Effects of Climate Change and the Coping Strategies of Smallholding Cocoyam Farmers in Southwest Nigeria

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ABSTRACT

Nigeria is known as the world largest producer of Cocoyam with annual production of 5.49 million metric tons and it is planted in the South and middle belt zones of the country that are vulnerable to change in climate conditions. This study examined the socio-economic characteristics of Cocoyam farmers, profiling the coping strategies and the effects of climate change on the production of Cocoyam. Descriptive statistics was used to capture the socio economics characteristics and in profiling the coping strategies while regression analysis was used to capture the effects of climate change. Data was collected purposively with the use of a well-structured questionnaire with 120 respondents. The results showed that majority of the respondents fell within the active age of 31- 40 and 41-50 with both groups having 35.8%. most of the respondents are male with 60.0%, it was observed that almost all the respondents were educated with 40.8% having tertiary education. The result showed that total rainfall (-0.6039546), extent of pest and diseases (-0.401585) had negative significant influence on cocoyam production; however, average daily temperature (0.2097042), days of drought (0.3641327), change in rainfall pattern (0.0077075) had significant positive influence on cocoyam production. The result also showed that cocoyam farming is a lucrative business if properly managed and there has been increases in the production of cocoyam due to the increase in the prices of cocoyam leading to high profits for farmers.

Keywords: Climate, Profiling, Socioeconomic, Drought, Cocoyam

INTRODUCTION

Climate change is a subject that has attracted considerable attention in recent years due to its deleterious effects on ecosystem. Until recently, the effects of man's activities on climate variations were perceived as negligible and so climate change was generally taken for granted. However, it is palpably established that climate change is no longer a trivial issue; it is a reality that is seriously affecting the earth already, especially challenging agricultural productivity and food security in both developed and developing economies of the world and thus requires urgent attention. Although, the impacts of climate change on agricultural productivity may be positive or negative; however, empirical studies show that the latter outweighs the former. Climate change threatens food production and derails progress in poverty reduction in Nigeria [United Nations Environmental Programme (UNEP), 2014]. Climate change is presenting more risks than ever before in terms of bod shortage, water crises, constrained economic growth, weather societal cohesion and increased security risk (Reyes, 2016). In recent times, various countries have been threatened by changes in climatic conditions ranging from draught, delayed rainfall, continuous melting of the polar region causing severe flood in some countries and speculation about the acid rain.

The agricultural sector in Nigeria has witnessed many uncertainties in production as result of increasing climatic aberration (UNFCCC, 2007) for instance few years ago, certain areas in Nigeria witnessed different magnitudes of flooding which resulted in lots of loss in crops and livestock and thereby affecting food production and availability (Agbonkhese, 2014). Also, the devastating effects of series of bush burning are seen in the destruction of the environmental green cover, crops and biodiversity. To a great extent, dry season farming has been named into a very risky venture and this contributes to occasional scarcity of vegetables in Ekiti State there is also the increasing risk of environmental hazards such as heat stress, flooding, etc. in this regard, there is need for considerable attention to be given to climate change risks in order to provide economic support to farmers stabilize farm income, encourage farmers to invest more in agriculture and reduce in agriculture and reduce indebtedness.

Cocoyam(Colocasia esculenta"taro"and Xanthosoma sagittifolium"tannia") belong to the Araceae family, an important staple food in the plant family, growing South Eastern and South Western part of Nigeria (Chukwu *et al*., 2009). Cocoyam ranks third in importance after cassava and yam among the root and tuber crops cultivated and consumed in Nigeria. Cocoyam is a useful over crop and the corms are ready to harvesting to 12months .It is one of the major five tuber crops produced in Nigeria for local consumption alongside yam (Discoreaspp), Cassava (Manihotesculenta), Irish-potato(Solanumtuberosus) and Sweet-potato (Ipomeabatata) and specifically referred to as Nigeria's giant crop because it is nutritionally superior too the roots and tuber crops in Nigeria(Agbelemoge,2013).

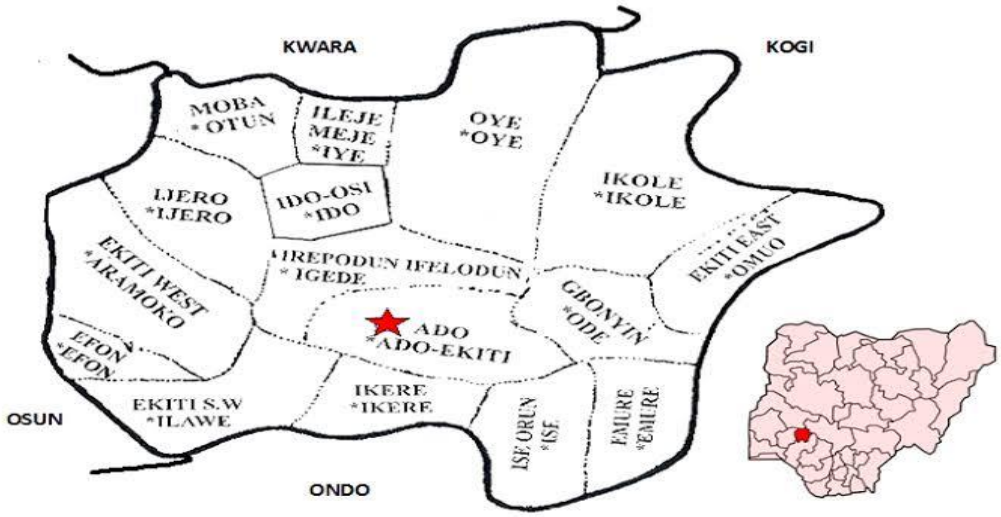
Nigeria is the largest producer of cocoyam in the world with an annual production of 5.49million metric ones equivalent to 45.9% of the world's production and 72.2% of West Africa's total output. Relative to cassava and yam, cocoyam contains higher contents of protein, phosphorous, vitamins and easily digestible starch while the root is rich in carbohydrates and minerals (Ezedinma *et al*.,2014). It can be consumed in various forms when boiled, fried, pounded, roasted and can be processed into cocoyam flour and chips(Ume *et al*.,2016).The leaves are used as vegetables in form of spinach for soup preparation in various parts of the world(Ukonze,2013). It is highly medicinal for diabetic patients, persons with intestinal disorders, the aged, and recommended for children with allergy (Ume *et al*.,2018). Despite the nutritional importance of cocoyam, their advantage over other tuber crops, its potentials for poverty alleviation and food security abilities, its grow this often threatened with drought, excessive rainfall,and pest and diseases infestation, increased temperature occasioned by climate change resulting to poor yield of cocoyam. Hence, there is a need to examine the analysis of the effect of climate change on cocoyam production in Ekiti region of Nigeria.

MATERIALS AND METHODS

Study Area

The study was conducted in Ekiti state State, Nigeria; Ekiti state is located between latitudes 7º25' and 80º 5' East of Greenwich Meridian and between longitude 4º 45' and 46º 5' North of the Equator. The state is bounded to the North by Kwara and Kogi states while it is bounded by Osun state to the West, Edo to the East, and Ondo to the South. Ekiti state is a landlocked state, having no coastal boundary. The Ekiti people are culturally homogenous and speak a dialect of the Yoruba language known as Ekiti. In terms of arts and culture, Ekiti State is among the richest in the federation in the variety and quality of its tradition, arts, music and poetry. The Ekiti people are good wood carvers, blacksmith, and ornamental potters, mat weavers and basket makers. The main occupation of Ekiti people is farming. Hence, the State is agrarian in nature and therefore has many rural settlements. The state enjoys a tropical climate with two distinct seasons: rainy season (April to October) and dry season (November to March). The temperature ranges from 21°C to 28°C, with high humidity. The population of the inhabitants of the state, according to a 2006 population census, was 2,737,186 (NPC, 2006). Their major agricultural produce includes cocoa, kolanut, orange (and other citrus), oil palm, maize, rice, cassava, yam, cocoyam, sweet potato and melon.

Fig .1 Map of Ekiti State.



Source: researchgate.net

Sampling Procedure and Sample Size

Multistage sampling procedure was employed. In the first stage, two local Government Areas (LGAs) were purposively selected out of the sixteen (16) Local Government Areas in Ekiti state being the highest producers of Cocoyam in the State, these are; Ikole, and Oye LGA. In the second stage, three communities were randomly selected from each LGA using simple random sampling technique. In the third stage, 20 farmers were selected from each community using simple random sampling and thus, making a total of 120 cocoyam farmers from the two LGAs.

The Table 1 below Shows a Summary of Sampling Procedures and Sample Size for the Study

Local Government	**Communities**	**Respondent**
Oye local government	Ilupeju	20
	Itapa	20
	Ayegbaju	20
Ikole local government	Isaba	20
	Ijesa- isu	20
	Odo oro	20
Total	6	120

Sources: field, 2024

Data collection and type of data

Primary data were sourced from cocoyam farmers for the study between April 2024 to Novembre 2024 in the selected communities. The primary data were elicited with the use of structured questionnaires from the community head that consulted with the farming household on the need to cooperate with the team and give us all the necessary information on the coping strategies on climate change and challenges faced when using these

strategies. Data were also collected on the socioeconomic characteristics of the farmers, such as the sex,age,and educational level of cocoyam farmers.

The analytical tools used in this study area were Descriptive analysis and Regression analysis. Descriptive statistics were used to analyse the socioeconomic characteristics of the Cocoyam farmers.

While regression analysis was used to capture the effect of climate change on cocoyam production in the study area.

Analytical techniques

Data collected were subjected to different statistical techniques.

1. These include the descriptive statistics such as frequency distribution, percentages and mean

2. Multiple Linear Regression was used to analyse the model specifying the relationship between a continuous dependent variable and one or more independent variables. To find the effect of climate change on cocoyam production in a study area, a Multiple Linear Regression model was formulated as follows:

The Multiple Linear Regression model can be expressed as:

$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + ... + \beta_n X_n + \varepsilon$

Where:

Y is the cocoyam production

B_0 is the intercept (the value of Y when all X's are zero)

B_1, β_2, β_3, ..., β_n are the coefficients associated with each independent variable, representing the change in Y for a unit change in the corresponding X, holding all other variables constant

X_1, X_2, X_3, ..., X_N are the independent variables (climate factors and other relevant factors)

ε is the error term

X_1: Average daily temperature

X_2: Total rainfall

X_3: Days of drought

X_4: Extreme weather events

X_5: Extent pest and diseases

X_6: Increasing temperature negatively

X_7: Change in rainfall pattern

RESULTS AND DISCUSSION

Socio-economic Characteristics of Cocoyam farmers in Ekiti State

Socio-economic characteristics of respondents in the study area who were cocoyam farmer were collected through the use of structured questionnaires

Table3. 1**:** Distribution of Respondents According to Age

Age	Frequency	Percentage
21-30	13	10.8
31-40	43	35.8
41-50	43	35.8
>50	21	17.5
Total	120	100
Mean	42.9	
Standard deviation	10.01	

Source: *Field Survey*, 2024

The result of analysis in table 1 shows the age distribution of the respondents that majority of the respondents representing (35.8%) were within the ages of 31 – 40 and 41 - 50 years (35.8%). However, (17.5%) were above 50 years,(10.8%) were within 21 – 30 years. This is an indication that the respondent was composed of youth who were energetic and adult who were full of experiences from their lifetime of farming practices.

Table 3: 2 Distribution of Respondents According to Sex

Sex	Frequency	Percentage
Male	72	60
Female	48	40
Total	120	100

Source: *Field Survey*, 2024

Table 2 below revealed that (60.0%) of the respondent were male, while (40.0%) were female. This shows that the number of males was fairly greater than the number of females. This is an indication that farming is male dominated in the study area

Table 3.3: Distribution of Respondents According to Marital Status

Marital Status	Frequency	Percentage
Single	18	15
Married	85	70.8
Divorced	9	7.5
Widowed	8	6.7
Total	120	100

Source: *Field Survey*, 2024

Table 3 further shows the marital status which reveals that the majority (70.8%) of respondents are married followed by single individuals (15.0%), divorced (7.5%), and widowed (6.7%). This implies that married people are highly involved in cocoyam farming and it agrees with the notion that farming is a family business conducted by farm families with both spouses making means to cut labour expense

Table 3.4: Distribution of Respondents According to Family size

Family size	Frequency	Percentage
1-3	25	20.8
4-5	63	52.5
6-8	29	24.2
9 and above	3	2.5
Total	120	100

Source: *Field Survey*, 2024

Table 4, reveals that the majority (52.5%) of respondents belong to households with 4-5 members, followed by households with 6-8 members (24.2%), followed by household with 1- 3 members (20.8%), followed by household of 9 and above members 3(2.5%)

Table 3.5: Distribution of Respondents According to Income

Income	Frequency	Percentage
50,000-59,000	24	20
60,000-69,000	14	11.7
70,000-79,000	15	12.5
80,000-89,000	24	20
90,000 and above	43	35.8
Total	120	100

Source: *Field Survey*, 2024

Table 5 further shows that majority (35.8%) of the respondents earn the sum of #90,000 and above, followed by #80,000-#89,000 (20%) and #50,000-#59,000 (20%), followed by #70,000-#79,000 (12.5%), #60,000-#69,000 (11.7%). The mean income is #700,000 with a standard deviation of 1.552445. This implies that an average respondent received an estimate of #58000 every month which also influences their involvement in cooperative. The findings of this result agree with Ekwere and Gabriel (2019) who reported that the average farmer in cooperatives received a monthly income of 40000 and above during their research on Effect of membership on income of members of farmers multipurpose cooperative societies in Anambra state, Nigeria.

Table 3.6: Distribution of Respondents According to Educational Qualification

Education qualification	Frequency	Percentage
No primary education	3	2.5
Primary education	9	7.5
Secondary education	59	49.2
Tertiary education	49	40.8
Total	120	100

Source: *Field Survey*, 2024

As regard the educational qualification of the respondents, the table 7 below shows that 49.2% attained secondary education, followed by tertiary institution (40.8%), primary education (7.5%), no primary education (14.2%), This shows that majority of the respondent were SSCE and B.Sc. holders who had a fair knowledge of agriculture and could read and write, which means that they will be receptive to an innovation and any new technology that can help them be more productive in their farms. These findings is in conformity with Onya *et al.,* (2019) on the Farm-level determinants of access to land by arable crop farmers in Abia State, who found out that majority of the arable crop farmers could read and write.

Table3.7 : Distribution of Respondents According to Educational Qualification

Occupation	Frequency	Percentage
Trading	34	28.3
Farming	49	40.8
Civil/public servant	20	16.7
Artisan	17	14.2
Total	120	100

Source: *Field Survey*, 2024

Table 7,shows that 40.8% of the respondent involved in farming, followed by trading (28.3%), followed by civil servant (16.7%) and Artisan (14.2%). This shows that there are a lot of farmers in the study area.

Table3.9: Distribution of Respondents According to member of cooperative

Member of cooperative	Frequency	Percentage
Yes	76	63.3
No	44	36.7
Total	120	100

Source: *Field Survey*, 2024

The result shown in Table 10, reveals that 63.3% of the respondents belong to cooperative association while 36.7% does not belong to any belong cooperative association in the study area.

Table 11: Distribution of respondents on Years of Experience

Years of Experience	Frequency	Percentage
Below 5	43	35.8
6-10	50	41.7
11-15	21	17.5
16 and above	6	5.0
Total	120	100
Mean	8.0083	
Standard deviation	3.48465	

Source: *Field Survey*, 2024

As regards the years of farming experiences of the respondents, the table below shows that majority of the Respondent (41.7%) had 6-10 farming experience, whereas (35.8%) had below 5 years farming experiences, while (17.5%) had about 11 – 15 years farming experience, and (5.0%) had 16 and above of farming experience.

Table 12: The regression result of the effects of climate change on cocoyam output

S/N	Variables	Coefficient	St. Error	P > |t|
1	Average daily temperature	0.2097042	0.2206239	0.344**
2	Total rainfall	-0.6039546	0.1831422	0.001**
3	Days of drought	0.3641327	0.1338697	0.008**
4	Experience any extreme weather	0.1905035	0.1176778	0.108
5	Increasing temperature negatively	0.293754	0.0346479	0.398*
6	Change rainfall pattern	0.0077075	0.1560206	0.961
7	Extent pest and diseases Observation 120	-0.401585	0.1904026	0.037**
	R^2	0.2819		
	Adj. R^2	0.2160		

Source: Field Survey, 2024 *, **, and *** represents 10%,5% and 1% Significant levels respectively.

The regression result of the effects of climate change on cocoyam output is presented in Table 16. Factors such as average daily temperature, total rainfall, extent of pest and diseases, Days of drought, experience any extreme weather (heat waves, flood), increasing temperature negatively and changing rainfall pattern were regressed against the cocoyam output.

As indicated in the result, the coefficient of average daily of temperature is 0.2097042 ($p < 0.05$) which indicated that it has positive effect on cocoyam output at 5% level of significance. The result is in line with apriority expectation and implies that optimal temperature is a good requirement which promote better starch accumulation, resulting in higher quality tubers.

The coefficient of total rainfall is -0.6039546 ($p<0.05$) which indicates that total rainfall has negative significant effect on the cocoyam output at 5% level of significance. It implies that the inconsistency in rainfall could jeopardize the increased yield of cocoyam as the crop require certain amount of water (rainfall) for transpiration of soil nutrients to the needed parts especially at critical stages such as flowering and corm production. This agrees with the findings of Molua and Lambi (2007) which stated that sufficient and irregularity of rainfall could affect yields adversely especially its failure to arrive during the crucial growing stage of the crops.

The coefficient of days of drought was 0.3641327 ($p<0.05$) which indicated that it had positive significant effect on the cocoyam output at 5% level of significance. This implies that often occurrence of drought as a result of low rainfall reduces the incidence of pest and disease that thrive in moist environment.

The coefficient of extent of pest and disease was -0.401585 ($p<0.05$) which shows that it had negative significance effect on cocoyam output at 5% level of significance. The result is in line with apriority expectation and implies that pest and diseases can damage cocoyam tubers, leading to reduced yields and lower harvest quality.

The coefficient of increasing weather negatively was 0.293754 ($p<0.05$) which shows that it had positive significance effect on cocoyam output at 5% level of significance. The result suggests that increasing temperature is associated with an increase in the dependent variable.

The coefficient of experience any extreme weather was 0.1905035 ($p<0.05$) which shows that it had positive significance effect on cocoyam output at 5% level of significance. The result suggests that experiencing extreme weather correlates with an increase in the dependent variable.

The coefficient of change in rainfall pattern was 0.0077075 ($p<0.05$) which shows that it had positive significance effect on cocoyam output at 5% level of significance. This agrees with the findings of Chiedoz (2016) which implies that increased rainfall can provide adequate water for cocoyam growth, leading to higher yields.

The coefficient of multiple determination (R^2) was 0.2819 and it showed that the explanatory variables included in the model explained 28.19% of the variation in the cocoyam output.

Table 12 highlights the significant impact of certain climate-related factors on dependent variable. Noted, total rainfall and days of drought have strong, significant effects. Total rainfall shows a negative impact, while days of drought have positive impact, both at high significant levels (p-values of 0.001 and 0.008, respectively).

The extent of pest and diseases also significantly affects the dependent variable, with a negative coefficient, suggesting that higher pest and disease incidence decrease the dependent variable

Other variables, such as average daily temperature, experiencing extreme weather and changes in rainfall patterns do not statistically significant impacts within this model, as indicated by their higher p-values. This suggest that their effect are less direct than those of total rainfall and drought days.

Adaptation measures used by cocoyam farmers to cope with climate change in the study area.

Table 13 presents the percentage distribution of adaptation measures used by famers, indicating the frequency and percentage of those who implement each strategy. Notably, Mulching techniques are most widely adopted (92.50%), followed by minimum tillage practices and planting dates of cocoyam(both at 86.67%), monitoring weather forecasts(80.83%) and cultivating other crops(85.0%) also rank highly. Conversely, the least adopted strategies include planting trees (38.33%) and practicing mixed cropping (61.67%). These findings align with previous research emphasizing the importance of diverse adaptation strategies to mitigate impact on agriculture (FAO, 2016; IPCC, 2014).

Table 13: percentage distribution of adaptation measures used by farmers

S/n	Adaptation Strategies	Yes		No	
		Frequency	Percentage	Frequency	Percentage
1	Implement Irrigation System	57	47.50	63	52.50
2	Practice Mixed cropping	74	61.67	46	38.33
3	Planting variety of cocoyam	66	55.00	54	45.00
4	Cultivate other crop	102	85.00	18	15.00
5	Monitor weather forecast	97	80.83	23	19.17
6	Minimum tillage practices	104	86.67	16	13.33
7	Planting dates of cocoyam	104	86.67	16	13.33
8	Mulching Techniques	111	92.50	9	7.50
9	Chemical input	85	70.83	35	29.17
10	Planted trees	46	38.33	74	61.67

Source: Field Survey, 2024

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CONCULSION

The study indicated that most of the farmers are youth who were energetic and adult who were full of experiences from their lifetime of farming practices, averagely educated, and are aware of the existence of climate change whose variables affected their cocoyam production in the study area. Specifically, the study concluded that such climatic change variables total rainfall, pest and diseases, and drought had negative effects on cocoyam production and hence its output. To mitigate this situation, the farmers use mulching techniques. Conclusively, the trend in cocoyam production though on the increase was not enough to meet the demand by the consuming populace as evidenced in the price per kilogram of cocoyam. There is therefore the need to improve on farmer's enlightenment of climate change variables towards helping the farmers further improve their output and hence reduce the price sold.

RECOMMENDATION

1. There must be more awareness program on climate change as an enlightenment strategy to all the famers.
2. The general public should be involved in the cultivation of cocoyam as it helps to provide food for the household.
3. Sale of cocoyam is a lucrative venture as it helps to alleviate poverty level and provides employment so people must be advised to take up cocoyam farming as a real business
4. Government needs to provide aids in grants to farmers to encourage them
5. Storage facilities must be put in place to reduce waste and to encourage more production.
6. Cocoyam is highly profitable since no part of it is wasted, therefore, I encourage more people to go into cocoyam farming.

Conflict of Interest

The authors declare no conflict of interest

Authors' Declaration

The authors declared that the work presented in this article is original and any liability for claim relating to the content of this article will be borne by them.

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