Impact of Climate on Tuber Crops Yield in Kwara State, Nigeria

Akpenpuun, Timothy Denen
Department of Agricultural and Biosystems Engineering
Faculty of Engineering and Technology
University of Ilorin, Ilorin, Nigeria.

Busari, Rasheed Amao
Department of Food, Agricultural and Bio-Engineering
College of Engineering,
Kwara State University Malete, Nigeria.

Abstract

Climatic 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 analyzed using correlation analytical techniques,multiple regression and trend analysis in order to evaluate the impact of climate on the yield of the most important tuber crops in Kwara State, Nigeria viz: cassava, yam, and sweet potato. The result obtained shows that the impact of climate onyieldis significant for yam and cassava at 95% probability levels, however, insignificant 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 bysupplementingrain-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 (CFSCNAAC, 2003). 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 (AbdulAziz, 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.

Climate is a long-term average weather conditions that exercise either 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 vegetative period are critical for the yield formation of cassava crop at Kabba, Kogi State.

From above, it can be deduced that climate 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 agriculture in Kwara State. The specific objectives are to:

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

Study Area

The study area is, University of Ilorin, Ilorin, Kwara state. Ilorin is located between latitudes 8° 05`N to 10° 05`N (8°30′N) and longitudes 2° 50`E to 6° 05` E (4°33′E). The state has an elongated shape running from west to east and covering an area of about 32,500 sq. km and has River Niger as its natural boundary along its northern and eastern margins see Fig. 1. Kwara state and shares a common internal 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.

Kwara state lies within a region described as tropical climate and is characterized by double rainfall maxima and has tropical wet and dry climate (Olanrewaju, 2009). Both seasons last for about six months. Kwara State is a summer rainfall area, with an annual rainfall range of 1000 mm to 1500 mm. 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. Temperature is uniformly high and ranges between 25^{o}C and 30^{o}C in the wet season throughout the season except in July – August when the clouding of the sky prevents direct insolation (heatstroke) while in the dry season it ranges between 33^{o}C to 34^{o}C.

Relative humidity at Ilorin in the wet season is between 75 to 80% while in the dry season it is about 65%. The daytimes are sunny and the sun shines brightly for about 6.5 to 7.7 hours daily from November to May (NBS, 2009).The geology of the study area consists of Precambrian basement complex rock. The elevation on the western side varies from 273m to 333m above sea level while on the Eastern side it varies from 273m to 364m. Ilorin is majorly drained by Asa River, whose course enters the southern end of the industrial estate from Asa Dam and it runs northwards through residential and commercial areas of Ilorin city (Ajadi et al, 2011).

The soils of Ilorin are loamy soil and easy to farm. However, low fertility is observed due to leaching of minerals and nutrients because of the high seasonal rainfall coupled with the high temperatures.The climate of Kwara state supports tall grass interspersed with short scattered trees. This attribute predisposes the people of Kwara State to make farming their major occupation. Food crops produced in the state are mostly root crops namely yam, cassava, water yam and sweet potato and they constitute the main staple food aside cereals (Ajadi, et al 2011).

Fig. 1: Map of the Study Area

Source: Google Map

Material and Methods

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 products yield data and climate for a number of places within a given area for as long a period as 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 controlled environment. The second method was adopted by Ajadi et al, (2011) while investigating the impact of climate on urban agriculture in Ilorin, Nigeria.

This study will employ the second method which is studying agricultural products yield data and climate for a number of places within a given area for as long a period as constant record of both agriculture and climate allow. 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. While, 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)

Table 1 shows the descriptive analysis of the agricultural data in Kwara State 2002 – 2011. Out of the three selected tuber crops, cassava has the highest mean value (969.34). This was followed by yam (732.35) while sweet potato has the lowest mean value (67.83). This implies that within the years under study, cassava has the highest yield value. Similarly, the highest deviation was obtained in cassava production (359.98). 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 impact of climate on the crops and soil fertility.

Table 1: 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 2: 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, MxT = Maximum temperature, MnT = Minimum temperature, Ev = Evaporation, R/H = Relative humidity, SSH = Sunshine hours, ST = Soil temperature

Relationship between Climatic Variables and Crop Yield

The result of the regression analysis in 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 the climate. This implies 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 for yam and cassava yield at 95% probability levels.

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 the climate. This implies that the 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 except that of relative humidity, sunshine hours and soil temperature. This implies that the other climatic parameters apart from temperature have strong correlation coefficient with the selected crops. In case of cassava, evaporation and soil temperature have values greater 0.5 while for sweet potato, it is maximum atmospheric temperature and soil temperature that have values greater than 0.5. This implies that there is an average linear relationship between these climatic parameters and sweet potato yield in the study area. However, there is a weak relationship between sweet potato yield and rainfall, minimum temperature, evaporation, relative humidity and sunshine hours.

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 in to consideration these practices.

Conclusion

The result obtained from the regression and correlation statistics reveals that climate has impact on crop productivity within the years under consideration. The result implies that, though there has been increase in the area of cultivation and provision of farm inputs to 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. Application of fertilizer and other agro-chemicals to improve soil fertility and prevent field losses
ii. Adoption of modern agricultural techniques to boost crop yield,
iii. Adoption by farmers improved seedlings,
iv. Application of pesticides to reduce the effects of pests on crops and
v. Introduction of improved seedlings and input for high crops yields.

References

AbdulAziz, T. (2002). “Corruption” Sustainable Food Security for All by 2020, IFPRI, pp 172-175

Ajadi, B.S., Adeniyi A., Afolabi M. T., (2011).Impact of Climate on Urban Agriculture: Case Study of Ilorin City, Nigeria. Global Journal of Human Social Science Volume 11 Issue 1, Type: Double Blind Peer Reviewed International Research Journal Publisher: Global Journals Inc. (USA)

Reuben, J and Barau, A. D. (2012).Resource Use Efficiency in Yam Production in Taraba State, Nigeria, Journal of Agricultural Science, Kamla-Raj 3(2): 71-77.

Kwara State Agricultural Development Project (KWADP), (2012). Planning, Management and Evaluation (PME), AGRICULTURAL PRODUCTION SURVEY (APS), 2002 – 2011.

National Bureau of Statistics (NBS) - Commercial Agriculture Development Project (CADP), (2010). NBS/CADP Baseline Survey Report.

Olanrewaju, R. M., 2009. Climate and the Growth Cycle of Yam Plant in the Guinea Savannah Ecological Zone of Kwara State, Nigeria. Journal of Meteorological and Climate Science, 7: 43-48.

Olanrewaju, R. M., 2012. Effect of Climate on Yam Production in Kwara State, Nigeria. Environmental Issues, Department of Geography and Environmental Management, University of Ilorin, Ilorin, Vol. 3, No. 1

Wiebe, K. (2003) Land Quality, Agricultural Productivity, and Food Security at Local, Regional, and Global Scales Paper presented at the American Agricultural Economics Association Annual Meeting, Montreal, Canada, July 27–30, 2003 Economic Research Service, USDA.