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ANALYSIS OF FACTORS INFLUENCING ADAPTATION MEASURES TO CLIMATE CHANGE EFFECTS AMONG IRISH POTAOES (*solanum tuberosum*) FARMERS IN PLATEAU STATE, NIGERIA

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Abstract

This study analyzed the factors influencing climate change adaptation measures among Irish potato (Solanum tuberosum) farmers in Plateau State, Nigeria. Specifically, it described farmers' socioeconomic characteristics, analysed factors influencing adaptation, and identified constraints limiting the adoption of adaptation measures. A multi-stage sampling technique was used to select 231 respondents from four Local Government Areas, and primary data were collected using structured questionnaires. Descriptive statistics were used to analyse farmers' socioeconomic characteristics, and constraints limiting adaptation measures, while multinomial logistic regression was used to identify factors influencing adaptation. The findings revealed that the mean age of respondents was 39 years, with most of the respondents being male (67%), literate, and (49.5%) having tertiary education. The average farming experience was 17 years, household size was five persons, and (76.9%) of respondents were aware of climate change. The multinomial logit regression results showed that farming season ($\beta = 2.668$, $p < 0.05$), age ($\beta = 1.963$, $p < 0.10$), climate change awareness ($\beta = 6.557$, $p < 0.01$), extension contact ($\beta = 3.352$, $p < 0.01$), and access to credit ($\beta = 2.050$, $p < 0.10$) positively influenced adaptation, whereas farm size ($\beta = -3.030$, $p < 0.05$) had a negative effect. Major constraints included inadequate financial resources, land shortage, limited extension services, high input costs, and inadequate input availability. The study concludes that farming season, age, climate change awareness, extension contact, access to credit and farm size are the major factors influencing adaptation measures to climate change. It recommends that strengthening extension services, improving access to credit, promoting climate change awareness, and enhancing access to affordable agricultural inputs are essential for improving farmers' adaptive capacity.

Keywords:

Farmers, Climate change, Adaptation, constraint, Irish Potatoe

INTRODUCTION

Climate change, a major driver of natural hazards, poses a significant threat to human well-being, environmental sustainability, and economic development worldwide (Intergovernmental Panel on Climate Change (IPCC), 2023). It refers to long-term changes in average weather patterns, including temperature, precipitation, humidity, and wind conditions, resulting from both natural processes and human-induced greenhouse gas emissions (IPCC,

2023). Contemporary evidence indicates that climate change is characterized by rising global temperatures, increased evaporation rates, changing rainfall patterns, and a growing frequency and intensity of extreme weather events such as floods, droughts, and heatwaves (World Meteorological Organization (WMO), 2025). These changes contribute to excessive rainfall, increased surface runoff and flooding, prolonged dry spells, declining water availability, and recurrent droughts, all of which have adverse implications for agricultural productivity, water resources, and livelihoods. Future climate projections suggest that continued greenhouse gas emissions will further intensify changes in the climate system, increasing the occurrence and severity of climate-related hazards and posing substantial challenges to sustainable development and global economies (IPCC, 2023).

The Irish potato (*Solanum tuberosum*) was introduced into Nigeria during the late nineteenth and early twentieth centuries by European settlers, particularly tin miners, who cultivated the crop on the Jos Plateau because of its favorable climatic conditions (Jwanya *et al.* 2014). The establishment of the Irish Potato Programme at Kuru by the National Root Crops Research Institute (NRCRI) in 1976 facilitated the introduction, evaluation, and improvement of potato varieties adapted to the temperate highlands of Nigeria, thereby enhancing potato production in the region (NRCRI, 1976). Today, Irish potato is one of the most important food and cash crops cultivated in the northern and central zones of Plateau State, where it contributes significantly to household income, employment, and food security (National Bureau of Statistics (NBS), 2024).

Agricultural production is inherently dependent on weather and climatic conditions throughout the entire value chain, including land preparation, planting, crop growth, harvesting, storage, transportation, and marketing (Food and Agriculture Organization (FAO), 2024). Consequently, changes in climatic patterns have profound implications for agricultural productivity across Africa, underscoring the need to integrate climate resilience and adaptation strategies into agricultural development and financing initiatives (Ikpe *et al.*, 2023). Although the precise magnitude of future climate change impacts on agrarian infrastructure remains uncertain, growing evidence indicates that climate-related hazards threaten irrigation systems, rural roads, storage facilities, and other agricultural infrastructure essential for sustainable food production (Intergovernmental Panel on Climate Change (IPCC), 2023). These impacts are likely to influence agricultural productivity, disrupt food supply chains, and increase uncertainty regarding the long-term functionality of agrarian infrastructure systems. In Nigeria, where agriculture is predominantly rain-fed, climate variability has intensified challenges to agricultural production through increasing temperatures, erratic rainfall patterns, floods, and droughts, thereby threatening the livelihoods of millions of rural households and national food security (Federal Ministry of Environment (FME), 2021; IPCC, 2023). Consequently, changes in rainfall distribution directly influence the types of crops cultivated across different agroecological zones, with areas receiving higher rainfall supporting water-demanding crops, while drier regions are limited to drought-tolerant crop varieties.

Integrating indigenous knowledge with scientific innovations has been shown to improve the effectiveness, acceptability, and sustainability of climate adaptation interventions. Such integration encourages community participation in climate-related decision-making, promotes locally appropriate adaptation measures, enhances agricultural productivity, and contributes to improved food security and sustainable rural livelihoods. Therefore, strengthening farmers' adaptive capacity through the combined application of indigenous knowledge and scientific research remains essential for reducing the adverse impacts of climate change on agricultural production, particularly among smallholder farming communities in developing countries (FAO, 2016; Dorji *et al*. 2024)

Despite efforts by the Government and the Irish Potato Programme in Kuru, Jos, to improve the farming of Irish potato in Plateau State, the decreasing level of production indicated that there are constraints associated with the small and medium enterprises farmers of Irish potato in the North and Central Zones of Plateau State. Climate change is recognized as a major factor contributing to the low level of Irish potato farming (Bulus and Nimfa, 2017), hence the research gap to be filled regarding the analysis of factors influencing adaptation measures to climate change among Irish potato farmers in Plateau State, Nigeria.

The following objectives guided the study:

i. describe the socioeconomic characteristics of Irish potato farmers in the study area;
ii. analyze factors influencing climate change adaptation measures in the study area;
iii. identify constraints limiting adoption of climate change adaptation measures in the study area.

Materials and Method

The Study Area

The study was carried out in Plateau State, Nigeria, as shown in Figure 2. Plateau State is situated in Nigeria's north-central region and covers approximately 30,913 square kilometres (Ogunmola and Olufayo, 2016). It is characterized by a high altitude averaging 1,200 meters above sea level (Adejuwon *et al*., 2007), located at geographical coordinates of Latitude 8°24′N - 10°24′N and Longitude 8°24′E - 10°30′E (National Population Commission (NPC), (2017), bounded by Bauchi State to the north, Kaduna State to the west, Nasarawa State to the south, and Taraba State to the east. Plateau State has 17 local government areas, with Jos as the state capital (NPC, 2017). The state is known for the production of millet, Irish potato, maize, finger millet and vegetables. The key LGAs for Irish potato farming are Bokkos, Jos South, Barkin Ladi, Riyom, and Mangu. The state experiences mild temperatures ranging from 18°C to 25°C, moderate annual rainfall of between 1,000 and 2,000 mm, and clearly defined wet and dry seasons (Ogunmola and Olufayo, 2016). Its vegetation includes savanna grasslands, Montane forests, and gallery forests along the riverbank (Adejuwon *et al*., 2007)

Sampling Technique

A multistage and proportionate sampling technique were adopted for this study to ensure adequate representation of all towns while maintaining cost-effectiveness and randomization. In the first stage, four local government areas were purposively sampled from the highland and midland agricultural zones of Plateau State with the highest registered population of potato farmers (Jos South 80, Barkin Ladi 150, Mangu 150, and Bokkos 200) (NRCRI, 2018). In the second stage, two (2) wards were randomly selected from each local government area: Jos South (Vwang, Turu), Barkin Ladi (Heipang, Barkin Ladi), Mangu (Kerrang, Panyam), Bokkos (Bokkos, Musherrre), making a total of eight wards. The third stage were random sampling of Irish potato farming households and individuals within the wards, making a total of 231 respondents.

To determine the total sampling size.

Total number of registered farmers N=580

Table 1: Number of registered farmers

Local government areas	Villages	Number of registered potato farmers	Sample
Jos South	Vwang	80	28
	Turu		28
Barkin Ladi	Heipang	150	28
	Barkin ladi		28
Mangu	Kerrang	150	29
	Panyam		29
Bokkos	Bokkos	200	30
	musherre		31
Total		**580**	**231**

Using the formula by $sample\ size = \frac{\frac{z^2 \times \mathcal{P}(1-\mathcal{P})}{\mathcal{E}^2}}{1+\left(\frac{Z^2 \times \mathcal{P}(1-\mathcal{P})}{\mathcal{E}^2 N}\right)}$

Cochran (1977), the formula is a modified version of the Cochran formula for sample size determination, often used in survey research, statistics, and population studies when dealing with finite populations.

N=Population

$\mathcal{E}$= Error margin (0.05 for 5%)

$z =$ Z-score (based on confidence level, 1.96 for 95%)

$\mathcal{P}$= Estimated proportion of an attribute in the population (0.5) for maximum variability

$$sample\ size = \frac{\frac{1.96^2 \times 0.5(1-0.5)}{0.05^2}}{1+\left(\frac{1.96^2 \times 0.5(1-0.5)}{0.05^2 \times 580}\right)}$$

$sample\ size\ = \frac{384.16}{1.66234}$ =231.06

$sample\ size\ $ =231

Therefore, the total sampling size is 231. The total questionnaires administered were 231, and 186 were properly completed and found suitable for analysis, while 45 were excluded due to incomplete responses, and some were not retrieved; therefore, 80.5% were valid

Method of Data Collection

Primary data was used for the study. Primary data were obtained from the farmers through the use of structured questionnaires.

Validity and Reliability of the Research Instrument

The instrument for this study was validated by passing the research instrument through an expert in the Department of Agricultural Economics and Extension Service, Federal University Wukari, to ensure that it possesses both face and content validity.

Data Analysis Techniques

Descriptive statistics such as frequency counts, percentages, mean, and standard deviation, Likert scale were used to analyze objective i (describe the socioeconomic characteristics of Irish potatoes farmers in the study area), objective iii (identify constraints limiting adoption of climate change adaptation measures in the study area) while multinomial logistic regression was used to analyze objective ii (analyze factors influencing climate change adaptation measures in the study area).

Descriptive statistics model (mean)

$$\bar{x}=\frac{\sum_{i-1}^{n} fixi}{\sum_{i=1}^{n} fi}$$

$\bar{x} =$ arithemetic mean of grouped data

$$xi = \text{mid point of the class interval}$$

$$fi = \text{frequency}$$

$$n = \text{total number of class interval}$$

Standard deviation (SD)

$$\mathcal{S} = \sqrt{\frac{\sum_{i=1}^{n}(\chi_i - \bar{\chi})^2}{n-1}}$$

$$\mathcal{S} = sample\ starndard\ deviation$$

$$\chi_i = each\ observtion\ in\ the\ sample$$

$$\bar{\chi} = sample\ mean$$

$$n = number\ of\ observation\ in\ the\ sample$$

Likert scale of a 5-point rating was used in this study to measure the extent of the constraints. The grading was in this order:

Strongly agree =5

Agree (A) =4

Neutral (N) = 3

Disagree (D) =2

Strongly disagree (SD) =1

The values of the Likert scale were added to get 15, which was divided by 5 to get a mean score of 3 (i.e., 5+4+3+2+1=15/5=3) as the cut-off point. The respondents' mean score

was obtained from each response item, such that any score higher than or equal to 3 was categorized as agree, while any score less than 3 was categorized as disagree

The specification of the multinomial logistic regression in its linear form is as follows:

$Y_1 = \beta o+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+\beta_7X_7 + \beta_8X_8 + \beta_9X_9+ \beta_{10}X_{10}$

Y_1 = Dependent variable (Number of adaptation strategies adopted)

β_o is the intercept or constant term

β_1, β_2 …… β_{10} are the coefficients of the predictors

X_1, X_2..... X_{10} are the predictors' variables

The explanatory variables are

X_1 = Farming season, (irrigation=1, otherwise=0)

X_2 = Sex (male=1, female=0)

X_3 = Age (years)

X_4 = Educational level (number of years spent in school)

X_5 = Farming experience (number of years)

X_6 = Household size (total number of household members)

X_7 = Climate change awareness (aware=1, Not aware=0)

X_8 = Farm size (unit in hectares)

X_9 = Contact with extension service (number of contacts)

X_{10} = Access to credit (yes=1, No=2)

u = Error term

RESULTS AND DISCUSSION

Socio-Economic Characteristics of Farmers

The major socio-economic characteristics considered in the study are age, sex, educational experience, farm size, educational level, marital status, household size, access to credit facility, contact with extension agents, and climate change awareness

The distribution of Irish potato farmers by age is presented in Table 2. The mean age of 39 years, with a standard deviation of 12.09, indicates that the average Irish potato farmer in the study area is within the economically active and productive age group, which is important for effective decision-making and the adoption of climate change adaptation measures. This finding agrees with the study of Adamu and Michael (2023), which reported that most Irish potato farmers (67.57%) were within the mean age of 38years and are young and agriculturally productive; they are more willing to adopt adaptation strategies compared to older farmers, thereby enhancing resilience to climate change effects.

The result of sex distribution further shows that (64%) of Irish potato farmers sampled were males, while (36%) were females, indicating that the majority of respondents involved in Irish potato production in Plateau State are men. This implies that male farmers dominate Irish potato farming activities and decision-making processes. The higher participation of males suggests that they are more actively engaged in farm operations that require physical strength and resource control, such as land preparation, irrigation, and investment in improved farming

technologies. This finding is consistent with the study of Adamu and Michael (2023), who reported that (67%) of Irish farmers are male.

The result of farming experience indicates a mean farming experience of 17 years with a standard deviation of 12.64 implies that, on average, Irish potato farmers in Plateau State possess substantial farming experience, suggesting that respondents have accumulated practical knowledge and skills that could influence their ability to perceive climate change effects and adopt appropriate adaptation measures. This finding is similar to the study of Goni, *et al.* (2024), who reported a mean farming experience of 15 years.

The result for the farm size reveals a mean farm size of 2 hectares with a standard deviation of 2.62, indicating that Irish potato farmers in Plateau State operate relatively small-scale farms, suggesting that most respondents are smallholder farmers whose production capacity and adaptation options to climate change may be limited by land size and available resources. This finding aligns with the study of Sani, *et al.* (2015), who reported that the average farm size was 2 hectares.

The findings from the educational level of respondents show that a substantial proportion of Irish potato farmers in Plateau State possess formal education, with tertiary education recording the highest percentage (49.5%), followed by secondary education (29.6%), while primary education accounted for (11.3%) and non-formal education accounted for (9.7%). This implies that most farmers involved in Irish potato production are relatively educated, which is important for understanding climate change information, accessing extension services, and adopting improved adaptation measures to reduce climate-related risks. This finding supports the study of Udoh *et al.* (2025), who reported that (44%) of Irish potato farmers held tertiary education. Education positively influences farmers' adaptation decisions because educated farmers are more likely to understand climate change impacts and adopt suitable adaptation strategies to improve agricultural productivity and resilience.

The research on the marital status distribution indicates that the majority of Irish potato farmers in Plateau State were married (69.9%). This implies that most respondents likely have family responsibilities, which may influence their decisions regarding adaptation measures to climate change effects, as married farmers often seek stable and sustainable farming practices to secure household income and food security. This finding agrees with the study of Kolo and Balare (2018), which reported that the majority (62.22%) of the farmers were married; this is an indication that the majority of farmers are likely to have family responsibilities and commitments, especially regarding household food provision and upkeep, educational and health demands and savings.

The distribution of household size indicates that the mean household size is 5, and the majority of Irish potato farmers in Plateau State had household sizes ranging from 1–5 members (57.5%), followed by (39.8%) with household sizes of 6–10 members, while only (2.7%) had households of 11–15 members. This implies that most farmers operate within moderate household sizes, which can positively influence adaptation to climate change effects through the availability of family labour for farm operations such as land preparation, planting, and implementation of adaptation practices. This finding is consistent with the study of Mugagga *et al.* (2020), who reported that the average household size of Irish potato farmers is 5, and who also noted that household size significantly affects farmers' adaptation choices, as larger households often provide additional labour that enhances the ability of farmers to implement climate change adaptation measures.

The result on access to credit facilities shows that only (15.6%) of Irish potato farmers in Plateau State had access to credit, while a large majority (84.4%) did not. In simple terms, most of the farmers are financing their farming activities on their own, which can make it

difficult for them to adopt costly but effective adaptation measures to climate change, such as irrigation systems, improved seed varieties, or modern farming inputs. This finding is similar to the report of Falola and Achem (2017), who reported that the majority (83%) of Irish potato farmers had no access to credit facilities.

The findings on contact with extension services reveal that only (17.2%) of Irish potato farmers in Plateau State had regular contact with agricultural extension agents, while the vast majority (82.8%) did not. This suggests that most farmers have limited access to expert guidance, information, and training on modern farming practices and climate-smart adaptation strategies. This finding aligns with the study by Sani, *et al.* (2015), who reported that (85%) of the respondents in the study area had no contact with an agricultural extension agent.

The result on climate change awareness, as represented in Table 2, shows that a majority of Irish potato farmers in Plateau State (76.9%) were aware of climate change, while (23.1% were not. This suggests that most farmers have some understanding of climate variability and its potential effects on Irish potato production, which is an important factor influencing their adaptation measures. Awareness of climate change can motivate farmers to adopt strategies such as improved seed varieties, irrigation, crop diversification, and soil conservation practices to mitigate negative impacts. This finding is consistent with Wuyep *et al.* (2019), who reported that the majority of Irish potato farmers (93.3%) are aware of climate change.

Table 2: Socioeconomic characteristics of the respondents (n=186)

Age distribution	**Frequency**	**Percentage (%)**	**Mean (Standard Dev)**
19-28	43	23.1	
29-38	41	22	
39-48	59	31.7	39 (12.09)
49-58	30	16.1	
≥59	13	7	
Total	186	100	
Sex			
Female	67	36	
Male	119	64	
Total	**186**	**100**	
Years of farming			
1-10	73	39.2	
11-20	53	28.5	
21-30	36	19.4	17 (12.64)
31-40	19	10.2	
≥41	5	2.7	
Total	**186**	**100**	
Farm size(ha)			
0.1-1	82	44.1	
1.1-2	42	22.6	
2.1-3	26	14	2 (2.62)
3.1-4	12	6.5	
≥5	24	12.9	
Total	**186**	**100**	
Educational level			
Non-Formal Education	18	9.7	
Primary Education	21	11.3	
Secondary education	55	29.6	
Tertiary education	92	49.5	
Total	**186**	**100**	
Marital status			
Single	43	23.1	
Married	130	69.9	
Divorced	3	1.6	
Widowed	6	3.2	
Separated	4	2.2	
Total	**186**	**100**	

Household Size	**Frequency**	**Percentage (%)**	**Mean (Standard Dev)**
1-5	107	57.5	
6-10	74	39.8	5 (2.41)
11-15	5	2.7	
Total	**186**	**100**	

Credit facility		
Yes	29	15.6
No	157	84.4
Total	**186**	**100**
Contact with extension		
Yes	32	17.2
No	154	82.8
Total	**186**	**100**
Climate change awareness		
Aware	143	76.9
Not aware of climate change	43	23.1
Total	**186**	**100**

Source: Field survey, 2026

Factors Influencing Climate Change Adaptation Measures Among Irish Potato

The results of factors influencing climate change adaptation measures are presented in Table 3. The results indicate that farming season, age, climate change awareness, contact with extension agents, farm size, and access to credit significantly influenced adaptation measures among Irish potato farmers. Specifically, farming season is significant at 5% and has a positive coefficient (2.668, p=0.001), implying that farmers who cultivate with favorable weather condition especially under controlled environment are more likely to adopt climate change adaptation strategies since Irish potatoes is sensitive to both extreme weather condition, more also seasonal planning affects resource allocation and risk management, as this study support the finding of Aroyehun, *et al.* (2024), who observed that seasonal variations in rainfall patterns and climatic conditions influence farmers adaptation decisions as they seek to reduce production risks associated with climate change.

Age is significant at 10% with positive coefficient (1.963, p=0.099) this explains that as age of farmers increases, the likelihood of adopting climate change increases, in other words farmers tend to adopt more adaptation strategies than younger farmers, this may happen because they have more experience, better knowledge of past climate pattern and encountered climate related challenges over time, which helps them develop coping strategies, the result is in line with the finding of Sheikh, *et al.* (2024) who reported that age positively influences farmers adoption of climate change adaptation strategies because older farmers possess greater experience and awareness of climatic risk.

Climate change awareness is significant at 1% and has a positive coefficient (6.557, p=0.009), suggesting that farmers who are aware of the effects of climate change are more capable of implementing strategies like early planting, crop diversification, improved seed varieties, and soil conservation. The studies strongly agree with Ogundele, *et al.* (2024), who found that farmers with greater awareness of climate change were more likely to adopt adaptation measures aimed at reducing climate-related risk.

Contact with an extension agent is significant at 10% and has a positive coefficient (3.352, p=0.009), indicating that farmers who frequently interact with extension agents are more likely to adopt climate change adaptation measures. The study does not support the finding of Goni *et al*. (2024), who reported that access to extension services is not significant and does not influence climate change adaptation measures.

Farm size is significant at the 5% level, and the coefficient is negative (−3.030, p=0.047), implying that farmers with larger farm holdings are less likely to adopt climate

change adaptation strategies. This research is consistent with the findings of Khan, *et al.* (2023), who reported that farm size negatively influences farmers' adoption of some climate change adaptation measures because larger farm sizes require more financial and labour resources to implement such measures.

Access to credit is significant at 10% and has a positive coefficient (2.050, p=0.051), indicating that farmers who access credit facilities are more likely to adopt climate change adaptation measures. Access to credit enables farmers to invest in improved inputs and technologies that enhance their capacity to cope with climate change; the result is consistent with the research conducted by Enimu *et al.* (2022), who reported that access to credit is significant to solving the financial constraint to climate change adaptation measures. Other variables, such as sex, educational level, household size, and farming experience, were not statistically significant, implying that in this context, they do not strongly predict the adoption of adaptation measures.

Table 3: Multinomial Logit Regression Results of Factors Influencing Climate Change Adaptation measures (n=186)

Variables	Coefficient	Std. Error	p-value
Farming season	2.668**	4.27	0.001
Sex	1.916	2.576	0.921
Age	1.963*	1.924	0.099
Educational Level	−9.048	1.07	1.7
Farming Experience	−2.221	3.594	0.199
Household Size	−5.417	9.883	0.499
Climate Change Awareness	6.557***	0.02	0.009
Farm Size	−3.030**	8.675	0.047
Contact With Extension Agent	3.352***	3.33	0.009
Access To Credit	2.050*	4.296	0.051
Constant	−3.145***	5.68	0.009
Observations	**186**		
LR χ^2 ($p < 0.01$)	**432.85**		
Pseudo R^2	**0.435**		

*** = Significant at 1 % level, ** = Significant at 5 % level, * = Significant at 10 % level

Source: Field survey, 2026.

Constraints Limiting the Adoption of Climate Change Adaptation Measures

The findings on limiting factors to climate change adaptation are presented in Table 4. It reveals that inadequate financial resources (4.40) emerged as the most significant barrier, indicating that limited capital strongly restricts farmers' capacity to adopt adaptation strategies and technologies. This agrees with the study conducted by Damla, *et al.* (2023), who reported that (76.5%) are constrained by inadequate financial resources. The second highly ranked limiting factor is a shortage of land (4.26). The finding corroborates the findings of Kuang, *et al*. (2020), who reported a shortage of land as a major constraint to farmers' adaptation strategies to climate change. Inadequate access to extension services is third limiting factor (4.26), the extension agents provide relevant and timely information to farmers to enable them to

understand the adaptation strategies available and make decisions about practicing them, this aligns with the study of Ofuoku and Okompu (2022) who opined (3.65 mean) of those in contacts with extension agents expand their knowledge of modern farming techniques, address their challenges, and improves communication between advisors and research institutions.

High cost of inputs such as improved seeds and fertilisers (4.25); the finding from this research aligns with the research conducted by Nicholas *et al*. (2014), who reported that the high cost of farm inputs emerged as factor 3 of the major constraint limiting adaptation to climate change. Non-availability of farm inputs is (4.20). This disagrees with the finding of Patrick (2020), who reported that only (1.14%) of farmers opined that the non-availability of farm inputs is a constraint limiting the adoption of climate change adaptation measures. The high cost of farm labour is (4.19); this disagrees with the findings of Patrick (2020), who reported that less than (10.97%) of farmers view the high cost of farm labour as a constraint limiting the adoption of climate change adaptation measures. Respondents also agreed that the high cost of irrigation facilities (4.17), which disagrees with the result of Muriithi (2023), who reported that a smaller proportion of farmers (7%) view the high cost of irrigation facilities as a constraint limiting the adoption of climate change adaptation measures.

Lack of access to weather forecasts and weather information is (4.17); the result does not align with the findings of Farauta *et al.* (2020), who reported that the mean of (2.24) farmers lacked access to weather forecasts and weather information, which is a major constraint to climate change adaptation measures. The absence of supportive government policies (4.12) was perceived as a notable institutional barrier. The result agrees with the research by Ricart, *et al*. (2023), who reported that the lack of government support is a major constraint to climate change adaptation measures. Poor access to technology necessary for adaptation is a major constraint (4.11). This result is consistent with the finding of Noelle (2021), who reported that the absence of such technology impedes climate change adaptation measures. Limited access to improved crop varieties emerged with an average of 4.09; the result corroborates the finding of Goni *et al*. (2024), who opined that (73.5%) of farmers are constrained by limited access to improved varieties of Irish potato. The limited presence of adaptation measures is (4.06); the study disagrees with the finding of Farauta *et al*. (2020), who reported that the mean of (2.23) is constrained by the limited presence of adaptation measures. Poor access to adaptation-related information limits their adaptive capacity (4.04). This result is consistent with the finding of Egwuonwu (2024), who reported that the mean is 3.50, indicating that respondents are constrained by inadequate access to information relating to climate change adaptation.

Table 4: Constraints Limiting the Adaptation of Climate Change Adaptation Measures among Respondents

S/No	Limiting factors to climate adaptation	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean/ Std. Deviation	Remark
1	Inadequate financial resources	1(0.5)	3(1.6)	14(7.5)	68(36.6)	100(53.8)	4.4(0.74)	1st
2	Shortage of land	7(3.8)	8(4.3)	22(11.8)	40(21.5)	109(58.6)	4.26(1.07)	2nd
3	Inadequate access to extension services	3(1.6)	4(2.2)	24(12.9)	65(34.9)	90(48.4)	4.26(0.88)	3rd
4	High cost of inputs (improved seed varieties, fertilizers, pesticides)	0(0)	8(4.3)	26(14.0)	63(33.9)	89(47.8)	4.25(0.85)	4th
5	Non-availability of farm inputs (improved seeds, fertilizers, pesticides)	2(1.1)	12(6.5)	19(10.2)	66(35.5)	87(46.8)	4.2(0.94)	5th
6	High cost of farm labour	0(0)	11(5.9)	29(15.6)	58(31.2)	88(47.3)	4.19(0.91)	6th
7	High cost of irrigation facilities	2(1.1)	11(5.9)	22(11.8)	68(36.6)	83(44.6)	4.17(0.93)	7th
8	Lack of access to weather forecasts	3(1.6)	12(6.5)	27(14.5)	52(38.0)	92(49.5)	4.17(1.01)	8th
9	Absence of government policy on adaptation	2(1.1)	17(9.1)	20(10.8)	63(33.9)	84(45.2)	4.12(1)	9th
10	Poor access to the technologies necessary for adaptation	4(2.2)	15(8.1)	18(9.7)	67(36.0)	82(44.1)	4.11(1.02)	10th
11	Limited access to improved crop varieties	6(3.2)	5(2.7)	32(17.2)	66(35.5)	77(41.4)	4.09(0.99)	11th
12	Limited presence of adaptation measures	3(1.6)	13(7.0)	24(12.9)	75(40.3)	71(38.2)	4.06	12th
13	Poor access to information sources relevant to adaptation	0(0)	13(7.0)	33(17.7)	72(38.7)	68(36.6)	4.04	13th

Source: Field survey, 2026 n=186 Mean ≥ 3.0

Conclusion

The study concludes that climate change has become a significant and multidimensional challenge affecting agricultural production and the livelihoods of farming households, as evidenced by respondents. It can be concluded that respondents in the study area are relatively young and physically active; the majority of the respondents were male, the majority are married, majority attained formal education. The multinomial regression analysis provided deeper insights into the factors influencing the adoption of these adaptation measures. Farming season, age, climate change awareness, contact with extension agents, and access to credit are significant with positive coefficients, while farm size is significant and exhibited a negative coefficient. Nevertheless, the study reveals that the overall effectiveness of these adaptation strategies is constrained by critical limiting factors such as inadequate financial resources, high costs and limited availability of farm inputs, poor access to extension and climate information services, limited access to improved technologies and crop varieties, insufficient irrigation infrastructure, and weak policy and institutional support. These constraints reduce farmers' adaptive capacity and increase their vulnerability to climate shocks despite their willingness to adapt. Therefore, achieving sustainable agricultural productivity and resilience in the face of climate change will require integrated interventions that combine financial empowerment, technological innovation, institutional strengthening, policy implementation, and continuous capacity building to support farmers in transitioning toward climate-smart and sustainable agricultural practices.

Recommendation

Based on the results of the study, the following recommendations were made.

1. Government and development agencies such as the Bank of Agriculture and agricultural development programmes (ADPs) should provide affordable credit facilities, subsidies, and climate adaptation grants to enable farmers to adopt improved technologies and adaptation strategies.
2. The government and its agricultural development agencies should strengthen the agricultural extension service by regular training and capacity-building programs to help improve farmers' knowledge of climate-smart agricultural practices and adaptation techniques.
3. Enhance access to climate information and climate-smart agricultural technologies. The National Root Crops Research Institute (NRCRI) and other relevant stakeholders should strengthen the dissemination of climate-smart technologies by improving farmers' access to irrigation facilities, improved potato seed varieties, and soil conservation technologies.
4. Programmes that focus on raising awareness about climate change should be promoted among rural farmers who rely solely on rain-fed agriculture. This will educate farmers on the implications of climate change, the importance of conserving the natural environment, and help in achieving the Millennium Development Goals (MDGs).
5. Policymakers and extension agencies should design targeted support programs for large-scale farmers by improving access to labour, mechanization, extension services, and financial assistance to reduce the constraints associated with implementing adaptation practices on larger farms.

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