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Effects of Climate Change Anomalies on Plantain Production in Akinyele Local Government Area of Oyo State, Nigeria

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Abstract

Plantains have a propensity to retain water, but their production is significantly impacted by climate change. This study examined the effects of climate change anomalies on plantain production in Akinyele Local Government Area of Oyo State, Nigeria. Using a questionnaire survey, a two-stage sampling procedure was used to collect data from 120 plantain farmers. The data were then analysed and presented using frequency, Pearson Product Moment Correlation (PPMC), while multiple linear regression was employed to predict the determinants of farmers' observation of climatic indicators and perception of climate change. The results of the study show that during the previous five years (2019-2023), the respondents experienced a temperature rise ($\bar{x}$=1.79), prolonged drought ($\bar{x}$=1.46) and decreasing rainfall ($\bar{x}$=1.24). As a result, most respondents (84.1%) indicated that the climate was changing. Furthermore, decreased yield ($\bar{x}$=2.68), drooping/wilting ($\bar{x}$=2.45) and lodging and bending ($\bar{x}$=2.40) were the primary effects of climate change on plantain production. Furthermore, planting of heat-resistant and early maturing varieties and, mixed cropping were the common adaptation measures consistently used by the respondents. Statistically, a significant relationship was discovered between average annual income ($r = -0.325$, $p = 0.001$) and farm size ($r = 0.213$, $p = 0.021$) and the possibility of perceiving the consequences of climate change. The strongest predictors of farmers' perception and observation of climate change indicators were education ($t=-1.968$, $p<0.05$) and membership of farmers' associations ($t=-2.647$, $p<0.05$), respectively. The investigation concluded that climate change has a major effect on plantain production in the study area. The study suggested that the use of irrigation to guarantee sustainable plantain production.

Introduction

Climate change manifests as a deviation in the mean values of climate indices over time, which has put agriculture the core of the African economy at risk. It is acknowledged that Africa is one of the regions most affected by climate change (Tajudeen *et al*., 2022). The consequences of these shifts in agriculture are especially evident, for example, in Nigeria, where the majority of rural farmers practice rain-fed agriculture. This suggests that climate change poses one of the highest threats to human survival because, without agriculture, it is practically difficult for man to exist (Azeez *et al*., 2024).

Despite that the plantains can retain water, the impacts of prolonged drought can be extremely detrimental to their production. This is especially true for Musa species. These irregularities, also known as anomalies, can result from both natural occurrences and the inadvertent effects of human activity, such as excessive grazing, bush burning, and other poor

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farming techniques. Over the past few decades, the latter has gained more traction (Azeez *et al*., 2024).

Moreover, it has been found that all crops are susceptible to the effects of climate change at any point in the production cycle, from soil preparation to growth and processing stages to the final consumers. Plantain yield may be significantly reduced by extreme weather conditions such as heat waves, storms, droughts, and flooding (Olotu, 2019). Moreover, wind and/or whirlwinds are other climate change factors that impact plantain crops at any stage of production. Any type of wind has the potential to bend and/or uproot immature plantain crops when the parent plant is frail due to prolong drought, which results in a loss. Excesses in the mean levels of rainfall and temperature are typically what set off climate change.

Furthermore, elevated temperatures can cause tropical crops, such as plantains, to produce less fruit, produce less photosynthesis, and become more vulnerable to pests and illnesses (Skendzic *et al.,* 2021). In Nigeria, plantains are a staple food that is eaten by several. When ripe, they can be boiled, fried, processed into plantain chips, flour, paste, and eaten raw. They also offer income and jobs up their value chain. Their peels and leaves are fed to animals, and can be used as roofing material. Dried and unripe peels can also be used medicinally for other purposes. Adaptation to climate change has been studied by Ogunwale *et al*. (2021) and Olagunju (2022), but scanty investigations have been done, particularly on plantain production in the study area.

There is a paucity of empirical studies on predictors of farmers' observation of climatic variables and perception of climate change. To create policies on the effects of climate change, it is imperative to investigate these effects in light of the consequences for sustainable production of plantain in the study area. To have an improved performances of smallholder farmers' and agricultural extension agents' involvement is vital among other stakeholders (Akinnagbe *et al*., 2024).

Specifically, the objectives of the study were to (i) determine the farmers' observation of climate change indicators; (ii) examine the farmers' perception of climate change; (iii) examine the effects of climate change on plantain production; (iv) determine the adaptation strategies used by the respondents to adapt to climate change, and (v) ascertain the determinants of farmers' observation of climate indicators as well as the determinants of the respondents' perceptions of climate change.

Materials and Methods

The study was conducted in Akinyele Local Government Area of Oyo State. It is located in the south-western geopolitical zone, between latitude 7054' north of the equator and longitude 3054' of the Greenwich meridian (Ogunwale *et al*., 2021). Its land size is 464,892 square kilometres, and it has 12 wards (Ogunwale *et al*., 2021). Rainfall arrives from May to October and amounts to about 1,500 millimetres on average each year.

Sampling procedure

This study quantitatively used a questionnaire survey and employed a two-stage sampling approach to obtain data from the respondents. In the first stage, six political wards in the LGA, where plantains are grown were purposefully chosen. The second stage involved the selection of twenty (20) plantain farmers via snowballing technique, making a total of 120 farmers that were interviewed for the study.

Analytical techniques.

A three-point- Likert-type scale was used to measure the farmers' observation of climate change indicators in the last five years (2019-2023) as increasing (3), decreasing (2), and no change (1). Also, the effects of climate change were measured as major effect (3), minor effect (2) and no effect (1) while adaptation strategies of the farmers were measured as 'always use (3), occasional use (2) and never used (1). In addition, farmers' perception of climate change was measured on a 5-point Likert scale of strongly agree (5), agree (4), undecided (3, disagree (2) and strongly disagree (1). To summarize, present, and accomplish the research objectives, frequency distribution tables, mean scores and percentages were employed. In the same vein, Pearson Product Moment Correlation were utilized to show the strength of the relationship between variables In addition, utilizing the Statistical Package for Social Sciences version 23, a multiple linear regression was employed to ascertain the elements that dictate the respondents' observation of

climate change indicators and perception of climate change as well.

Results and Discussion

Socio-economic characteristics of the farmers

Results in Table 1 indicate that the study sampled 50.8% of male farmers and 49.2% of female farmers. This demonstrates that there is no gender discrimination in the distribution of the respondents engaged in plantain production in the research area, meaning that both sexes are proactively involved in production of plantain in the study area. Results further show that the average age for the respondents was 45 years. This is an indication that the respondents are energetic and subsequently could assist in practising more adaptation strategies to address climate change anomalies. This finding is related to Agyo and Ornan (2021) who observed a mean age of 44 years for their respondents in a study conducted on climate change in Taraba State.

In addition, the majority (61.6%) of the farmers were married while 70% had an average of seven persons per household. This may indicate that family labour is available, which may help reduce the limitations for labour-related adaptability. This study is similar to that of Osuji *et al.* (2025), who reported seven people per household and buttressed that they could assist with farming productivity and employ more ways for adapting to climate change. Furthermore, the majority (98.3%) of the farmers cultivated less than 1.5 hectares of land for plantain. This could imply that the farmers only grow plantains on a limited scale, this might make it easier to recognize the effects of climate change and subsequently lower the projected cost of response. Similar to Adetayo (2022) found that most of his respondents (76.4%) cultivated less than a plot of land, however Orgu *et al.* (2024) noted 1.45 hectares and claimed that people with larger lands would not be able to adapt to their environment.

Furthermore, 85.8% of farmers reported having less than ten years of experience in plantain production. This suggests that the farmers could be familiar with the effects of climate change on plantain for nearly a decade. This result is in agreement with Soom *et al.*, (2024) who reported less than 8years in a study conducted on climate change. In the same vein, Orgu *et al*., (2024) asserted that climate change is yearly periodic decimals and the number of years of farming has helped to lessen its consequences.

Table 1: Socio-economic characteristics of the farmers

Variables	Percentage (%)	Mean ($\bar{x}$)
Sex		
Male	48.2	
Female	50.8	
Age (year)		
20-29	8.3	
30-39	22.5	
40-49	31.7	45years
50-59	23.3	
60-69	29.5	
Marital status		
Single	12.5	
Married	61.7	
Divorced/separated	9.2	
Widow (er)	15.8	
Farm size (ha)		
>1.5	98.3	
<1.5	1.7	
Farming experience (year)		
.>10	85.5	7people
11-20	2.5	
21-30	10.0	
31-40	0.8	
Educational qualification		
No formal	47.5	
Primary education	14.2	
Secondary education	19.2	
ND/ NCE	10.0	
HND/BSC.	9.2	
Household size		
>5	20	
5-8	70	7people
9-12	10	
Average annual income on plantain (₦)		
>50,000	63.3	₦48.100
51,000-100,000	31.7	
Greater than 101,000	5.0	
Membership of farmers' groups	90.0	

Source: Field Survey, 2023

Of the farmers surveyed for this study, about 47.5% of the respondents had no formal education. This could indicate a constraint in implementing adaptation methods requiring technical know-how and technological proficiency. This finding is in tandem with Ifeanyi-Obi (2012) cited in Ogunwale *et al*. (2021) that educated farmers are expected to be more aware of climate change impacts and they can easily adapt. The majority of the farmers (63.3%) in this study earned an average annual income of ₦48,100. This might suggest that the farmers might have limited adaptive capacity because finance is vital for procuring adaptation resources.

Farmers' observation of climate change indicators

Results in Table 2 show that the farmers observed various climate change anomalies such as increasing temperature ($\bar{x}$= 1.79), prolonged drought ($\bar{x}$=1.46) and a decreasing rainfall ($\bar{x}$=1.24). This suggests that throughout the preceding five years, climate change elements are varied. This study is in tandem with Ogunwale *et al.* (2021), Jha and Gupta (2021), Madaki *et al*. (2023), and Orgu *et al*. (2024), their respondents observed longer droughts, more unpredictable and less rainfall, and increased temperatures.

In addition, there was a discernible declined in incidence of floods, heat waves, and hail in the study area. This study is in agreement with Adetayo (2022) who reported changes in climatic variables in Kishi Local Government Area of Oyo State in a study conducted on adaptation to climate change.

Respondents' perception of climate change

Results in Table 3 show that the mean scores of the respondents' perception of climate change range from ($\bar{\mathbf{x}}$) =3.15 to 4.27. The higher the mean scores of farmers' perceptions, the higher the proportion of their responses. Most (84.1%) of the farmers perceived that the climate is changing ($\bar{\mathbf{x}}$= 4.27). This shows that the respondents were aware of climate change. This finding is in tandem with Okuwa (2020), Jha and Gupta (2021), and Azeez *et al*. (2024) that 96.6%, 91%, and 70.1% of their respondents respectively perceived climate change. Also, the respondents perceived that there was decrease occurrence of heavy rainfall ($\bar{x}$=4.08), unpredictable frequency of rainfall (($\bar{x}$= 3.99), there is a shift in raining season months ($\bar{x}$=3.94), rainfall arrives later than it used to be ($\bar{x}$=3.93) thereby causing change in the agricultural calendar ($\bar{\mathbf{x}}$=3.85). In addition, out of the fifteen perceptual statements, the majority of respondents agreed with eleven statements. Given that positive perception is a requirement for adaptation, this may suggest that having a positive perception is vital for taking decisions on how to adjust to climate change anomalies.

Table 2: Respondents' observation of climate change variables

Variables	Increasing frequency (%)	Decreasing frequency (%)	No change frequency (%)	Mean ($\bar{x}$)
Temperature	84.2	10.8	5.0	1.79
Drought	50.0	46.7	3.3	1.46
Rainfall	36.7	50.8	12.5	1.24
Heat waves	33.3	45.8	20.8	1.12
Storm	25.8	55.0	19.2	1.06
Flood	20.0	65.8	4.2	1.05
Hail	20.8	56.7	22.5	0.98

Source: Field Survey, 2023

Table 3: Respondents' perception of climate change

Perceptual statements	Strongly Agree F (%)	Agree F (%)	Undecided F (%)	Disagree F (%)	Strongly disagree F (%)	Mean ($\bar{x}$)
I perceived that the climate is changing	52(43.3)	49(40.8)	19(15.8)	0(0)	0(0)	4.27
There is a decrease occurrence of heavy rainfall	44(36.7)	49(40.8)	20(16.7)	7(5.8)	0(0)	4.08
Unpredictable frequency of rainfall	34(28.3)	58(48.3)	21(17.5)	7(5.8)	0(0)	3.99
There is a shift in raining season months	30(25.0)	70(58.3)	5(4.2)	13(10.8)	2(1.7)	3.94
Rainfall arrives later than it used to be	46(38.3)	42(35.0)	14(11.7)	14(11.7)	4(3.3)	3.93
There is a change in the agricultural calendar	32(26.7)	47(39.2)	37(30.8)	0(0)	4(3.3)	3.85
There has been a decrease in the volume of rainfall in the last five years	35(29.2)	39(32.5)	33(27.5)	10(8.3)	3(2.5)	3.77
Increasing temperature results in heat stress	29(24.2)	57(47.5)	15(12.5)	15(12.5)	4(3.3)	3.76
Rainfall season is not predictable for farming	34(28.3)	40(33.3)	26(21.7)	12(10.0)	8(6.7)	3.66
There is a seasonal incidence of flood	25(20.8)	43(35.8)	23(19.2)	24(20.0)	5(4.2)	3.49
The duration of rainfall is shorter	38(31.7)	39(32.5)	7(5.8)	16(13.3)	20(16.7)	3.49
Rainfall is not timely	23(19.2)	47(39.8)	26(21.7)	13(10.8)	11(9.2)	3.49
The volume of rainfall is decreasing	22(18.3)	41(34.2)	20(16.7)	24(20.0)	13(0.8)	3.29
Floods are more severe than in the past	15(12.5)	40(33.3)	29(24.2)	24(20.0)	12(10.0)	3.18
Decreased duration of drought	14(11.7)	37(30.8)	34(28.3)	23(19.2)	12(10.0)	3.15

Source: Field Survey, 2023

Effects of climate change on plantain production

Table 4 results indicate that decreased yield (x̄ = 2.68), lodging and bending (x̄ = 2.45), drooping/ wilting (x̄ = 2.40), plantain waste due to early bent or fall (x̄ = 2.39) and darkening of plantain fruits (x̄ = 2.36) were the effects of climatic change on plantain production in the study area. These findings show that the majority (70%) of the respondents experienced reduced yield as the major effect of climate change on plantain. This suggests that plantain production is susceptible to climate change anomalies. This study supports the findings of Olotu *et al.* (2019), Azeez and Oyekanmi (2021), Ogunwale *et al.* (2021), Olagunju (2022), and Orgu *et al*. (2024) that decrease in crop output occurred due to climate change.

Table 4: Effects of climate change on plantain production

Variables	Major effect F (%)	Minor effect F (%)	No effect F (%)	Mean (x̄)
Reduced yield	84(70.0)	34(28.3)	2(1.7)	2.68
Lodging and bending	54(45.0)	60(50.0)	12(5.0)	2.45
Drooping/wilting	54(45.0)	60(50.0)	6(5.0)	2.40
Darkening of plantain fruits	59(49.2)	49(40.8)	12(10.0)	2.39
Plantain waste due to early bent/fall	50(41.7)	63(52.5)	7(5.8)	2.36

Source: Field Survey, 2023

Adaptation strategies

Results in Table 5 indicate that the respondents employed various adaptation methods of climate change, the most adopted strategies were planting of heat-resistant varieties (x̄ = 2.64), early maturing varieties (x̄ = 2.51), and mixed cropping (x̄ = 2.48).

Table 5: Adaptation strategies

Adaptation strategies	Always use F (%)	Occasionally use F (%)	Never used F (%)	Mean (x̄)
Planting of heat-tolerant varieties	79(65.8)	39(32.5)	2(1.7)	2.64
Planting of early maturing plantain species	64(53.3)	54(45.0)	2(1.7)	2.51
Mixed cropping	60(50.0)	58(48.3)	2(1.7)	2.48
Intercropping	61(50.8)	50(41.7)	9(7.5)	2.43
Membership in self-help groups for financial assistance	46(38.3)	61(50.8)	13(10.8)	2.27
Changing of livelihood	36(30.0)	74(61.7)	10(8.3)	2.21

Source: Field Survey, 2023, Discriminating mean value=2.00

This confirms that the respondents are adapting to climate change anomalies. This study supports the findings of Olapade-Ogunwole *et al*. (2019), which showed that most respondents (63.8%) used drought-resistant cultivars as a means of adapting to climate change. Also, Osuji *et al*., (2025), reported that planting of early maturing varieties was among the majorly used adaptation strategies of their respondents. But switching to another source of income ($\bar{x}$=2.21) was the least successful tactic used among these farmers. This shows that the respondents would scarcely alter their livelihood even in the event of climate change. This result is inconsistent with Orgu *et al* (2024) that 99.17% of their respondents opted for diversification of livelihood. This might be explained by the respondents' desire to guarantee plantain production in the research area in a sustainable way.

Relationship between farmers' socioeconomic characteristics, observation of climate change indicators, and their perceive effects of climate change on plantain production

Table 6 reveals that there was no significant relationship ($p > 0.05$) between perceived effects of climate change and respondents' age ($r = 0.076$, $p = 0.41$), year of farming experience ($r = 0.077$, $p = 0.41$), household size ($r=0.024$, $p = 0.80$). This suggests that as farming experience, age and household size increase, likelihood of farmers to perceive the effects of climate change anomalies may potentially lessen. In addition, older farmers may possess the ability to perceive the consequences of climate change and quickly adopt appropriate mitigation measures. Moreover, having a larger family size may facilitate the possibility of perception of the effects of climate change.

However, a statistically significant relationship was discovered between average annual income ($r = -0.325$, $p = 0.001$) and farm size ($r = 0.213$, $p = 0.021$) and the possibility of perceiving the consequences of climate change. However, the strength of the relationships was weak (Evans, 1996). This shows that when farm size and income decrease, the respondents are able to perceive the effects of climate change easier and take prompt adaptation response. This is precise because increased financial standing and land are vital resources to improve farmers' adaptive capacity. The findings of the study support those of Azeez and Oyekanmi (2021), who revealed a substantial association between farm size and the effects of climate change. Additionally, Jha and Gupta (2021) corroborated the idea that farm size is frequently regarded as a measure of wealth and can influence adaptation decisions in both positive and negative ways.

Table 6: Test of the relationship between farmers' socio-economic characteristics and their perceived effects on plantain production

Variables	r- value	p- value
Age	0.076	0.413
Farm size	0.213	0.021*
Farming experience	0.077	0.413
Household size	0.024	0.800
Average income	0.325	0.001*

Source: Field Survey, 2023

Determinants of farmers' observation and perception of climate change

A multiple linear regression analysis was carried out to determine the factors that influence farmers' perception and observations of climate change indicators. The results are presented in Table 7, along with values for the constant and adjusted R^2 values, t-statistical value, and standardized regression coefficient.

The coefficients of determination of observation of climate change indicators for the farmers were adjusted R^2 of 0.149 and R^2 value of 0.241. Together, these factors accounted for 24.1% of the variation in the respondents' observations of indicators of climate change. Two (2) independent variables were found to have statistically significant beta coefficients (membership of farmers' group = -3.364, t= -2.647*, $p<0.01$) and farm size = 5.388, t= 2.561*, $p<0.01$).

The results show that membership of farmers' associations and the size of the farm were the main factors influencing the respondents' observation of climate change indicators. The study also showed that membership of farmers' associations was the best predictor of observing climate change indicators. This implies that belonging to a farmers' association provides the opportunity to become more informed

about indicators of climate change, probably as a result of their contacts with one another. This implies that these variables might have a positive influence on the likelihood that the respondents will keenly observe the climate elements.

Similarly, the coefficients of determination for the farmers were adjusted R^2 of 0.149 and R^2 of 23.5% for the perception of climate change. Collectively, these factors accounted for 24.3% of the variation in farmers' perceptions of climate change. Findings in Table 8 demonstrated that both of the independent variables (household size = --0.7770, t = -2.050*, p<0.01) and education = -0.999, t = 1.968*, p<0.01) had statistically significant beta coefficient values. They thus serve as the primary indicators of respondents' perceptions of climate change. A greater observation of climate change is therefore more likely when members in households discuss climate change issues while improved education levels are taken into account. This finding is consistent with the finding of Tuitjer and Dirksmeier (2021) that education was one of the best indicators of climate change consciousness.

Table 7: Determinants of farmers' observation of climate change indicators and perception of climate change.

	Observation		**Perception**	
Determinants	**β-value**	**t-value**	**β-value**	**t-value**
Age	0.013	0.288	0.186	1.803
Sex	0.520	0.103	-0.227	-0.169
Marital status	0.482	1.192	-0.032	-0.035
Farm size	5.388	2.561*	2.530	0.533
Farming experience	-0.059	-1.198	0.133	0.324
Education	-0.465	-2.089	-0.999	-1.968*
Household size	-0.044	-0.263	-0.777	-2.050*
Membership of farmers' association	-3.364	-2.647*	0.805	0.282
R	0.491		0.484	
R^2	0. 241		0.235	
Adjusted R^2	0.149		0.140	
F change	2.626		2.479	
Standard error	2.446		5.498	
Significance	0.01		0.09	

P>0.05

Conclusions

A crop that is particularly vulnerable to the effects of climate change is plantain. According to the study, in the last five years (2019-2024). There has been an increase in temperature and drop in rainfall. This suggests that there are variations in these climate elements. The respondents also expressed keen views regarding climate change. In light of the possibility that farmers are aware of climate change, this might enhance their ability to implement more adaptation strategies. In addition, the study shows that reduced yield was the principal consequence of climate change on plantain production. This may suggest that plantain production is vulnerable to climate change like any other crop and raises the likelihood of a shortage in plantain production in the study area.

Furthermore, the survey revealed that the respondents' primary methods of adaptation were planting of heat-resistant varieties, early maturing varieties and mixed cropping. This is an indication that despite that the respondents are using various adaptation measure, they still experienced a reduced yield. In addition, mixed cropping provides alternative crop (s) and make farmers less affected by climate change, early maturing varieties mature timely, allowing farmers to harvest their plants earlier while

heat resistant varieties are less affected by severe drought. The policy implications include the possibility for the government to subsidize better plantain suckers that can withstand prolonged drought as well as irrigation facilities that would help farmers deal with severe droughts.

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