strategies for climate change effects using PPMC (Study hypothesis).

Result of PPMC analysis between socio-economic characteristics and coping strategies for climate change effects as presented in Table 9 indicated that educational status (r = 0.390), farm size (r = 0.252), farming experience (r = 0.556), membership of farmers group/association (r=0.250), and sources of information (r = 0.199) showed positive significant relationship with the choice of coping strategies employed by cowpea based farmers for the effects of climate change experienced. These findings indicated that increase in years of schooling, acres of land cultivated for cowpea, years of experience in cowpea farming, years of membership, and additional sources of information of climate change will increase informed choice of coping strategies to employed for the effects of climate variability among cowpea based farmers in the study area at $p<0.05$ level of significant. Factors found in this study are similar to studies that found education (Qazlbash *et al.*, 2020; Okunlola *et al.*, 2022), farming experience (Baley *et al.*, 2022; Atube *et al.*, 2021), farm size (Al-Amin *et al.*, 2020), membership of group (Mwinkom *et al.*, 2021) and access to climate information (Belay *et al.*, 2022).

**Table 9. Relationship between socio-economic characteristics of cowpea based farmers and the coping strategies employed against climate change effects.**

| Variables | r-value | Sig. (p-value) |
|---|---|---|
| Age (years) | 0.03 | 0.75 |
| Sex | -0.04 | 0.64 |
| Marital Status | 0.01 | 0.99 |
| Household size (persons) | 0.05 | 0.63 |
| Educational status | 0.39** | 0.00 |
| Farm size (acre) | 0.25** | 0.01 |
| Farming experience (years) | 0.56** | 0.00 |
| Annual income (Naira) | -0.15 | 0.09 |
| Engagement in non-farming activities | 0.09 | 0.28 |
| Membership of farmers group/association | 0.25** | 0.01 |
| Sources of information | 0.199* | 0.03 |

**Significant at 0.01 level
*Significant at 0.05 level

This study therefore recommend that agricultural extension programmes aimed to promote adaptability of farmers against the effects of climate change should consider the socioeconomic factors that support the adoption of the coping strategies (farmers with increased years of schooling, cowpea farm size, years of experience in cowpea farming, years of membership in farmers group, and additional sources of information on cowpea production) in order to achieve high success.

On the problem of inadequate access to extension services and high cost of agrochemicals hindering the use of coping strategies found in this study, agricultural extension organizations in the study area should also intensify efforts to recruit more extension workers. Adequate extension workers will increase their availability and accessibility to farmers, thereby increase more changes for the dissemination of improved coping strategies to mitigate the effects of climate in cowpea farming. Additionally, government at all levels through concern agencies should introduce subsidy on agro-chemicals to increase the adaptive capacity of farmers on climate change effects.

## CONCLUSIONS

Based on major findings, this study concludes that abnormal rise in temperature, irregular and excessive rainfalls possess a threat to cowpea production in the study area. The farmers mainly used soil fertilizer, herbicides and planting of early maturing varieties of crops to cope with the effects of climate change and variability. Socioeconomic factors that positively support the use of coping strategies for climate change effects were farmers' increase in years of schooling, acres of land cultivated for cowpea, years of experience in cowpea farming, years of membership, and additional sources of information of climate change.

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**Compliance with ethical standards.** The conduct of the study follows KWASU research ethics. Ethical approval was obtained by the university ethical committee while informed consent was obtained from farmers involved in the study.

**Data Availability**. Data are available with Latifat Kehinde Olatinwo (Email: latifatolatinwo01@gmail.com) upon request

**Author contribution statement (CRediT). L. K. Olatinwo**: conceptualization, investigation, methodology, validation, project administration, supervision; **S. E. Komolafe**: formal analysis, investigation, methodology, writing – original draft, editing; **M. O. Asifat:** conceptualization, data collection, formal analysis, investigation, methodology, writing – original draft, writing-review.

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