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Climate and Grain 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.

Abstract

Climatic data on rainfall, evaporation, relative humidity, maximum and minimum atmospheric temperature, soil temperature and sunshine hours were obtained from the National Bureau of Statistics (NBS) for a decade (2002 – 2011) while crop yield data were sourced from Kwara State Agricultural and Development Project (KWADP). These data were analysed in order to evaluate the impact of climate on the cultivation of maize, sorghum, rice, millet and cowpea in Kwara State, Nigeria. Multiple regression, trend analysis and correlation analytical techniques were used to analyze the data. The result obtained shows that the impact of climate on grain cultivation is significant for maize and rice yield at 95% probability levels. This implies that climate has a strong linear correlation with two of the selected crops within the years under review. As a result, it is recommended that investment should be made in to supplement rain-fed agriculture under these practices of extensive agricultural extension services, adoption of modern agricultural techniques and provision of agro-chemicals to farmers. Agricultural yield in the study area will be greatly improved if the above recommendations and other government policies are put in place. This study aimed at determining the relationship that exists between grain crops yield and climatic parameters. The result of the analysis of data collected showed that climatic parameters had significant impact on yield in the study area.

Keywords: agriculture, climate, grain-crops, yield, decade, Nigeria.

INTRODUCTION

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).

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 directly or indirectly effects on agricultural production. 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.

In view of the foregoing, Odjugo (2010) stated that climate change is unequivocal and its impacts are here with us. Available pieces of evidence show that each day brings fresh proofs of climate change effects and these effects include increasing temperatures, decreasing rainfall in the continental interiors, drought, desert encroachment, melting ice, extreme weather, floods, sea level rise, sinking of Islands, water scarcity, health and agricultural problems.

The impact of climate change on agricultural production in Nigeria has received limited attention despite the fact that over 60% of the active population of Nigerians are farmers. Studies on climate change globally and in Nigeria have reviewed that the potential impacts of climate change will include every aspect of the four dimensions of food security; food availability (production and trade), food accessibility, food stable supplies, and food utilization (Nwafor, 2007).

Olarenwaju (2012) reported that many of the problems facing agricultural production 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 grain crops in the state and
2. Examine the contribution of climatic element to the trends and variation of grain 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, 2010).

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

LIMITATION OF THE STUDY

This investigation was conducted to determine the significance of the impact of climate on crop yield for a decade (2002 – 2011). The analysis was based on the impact of individual climatic parameters on grain crops yield neglecting other parameters such as soil characteristics, pests and disease.

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.

The method of studying the relationship of agricultural products yields data and climatic parameters 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 maize, sorghum, rice, millet and cowpea. 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

Pattern of Agro-climatic Variables in Ilorin City (2002– 2011)

Table 2 shows the descriptive analysis of the agricultural data in Kwara State 2002– 2011. Out of the five selected crops, millet has the highest mean value (10.85). This was followed by groundnut (1.70) while cowpea has the lowest mean value (0.75). This implies that within the years under study, millet has the highest yield value. Similarly, the highest deviation was obtained in millet production (1.43). This reveals that the dispersion characteristics of the crop production in Kwara State are generally low. The coefficient of variation which shows the relative deviation between crop yields indicated that both cowpea and millet are heterogeneous with values greater than 33%. This suggests that the values of cowpea and millet produced in the study years differ significantly. The relative deviation in crop production could be as a result of impact of climate on soil fertility.

Table 1: Grain Crops Yield (Tons), Area Cultivated (Ha) and Yield (Tons/Ha)

S/NO	CROPS	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1.	**MAIZE**										
	TON	70.91	100.40	86.74	113.40	150.38	149.89	164.53	189.78	196.56	210.70
	HA	57.66	57.66	64.05	82.9	110.42	109.20	114.66	126.22	133.27	141.16
	YIELD (Tons/Ha)	1.30	1.47	1.25	1.35	1.58	1.37	1.43	1.50	1.47	1.49
2.	**SORGHUIM**										
	TON	73.27	42.65	47.47	60.30	75.33	102.97	112.70	131.05	137.96	146.00
	HA	40.32	33.47	30.67	47.6	57.12	67.30	80.50	84.93	87.32	96.26
	YIELD (Tons/Ha)	1.70	1.27	1.42	1.27	1.32	1.53	1.4	1.54	1.58	1.52
3.	**RICE**										
	TON	22.72	18.71	47.47	71.90	118.31	234.21	345.69	440.43	480.80	384.44
	HA	8.19	8.20	20.85	31.3	50.01	97.18	135.04	142.81	147.13	128.75
	YIELD (Tons/Ha)	2.77	2.28	2.30	2.36	2.37	2.41	2.56	3.08	3.27	2.986
4.	**MILLET**										
	TON	12.20	13.00	8.74	11.30	14.66	25.39	28.44	19.54	20.50	26.01
	HA	11.87	12.00	5.02	6.5	8.06	13.43	15.05	16.64	17.09	19.26
	YIELD (Tons/Ha)	1.03	1.04	2.30	.75	1.82	1.89	1.89	1.17	1.20	1.35
5.	**COWPEA**										
	TON	4.95	5.56	0.67	0.721	0.70	0.968	1.08	3.12	3.27	3.58
	HA	7.04	7.74	1.47	1.5	1.39	4.34	5.12	5.42	5.54	5.91
	YIELD (Tons/Ha)	0.69	0.72	0.46	0.47	0.50	0.22	0.21	0.57	0.59	0.60

Source: KWADP, 2012

Table 2: Descriptive Statistics of Grain Yield Data (2002– 2011)

	MAIZE	*SORGHUIM*	*RICE*	*MILLET*	*COWPEA*
Mean	143.329	92.97	216.468	17.978	2.4619
Standard Error	15.36873	12.08515	57.83115	2.203068	0.592663
Median	150.135	89.15	176.26	17.1	2.1
Standard Deviation	48.60019	38.21661	182.8782	6.966713	1.874165
Sample Variance	2361.978	1460.509	33444.42	48.53508	3.512494
Kurtosis	-1.38758	-1.64281	-1.8501	-1.52934	-1.32513
Skewness	-0.12091	0.085793	0.290774	0.267545	0.524869
Range	139.79	103.35	462.09	19.7	4.89
Minimum	70.91	42.65	18.71	8.74	0.67
Maximum	210.7	146	480.8	28.44	5.56
Sum	1433.29	929.7	2164.68	179.78	24.619
Count	10	10	10	10	10
Confidence Level(95.0%)	34.76648	27.33851	130.8232	4.983686	1.340697

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

Year Rainfall (Mean)	RAINFALL (MM)	RAINING DAYS	MAX TEMPERATURE (°C)	MIN TEMPERATURE (°C)	Relative Humidity (%)	Soil Temperature	Sunshine Hour
2002	1028.5	66	36.44	20.30	77.00	29.6	5.6
2003	811.75	50	31.17	17.50	83.00	29.3	5.7
2004	1597.4	56	33.33	20.15	82.00	29.2	6.4
2005	1144.5	55	35.90	23.90	82.50	29.9	6.3
2006	1236.99	78	36.47	22.79	81.40	28.8	6.2
2007	1481.63	78	37.08	22.50	78.60	29.9	6.7
2008	1381.9	60	36.00	22.00	84.00	29.1	6.0
2009	1526.57	72	38.00	23.40	87.10	29.7	6.3
2010	1165.7	62	36.00	23.30	87.40	29.0	5.5
2011	1253.4	59	36.10	22.91	84.42	29.4	6.8

Source: Nigeria Meteorological Service, Oshodi, Lagos (2009).

Relationship between Climatic Variables and Crop Yield

The result of the regression analysis shows that 21.7%, 18.6%, 30.8%, 66.1% and 55.4% of the variance in millet, groundnut, sweet potato, cowpea and millet can be respectively explained by the climatic parameters (Table 3). This implies that the impact of climate on crop yield variation over the years under study is low except that of cowpea and millet. This therefore, suggests that variation in crop yield could be attributed to other non-climatic factors such as soil fertility and farm techniques amongst others.

Table 4: Statistical Relationship between Climate and Crop Yield

	R	R^2	Standard Error of Estimate	F	Significant
Maize	0.998	0.995	7.11	59.83	0.02
Sorghum	0.996	0.991	7.66	31.72	0.03
Rice	0.995	0.989	40.04	26.53	0.04
Millet	0.978	0.956	3.11	6.14	0.15
Cowpea	0.851	0.725	**2.08**	0.75	0.68

Trend in Crop Yield

The result of the trend analysis using Man-Kendull method shows that there is no significant difference or decline in the values of the crop yield at either 95% or 79% probability levels. This implies that no differential pattern of variation exist in output of crop yield in each successive year under review.

Table 5: Trend in Crop Yield

Crop	R (t)
Maize	1.000
Sorghum	0.778**
Rice	0.778**
Millet	0.600*
Cowpea	0.244

Correlation Analysis

The correlation coefficient (r) between the climatic parameters and the selected grain crop yields were computed (Table 5). This result shows that the correlation values of rainfall, maximum temperature and evaporation against maize, sorghum and rice yields are greater than 0.5. However, a weak correlation relationship exist between maize, sorghum and rice yields and minimum temperature, relative humidity, sunshine hours and soil temperature except for rice which has a value greater than 0.5 for soil temperature. For millet and cowpea, a strong relation exits for rainfall and minimum temperature respectively. While a weak and negative relationship exists for the other climatic parameter under consideration.

The above analysis implies that the effect of climate on grain yield in the study area is not significant. However, the effect of rainfall and evaporation on rice and evaporation on maize are significant,

Table 5: Correlation Analysis of Crop Yield and Climatic Indices

	MAIZE	*SORGHUIM*	*RICE*	*MILLET*	*COWPEA*
Rainfall	0.544017	0.539475	0.66829	0.545423	-0.11976
Maximum Temperature	0.546374	0.612795	0.612034	0.323776	0.359878
Minimum Temperature	0.268193	0.442928	0.49108	0.198866	0.5642
Evaporation	0.840847	0.609873	0.714551	0.61269	-0.15883
Relative Humidity	0.385533	0.265522	0.289819	-0.1333	-0.06391
Sunshine Hour	0.294933	0.194547	0.120116	0.295953	-0.51571
Soil Temperature	0.372177	0.508977	0.398753	0.277578	-0.37496

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

CONCLUSION

In this study, the result obtained from the regression and correlation statistics reveals that climate has little impact on crop productivity within the years under review. In other word, the result implies that, though there are variations in climatic parameters within the years, such variation has little impact on the selected crops. This suggests that variation in crop yield and climatic influence on agriculture in Kwara State could be as a result of other factors namely; soil or farm techniques in Kwara State, Nigeria.

RECOMMENDATIONS

Based on the above findings, the study thus recommends the following measures towards improving agriculture in Kwara State, Nigeria.

The application of fertilizer to improve soil fertility and productivity, the use of modern agricultural techniques to boost crop yield, introduction of crop improvement practices to increase productivity, application of insecticides to reduce the effects of pests on crops and introduction of improved seedlings and input for high crops yields.

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