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IMPACT OF CLIMATE ON THE YIELD OF MAJOR TUBER CROPS IN KWARA STATE, NIGERIA

TIMOTHY DENEN AKPENPUUN AND RASHEED AMAO BUSARI

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ABSTRACT

Rain fall, maximum temperature, minimum temperature, evaporation, relative humidity, sunshine hours, soil temperature data were obtained from the National Bureau of Statistics (NBS) for a decade (2002 – 2011), while crop yield data for the same period were sourced from Kwara State Agricultural and Development Project (KWADP). Both climatic and crop yield data were analysed using correlation analytical techniques, multiple regression and trend analysis in order to evaluate the impact of climate on the yield of the major tuber crops in Kwara State, Nigeria viz: cassava, yam, and sweet potato. The result obtained shows that the impact of climate on yield is significant ($p<0.05$) for yam and cassava, however, insignificant ($p<0.05$) for sweet potato. The implication of this is that climate has a strong linear correlation with yam and cassava within the years under review. Tuber crops yield in the study area can be improved upon by supplementing rain-fed cultivation with irrigation and application of modern agricultural techniques and operations by the farmers.

KEYWORDS: Agriculture, climate, tuber-crops, yield, decade, Nigeria.

INTRODUCTION

Agriculture is the growing, processing and distribution of food and other products through intensive plant cultivation and animal husbandry in and around cities. It includes green belts around cities, farming at the city edge, vegetable plots in community gardens and food production in thousands of vacant inner - city lots. Agriculture is the practice of crop cultivation and livestock keeping within the boundaries. The choice of what to produce and how to produce it is determined by the culture, traditions, market, water supply, climate, soil condition, plot size and distance from home (Abdul-Aziz, 2002; Wiebe, 2003). In view of the foregoing, climate has been undoubtedly identified as one of the fundamental factors that determine both crop cultivation and livestock keeping.

The climate is a long-term average weather condition that either exercises directly or indirectly controls or affects agricultural production. That is to say, climate forms the major part of the physical environment in which agriculture thrives. Climate determines the choice of what plant to cultivate, how to cultivate it, the yields of crops and nature of livestock to keep. Ajadi (2011) explained that solar radiation, temperature, moisture and other climatic parameters determine the global distribution of crops and livestock as well as crop yield and livestock productivity. Reuben and Barau (2012) observed that rainfall distribution and the occurrence of moisture stress condition during the vegetative period are critical for the yield formation of cassava crop at Kabba, Kogi State.

Ajadi *et. al.,* (2011) reported that there are three methods of establishing agriculture - climate relationships. The first method establishes the fundamentals of plant - climate relationship in terms of the solar radiation and moisture balance for various crops in various climatic environments. The second method involves studying agricultural produce yield data and climate for a number of places within a given area for as long a period as a constant record of both agriculture and climate allow, and deducing agroclimatological relationship from analyses of data, while the third method involves studying plant -climate relationship under a controlled environment. The second method was adopted by Ajadi et al, (2011) while investigating the impact of climate on urban agriculture in Ilorin, Nigeria.

From above, it can be deduced that climatic parameters are the major environmental factors capable of affecting agriculture. Olarenwaju, (2012) declared that many of the problems facing agricultural products are climate related. It is against this background that this paper is put forward to ascertain the impact of climate on crop production in Kwara State. The specific objectives are to:

i. examine the relationship between selected climatic elements and yield of the three major tuber crops in the state and
ii. examine the contribution of the climatic element to the trends and variation of tuber crop yield over the decade under review.

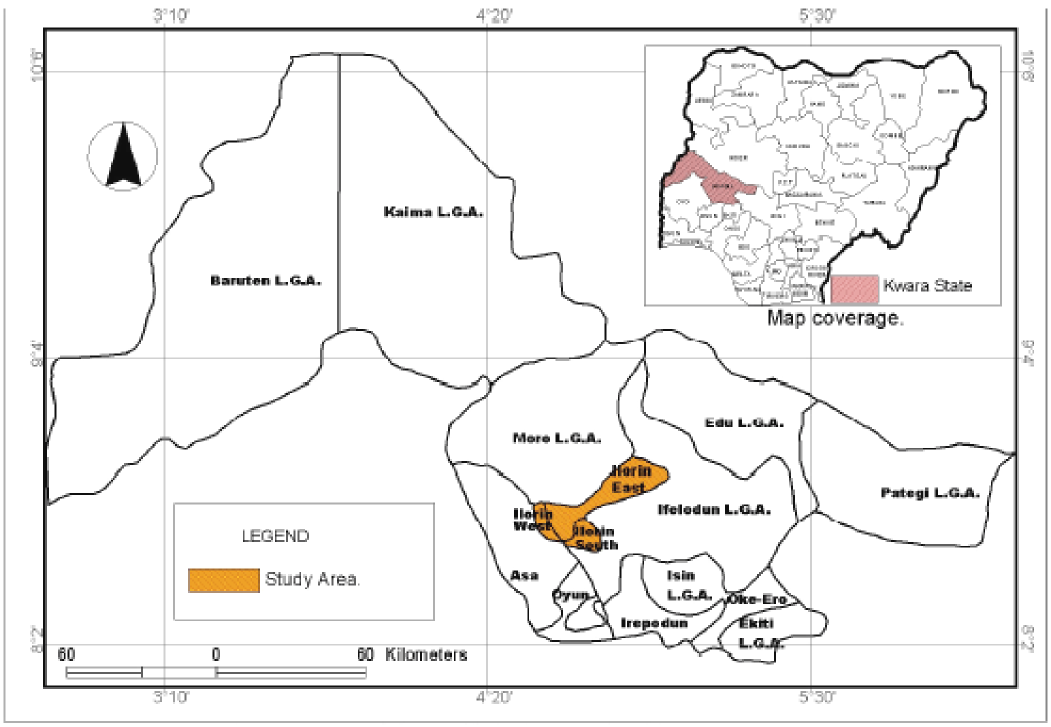
Study Area

The study area is Kwara State. Kwara State lies

Timothy Denen Akpenpuun, Department of Agricultural and Biosystems Engineering, University of Ilorin, Ilorin, Nigeria
Rasheed Amao Busari, Department of Food, Agricultural and Bio-Engineering, College of Engineering, Kwara State University Malete, Nigeria.

between latitudes 8° 05`N and 10° 05`N and longitudes 2° 50`E and 6° 05` E and located at an altitude of 304 m above mean sea level (Ejieji and Adeniran, 2009). Kwara State is located in the West-central area of Nigeria and lies in the region termed the Middle Belt. It is located in the forested savannah and enjoys moderate dry and wet seasons. The derived guinea savannah grasslands dominate the Northern part of the state while the Southern part falls within the rain forest.

The Kwara state has an elongated shape covering an area of about 32,500 sq. km. The state is bounded by River Niger along its northern and eastern boundaries and shares a common boundary with Niger State in the north, Kogi State in the east, Oyo, Ekiti and Osun States in the south and an international boundary with the Republic of Benin in the west. The soils of Ilorin are loam and clay. The state is shown in figure 3.1.



Figugre1: Kwara State
(**Source:** Lands and Survey, Kwara State)

The climate is tropical with annual rainfall, maximum temperature, maximum relative humidity and a daily photoperiod of 1500 mm, 38 °C, 77.50 % and 7.1 hours respectively (Olanrewaju, 2009). The rainy season begins at about the end of March and lasts until early September, while the dry season begins in early October and ends in early March. Food crops cultivated in the state include white yam, cassava, water yam, sweet potato, groundnut, sorghum, millet, maize and cowpea (Ajadi, *et. al.,* 2011).

MATERIAL AND METHODS

This studywasbased on the contribution of climatic parameters to the trends and variation of tuber crops yield over the decade under review. .A decade climatic data (rainfall, maximum temperature, minimum temperature, evaporation, relative humidity, sunshine hours, soil temperature) were obtained from Nigeria Meteorological Service, Oshodi, Lagos and National Bureau of Statistics (NBS), Lagos. Crop yield data were obtained from National Bureau of Statistics (NBS), Lagos and Kwara State Agricultural Development Project(KWADP), Ilorin, on cassava, sweet potato, and yam. The choice of the aforementioned climatic parameters is based on their vital role to the selected crops yield and the evaluation of a decade data is based on statistical theories.

Both descriptive and inferential statistical techniques were employed in data analysis,while simple correlation and multiple regressions were used in showing the relationship between climatic parameters and crop yield and showing the trend and variation in crop yield over the ten years in the study area. These statistical techniques were employed in the analysis of both crop yield data and climatic parameters because of their peculiarity in revealing the relationship and variation among variables.

RESULTS AND DISCUSSION

Climatic - Yield Variables in Kwara State (2002–2011)

Tables 1, 2 and 3 are the yield and hectarage data, descriptive analysis of the major tuber yielddata in Kwara State (2002 – 2011) and pattern of meteorological data, respectively. Out of the three selected tuber crops, cassava has the highest mean value (969.34tonnes / ha). This was followed by yam (732.35 tonnes / ha) while sweet potato has the lowest mean value (67.83 tonnes / ha). This shows that within the years under study, cassava has the highest yield value. Similarly, the highest deviation was obtained in cassava production (359.98tonnes / ha). This reveals that the dispersion characteristics of cassava production in Kwara State are generally low. The coefficient of variation, which shows the relative deviation between crop yields, indicates that all the tuber crops (yam, cassava and sweet potato) are heterogeneous. This suggests that the value of yam, cassava and sweet potato yields in the study years does not differ significantly. The relative deviation in crop production could be as a result of the impact of climate on the crops and soil fertility. From table 3, 2011 was the year that had the highest rainfall (130.45 mm), maximum temperature (34.2 ^{o}C), evaporation (7.1 mm) and sunshine hours (6.8 hours), while 2002 had the least rainfall (95.1 mm), evaporation (3.6 mm).

Table 1: Yield and Area Harvested

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Yam										
Ton '000	624.11	563.48	327.74	385.9	412.89	810.7	948.58	1,006.07	1,054.52	1,189.51
Ha	51.26	48.85	28.03	33.2	34.83	69.53	76.13	80.72	84.15	90.49
Yield(Tons/Ha)	12.33	10.86	11.7	11.63	11.85	11.66	12.46	12.46	12.53	13.14
Cassava										
Ton '000	542.08	510	480.72	740.3	1184.48	1111.27	1195.24	1,219.27	1,310.05	1,400.04
Ha	41.36	40.61	38.59	59.4	77.5	65.41	69.73	76.36	79.52	83.3
Yield(Tons/Ha)	12.94	12.56	12.21	12.46	15.28	16.99	17.14	15.97	16.48	16.8
Sweet Potato										
Ton '000	71.97	40.5	63.6	59.8	60.38	67.59	67.7	71.26	81.27	94.25
Ha	8.85	5.53	9.3	7	7.12	7.82	8.05	8.19	8.78	9.87
Yield(Tons/Ha)	8.01	7.32	7.37	8.5	8.49	8.64	8.41	8.7	9.26	9.55

Table 2: Descriptive Statistics of the Major Tuber Crops Yield Data (2002– 2011)

Crop	Mean Yield	Standard Deviation	Skewness	Kurtosis	Co-efficient of Variation (%)
Yam	732.35	310.31	0.063	-1.636	82.8
Cassava	969.34	359.98	-0.429	-1.811	93.3
S/ Potato	67.83	14.11	-0.022	-1.635	72.2

Table 3: Pattern of Meteorological Data (2002 – 2011)

Yr	RF, mm	MxT	MnT	Ev	R/H	SSH	ST
2002	95.1	32.6	21.8	3.6	49	5.6	29.45
2003	109.9	32.8	22.1	5.9	50	5.7	28.2
2004	119.8	33.4	22.2	5.4	52	6.4	29
2005	108.7	31.9	20	5.7	52	6.3	29.3
2006	108.7	32.2	17.8	5.7	52	6.2	29.5
2007	108.8	32.6	20.5	6	51	6.7	29.55
2008	199.1	32.6	21.4	6.2	47	6	29.15
2009	199.1	33.5	23.4	6.2	51	6.3	29.83
2010	128	33.7	23.3	6.7	55	5.5	29.15
2011	130.45	34.2	22.91	7.1	53	6.8	29.32

Source: KWADP, 2012

Key: RF = Rain fall, mm, MxT = Maximum temperature, ^{o}C, MnT = Minimum temperature, ^{o}C,Ev = Evaporation, mm, R/H = Relative humidity, %, SSH = Sunshine hours,, hr, ST = Soil temperature, ^{o}C.

Relationship between Climatic Variables and Crop Yield

Table a4 is the regression analysis result. Table 3 shows that 99.8%, 99.9% and 82.4% of the variation in yam, cassava and sweet potato respectively can be explained as the effect of climate. This shows that the impact of climate on crop yield variation over the years under consideration is significant. This suggests that variations in tuber crops yield considered in this study could largely be attributed to climate. In addition, the impact of climate on tuber yield is significant ($p<0.05$)for yam and cassava yield. This shows that there is an inverse relationship between crop yield and climate, which is an increase in climatic parameters causes a decreases crop yield. Odjugo (2010) also reported that climate change would impact negatively on agricultural production and food security, especially in the developing countries.

Table 3: Statistical Relationship between Climate and Crop Yield

	R	R^2	SEE	F	Sig
Yam	0.999[a]	0.998	30.63	131.69	0.008
Cassava	0.999	0.999	28.63	203.0	0.005
S/ potato	0.908	0.824	12.55	1.34	0.491

Trend in Crop Yield

The result of the trend analysis using Kendall method on the yield in the number of years considered in this study in Table 4 below shows that there is a direct relationship between the tuber crops yield and climate. This shows that climate has in one way or the other affected the pattern of variation in crop yield within the years under review.

Table 4: Trend in Crop Yield between 2002 – 2011

Crop	Kendall's tau
Yam	.689**
Cassava	.822**
Sweet Potato	.600*

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Correlation Analysis

The correlation coefficient (r) between the climatic parameters and the selected crop yields is presented in Table 5. The result shows that the correlation coefficient values of rainfall, minimum and maximum temperature, and evaporation for yam yield are greater than 0.5, while those of relative humidity, sunshine hours and soil temperature were below 0.5. This shows that the other climatic parameters apart from temperature have a strong correlation coefficient with the selected crops. In the case of cassava, evaporation and soil temperature have values greater than 0.5 while for sweet potato, maximum atmospheric temperature and soil temperature that had values greater than 0.5. This shows that there is an average linear relationship between these climatic parameters and sweet potato yield in the study area. However, there was a weak relationship between sweet potato yield and rainfall, minimum temperature, evaporation, relative humidity and sunshine hours.Earlier studies also observed declining yield due to climate change effect on agriculture (Olanrewaju, 2012 and Ajadi *et. al.,* 2011),. The analysis of variance at $p<0.05$ revealed that the effect of climate on yam ($F_{statistics}$ = 0.03) and cassava ($F_{statistics}$ = 0.02) was significant, but insignificant on sweet potato ($F_{statistics}$ = 0.39)

Table 5: Correlation Analysis of Crop Yield and Climatic Indices

	Yam	Cassava	S/Potato
Rainfall	0.547*	0.485	0.209
Max. Temperature	0.668*	0.377	0.654*
Min. Temperature	0.609*	0.060	0.410
Evaporation	0.592*	0.719*	0.329
Relative humidity	0.106	0.299	0.381
Sunshine hours	0.085	0.302	0.287
Soil temperature	0.262	0.510*	0.554*

* Correlation is significant at the 0.05 % level (1–tailed).

Further Research

The analysis in this study was based on the effect of weather parameters on tuber crops yield neglecting the effect of soil management practices. A similar research can be carried out taking into consideration these practices.

CONCLUSION

The result obtained from the regression and correlation statistics reveals that climate has an impact on crop productivity within the years under consideration. The result shows that, though there has been an increase in the area of cultivation and provision of farm inputs to a farmer in the years specified, however, climate has taken its toll on the selected crops yield. This indicates clearly that variation in crop yield in Kwara State could be attributed to climatic influence on agriculture.

Taking into consideration the array of factors mitigating tuber crops yield in Kwara State, Nigeria, climate has been identified as the major culprit and the only factor that is impossible to control in the open field. As a result, this study recommends the following measures towards improving tuber crops production and agriculture in general.

i. adoptionof modern agricultural techniques, such as greenhouse technology, to boost crop yield,
ii. adoptionby farmers improved seedlings,
iii. timely provision of farm inputs to the farmers
iv. There is need to educate/train extension workers generally on issues concerning climate change and specifically on the causes, indicators and effects of climate change on agriculture.

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