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EVALUATION OF AGRO-CLIMATOLOGICAL CONSTRAINTS TO COTTON PRODUCTION IN MAKARFI AND ZARIA, KADUNA STATE, NIGERIA

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Abstract

Knowing and understanding the key agro-climatological variables, which affect cotton production, is of great importance for designing agricultural policies to enhance cotton production in the study area and the country at large. Little published thesis and journal have covered the research topic which has create paucity of knowledge and this study intend to fill. The aim of this study is to assess agro-climatological constraints to low cotton production in Makarfi and Zaria, Kaduna State, Nigeria. The methods of data analysis include mean, mean deviation, frequency percentage and multiple linear regression. The result revealed that annual rainfall tend to be decreasing in the study area despite the

Introduction

Agriculture constitutes one of the most important sectors of Nigeria economy. The sector is particularly important in terms of employment generations and its contribution to the Gross Domestic Product (GDP) and export earning. However, the sector has been characterized since 1970s by declining productivity and increase dependence on import of food and raw materials (Manyong *et al*., 2015). Efforts have been made by various tiers of government to reverse the trend by diversification of the productive base through increased production of cash crops like cotton, rubber, palm oil and ground nut as they were the main export crops of the country where large revenue have been generated in the 1960s (Idem, 2009).

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fluctuation in some years (2007, 2013 and 2015). The highest annual rainfall was in the year 1999 with 2272.4 mm and the lowest was in the year 2008 with 848.5 mm. The study also revealed that mean annual relative humidity tend to be decreasing despite the fluctuation. The highest mean annual relative humidity was recorded in the year 2013 with 56.4% and the least was recorded in the year 2010 with 47.4%. The finding revealed that the agro-constraints faced by cotton growers in the study area include inadequate fertilizer, inadequate pesticides, inadequate market opportunities, late planting, inadequate storage facilities after harvest and increased cotton diseases. As indicated in the result, R^2 was 0.552 for annual rainfall, thus, rainfall account for 55.2% of the explained variance between annual rainfall and cotton yield in the study area. This shows that other climatic variables like relative humidity and temperature too play significant role in cotton yield since the remaining 44.8% is left unexplained. As shown in the study, R^2 was 0.22 for relative humidity, thus, relative humidity account for 22.0% of the explained variance between relative humidity and cotton yield in the study area. It's therefore recommended that the Kaduna State Agricultural Development Programme (KSADP) should device way to motivate its agricultural extension workers to be able to assist the rural cotton growers on enhanced productivity and to guide them on new agricultural innovations.

Keywords: *Agro-constraints, Cotton production, and agro-climatological*

Cotton production has a relatively long history in Nigeria. The cultivation of the crop started well before the colonial era even though it was not produced in commercial quantities until the onset of the activities of the British Growing Association in 1903, since then considerable attention and resources have been devoted to the improvement of cotton production and utilization by both the public and the private organisations. Cotton is grown as a cash crop by about 0.8 million farmers on a total estimated area ranging from 0.6-08 million hectares. The major feature of cotton production in Nigeria is that about 80% of total production is by peasant farmers under rainfed conditions with simple tools and animal drawn implements (Onu and Atala, 2012; Adeniji, 2012).

Several authors both nationally and internationally have studied agro-climatological constraints and they include Ramasundaram (2011); Adeniyi (2012); Gohil *et al.,* (2016); Thomson *et al.,* (2014); Dalberg (2011); Kabwe (2013); Tschirley and Kabwe, (2017). Little published thesis and journal have

covered the research topic which has create paucity of knowledge and this study intend to fill.

Agro-climatological constraints in the study area identify include multiplicity of genotypes, use of non-certified seeds, non-adoption of proper spacing, more than recommended number of insecticide sprays, less/more than recommended quantity of fertilizer use, tied up credit and unscientific plant protection. Cotton yield in the study area are on the decrease because of competition among crops for land and labour, leading to lack of timeliness in field operations and to difficulties in weed control, insect control and picking. Failure to increase the supply of this crop is likely to result in higher prices for the finished good derived from cotton, putting the country textile security at risk. The vulnerability of the country textile industry was highlighted between the years 2002 and 2013, in which prices for agricultural commodities derived from cotton elevated rapidly. During this period, average prices of textile commodities gotten from cotton increased by over 50% (Tadesse *et al.,* 2014). These price increases were particularly steep for a number of the aforementioned crop. Therefore the aim of this study is to assess agro-climatological constraints to low cotton production in Makarfi and Zaria, Kaduna State, Nigeria.

The area is bounded by latitudes 11^0 04′ 28″ N and 11^0 35′ 53″ N and Longitudes 7^0 42′ 49″ E and 7^0 70′ 00″ E. It covers an area of approximately 563km^2, in the Basement Complex of North Central Nigeria (Figure. I). The estimated population of the selected sample points is 408,198 according to the 2018 estimation.

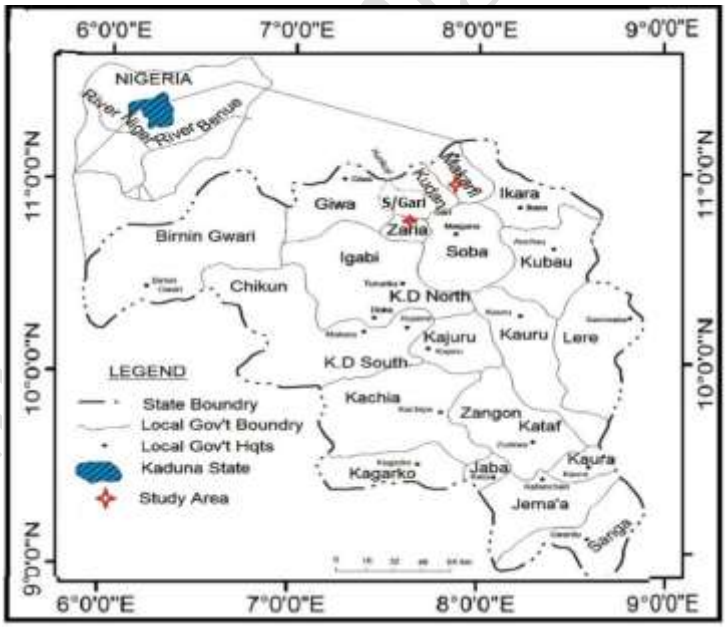

Figure 1: Location of Zaria and Makarfi Local Government Areas

Materials and Methods

Secondary data used were those data that were obtained from Kaduna State Agricultural and Rural Development Authority (KDARDA) for a period of twenty years (1998 to 2017), Nigerian

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Meteorological Agency (NIMET), previous researches, journals, textbooks, newspapers, magazines and encyclopedia. The data collected from KDARDA and NIMET they includes cotton yield and climatic parameters data respectively. The climatic parameters include rainfall and relative humidity. The data on cotton yield was obtained from the official records of the Kaduna State Agricultural and Rural Development Authority (KDARDA) for a period of twenty years (1998 to 2017). The methods of data analysis include mean, mean deviation, frequency percentage and multiple linear regression.

Results and Discussion

As revealed in Figure 2, annual rainfall tend to be decreasing in the study area despite the fluctuation in some years (2007, 2013 and 2015). The highest annual rainfall was in the year 1999 with 2272.4 mm and the lowest was in the year 2008 with 848.5 mm. This implies decrease in cotton production across the study area as a result of decrease in annual rainfall.

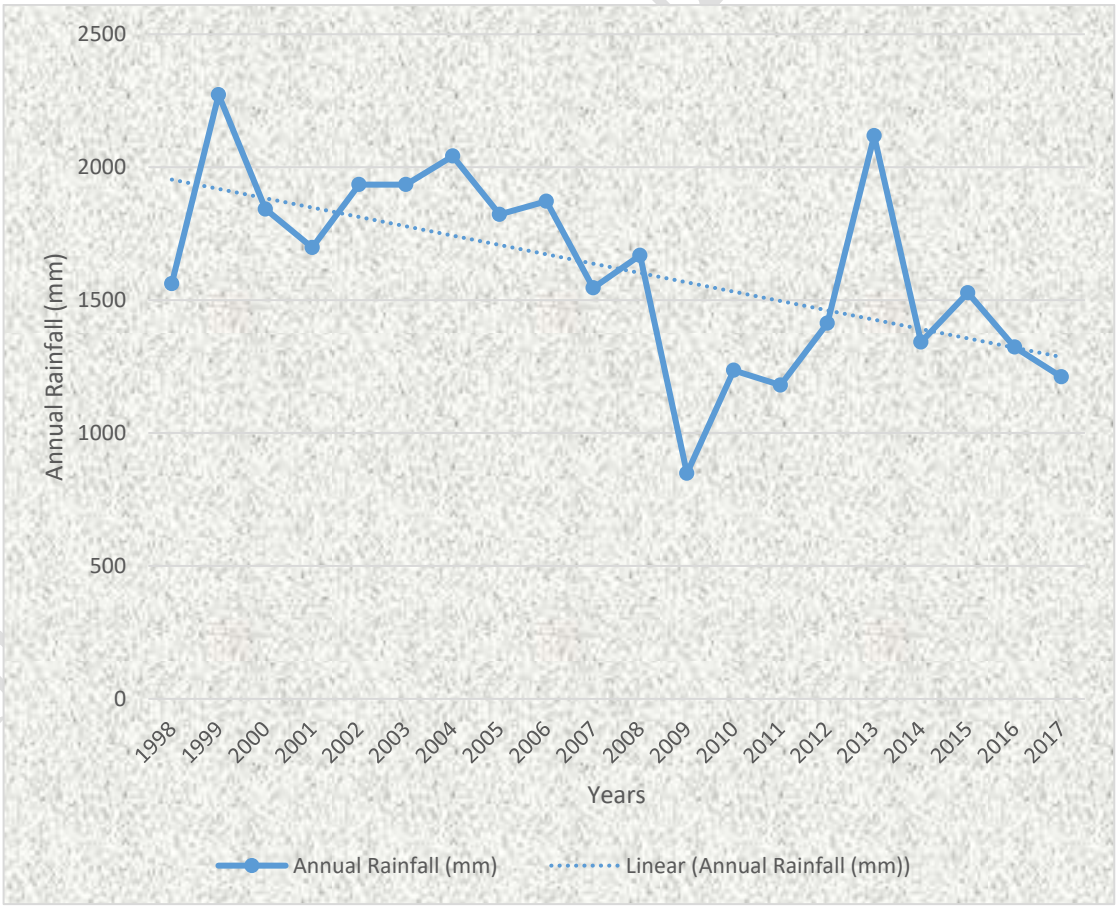

Figure 2: Annual Rainfall of the Study Area (1998 – 2017)

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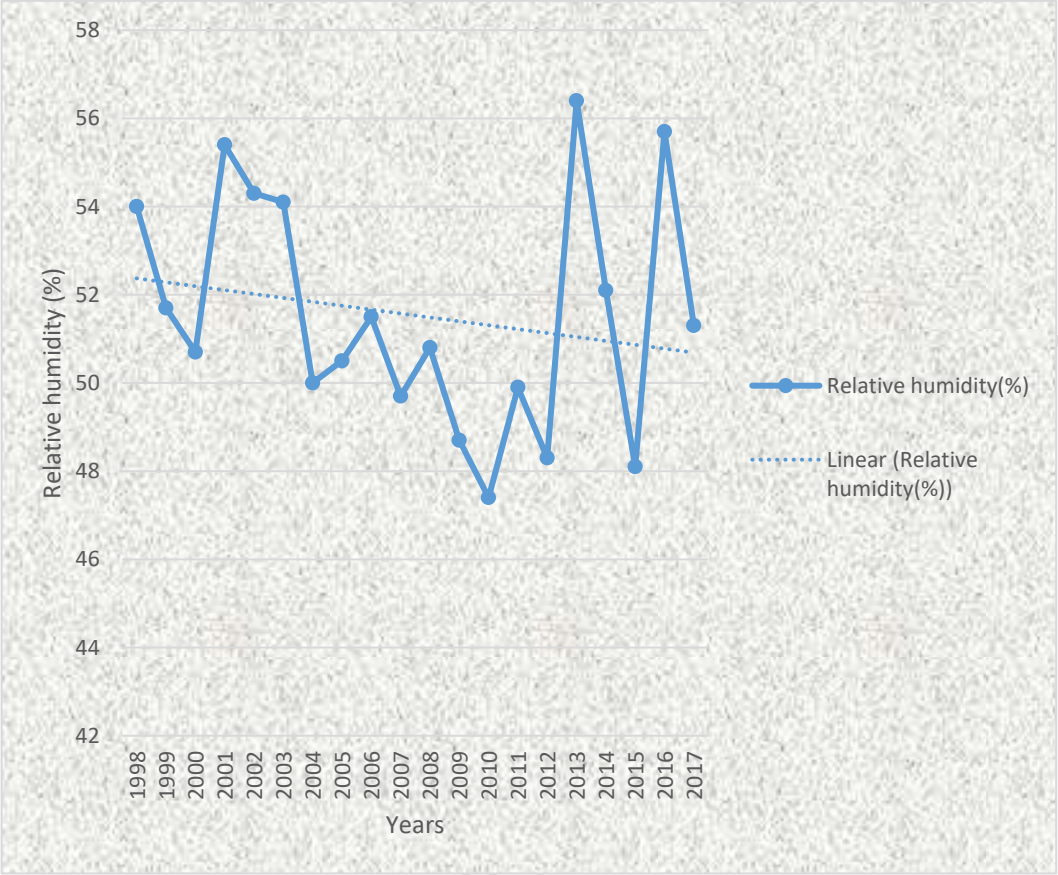

Figure 3: Mean Annual Relative Humidity of the Study Area (1998 – 2017)

As revealed in Figure 3 of the study, mean annual relative humidity tend to be decreasing despite the fluctuation. The highest mean annual relative humidity was recorded in the year 2013 with 56.4% and the least was recorded in the year 2010 with 47.4%. Cotton yield is a function of growth rates, flower production rates and boll retention during fruiting period depend on minimum relative humidity of 50%. This implies that the lower the relative humidity, the lower the cotton yield in the study area.

As revealed in Table 1, 301 respondents affirmed that their exist agro-constraints faced by cotton grower in the study area and 49 respondents said they do not suffer any agro-constraints since they have available fertilizers and pesticides. The details of these agro-constraints were given in Table 2.

Table 1: Presence of Agro-constraints Faced by Cotton Growers in the Study Area

Options	Frequency	Percentage (%)
Yes	301	86.0
No	49	14.0
Total	350	100

Source: Field Survey (2020)

The agro-constraints faced by cotton growers in the study area include inadequate fertilizer, inadequate pesticides, inadequate market opportunities, late planting, inadequate storage facilities after harvest and increased cotton diseases as indicated in Table 2 of the study.

Table 2: Agro-constraints Faced by Cotton Growers in the Study Area

Options	Frequency	Percentage (%)
Inadequate fertilizers	63	20.9
Inadequate pesticides	51	16.9
Inadequate market opportunities	32	10.6
Late planting	26	8.6
Inadequate storage facilities after harvest	59	19.6
Increased cotton diseases	70	23.4
Total	301	100

Source: Field Survey (2020)

As revealed in Table 2, increased cotton diseases ranked the highest with 23.4%, inadequate fertilizers ranked second with 20.9%, inadequate storage facilities after harvest ranked third with 19.6%, inadequate pesticides ranked fourth with 16.9%, inadequate market opportunities ranked fifth with 10.6% and late planting ranked the least with 8.6%. This implies that increased cotton diseases is the major agro-constraint facing cotton growers in the study area. About 23.4% of the respondents said their farms were attacked by aphids, bacteria blight (*Xanthmonas malvacearum* F. Smith) dowson and alternaria leaf spot (alternaria macopora Zim) the spread of these two diseases is capable of destroying an entire cotton crop. Most of the cotton

growers in the study area suffer in the hands of unscrupulous middle men who often exploit and rob them of benefits of their effort. The problem is compounded because of lack of interference by government on matters affecting marketing and pricing of cotton.

Table 3: Descriptive Statistics for Annual Rainfall and Cotton Production

	Mean	Std. Deviation	N
Cotton Yield (tonnes)	37.218	9.0383	20
Annual Rainfall (mm)	973.44	274.554	20

Table 3 revealed that standard deviation of cotton yield was 9.03tonnes and that of annual rainfall was 274.55mm. The mean of cotton yield was 37.21tonnes and that of annual rainfall was 973.44mm.

Table 4: Regression between Annual Rainfall and Cotton Production (ANOVA)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	1306.680	1	1306.680	34.440	.000[b]
	Residual	1062.329	18	37.940		
	Total	2369.010	19			
a. Dependent Variable: Cotton Yield (tonnes)						
b. Predictor: (Constant), Annual Rainfall (mm)						

At .05 confidence level, the significant value of F from Table 4 is 5.32. Hence, as value of F which is 34.44 is larger than 5.32, therefore indicates that there is a significant linear relationship between mean annual rainfall and cotton yield in the study area.

Table 5: Model Summary between Annual Rainfall and Cotton Yield

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.743[a]	.552	.536	6.1596

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As indicated in Table 5, R^2 was 0.552 for annual rainfall, thus, rainfall account for 55.2% of the explained variance between annual rainfall and cotton yield in the study area. This shows that other climatic variables like relative humidity and temperature too play significant role in cotton yield since the remaining 44.8% is left unexplained.

Table 6: Regression analysis between relative humidity and cotton yield

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	4.576	1	4.576	.054	.818[b]
	Residual	2364.434	18	84.444		
	Total	2369.010	19			

a. Dependent Variable: Cotton Yield (tonnes)

b. Predictors: (Constant), Relative Humidity (^{0}C)

At 0.05 confidence level, the F value from Table 6 is 5.32 therefore, since the F value of 0.54 is less than 5.32 indicates that a significant relationship exists between relative humidity and cotton yield within the study area.

Conclusion

The two main climatic elements of important to cotton production were found to be rainfall and relative humidity. When relative humidity rises above the acceptable limit (60%) for cotton growth, it brings about quicker development together with decreased cotton yields, consequently this discourages the farmers by lowering their morale and even their productivity. Agriculture and particularly cotton production in Zaria and Makarfi Local Government Areas is greatly sensitive to the variability in weather and climate, especially to those extreme weather phenomena like drought and severe storms.

From the foregoing findings, these conclusions may be drawn it is possible to grow cotton profitably if it is taken as a package. The study shows that yields are low due to inadequate fertilizer, inadequate pesticides, inadequate market opportunities, late planting, inadequate storage facilities after harvest and increased cotton diseases. Provision of enabling environment by

government in form of regulatory measures for marketing and prices will go a long way to facilitate increased cotton production.

Based on summary of findings and conclusion of this study, the following recommendations were highlighted to enhance cotton production in the study area and Kaduna State in general. Government as well as stakeholders alike should endeavor to facilitate lower input cotton cultivation and to promote its sustainability. They should also promote environmentally friendly farming technologies and instill in the farmers international best practices. The Kaduna State Agricultural Development Programme (KSADP) should device way to motivate its agricultural extension workers to be able to assist the rural cotton growers on enhanced productivity and to guide them on new agricultural innovations.

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