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ASSESSMENT OF CLIMATE VARIABILITY PERCEPTION AMONG FARMERS IN KEFFI LOCAL GOVERNMENT AREA, NASARAWA STATE, NIGERIA

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Abstract

Agricultural production is sometimes affected by the effects of variations in the climate which subsequently affect crop production. In this study, climate variability perception among farmers and its effects on cassava crop in Keffi Local Government Area is examined. Data of rainfall and temperature over a period of sixteen years in Keffi LGA were obtained from the Nigeria Meteorological Agency, National Programme on Food Security and Nasarawa State Ministry of Agriculture. This data was analysed using the correlation and regression analysis of the SPSS statistics package version 17 and trend function of the Microsoft Excel package. The result showed an increase in minimum temperature coupled with unreliable rainfall distribution over the investigated period. It identified poor yield with non-significant positive effect of rainfall, maximum and minimum temperature on cassava yield. The study recommends access to weather information for farmers which could serve as an adaptive strategy for positive crop yield production. The need to deploy Agricultural Extension Officers (AEO) to serve as guide to farmers through sensitization programmes and routine visit is imperative.

Keywords: Climate, Variability, Perception, Farmers, Crop

Introduction

There is a growing understanding that climate variability and change poses serious challenges to development in Nigeria (Dickson, 2010). The country is expected to experience changing pattern of rainfall, increased temperature leading to elevated evaporation rates and flooding. This will in turn lead to greater levels of land degradation, transmission of infectious diseases, and loss of surface and ground water potential. In addition, the Intergovernmental Panel on Climate Change (IPCC) projects that average global temperatures will increase by 1.4°C to 5.8°C every century (IPCC, 2004).

The United Nations Framework Convention on Climate Change (UNFCCC, 2012) in its Article 1 defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere, and which is in addition to natural climate variability observed over comparable time periods". The UNFCCC thus makes a distinction between climate variability attributable to human activities altering the atmospheric composition and climate variability attributable to natural causes, (Field and Van Aalst, 2014).

Climate change, according to Bernstein *et al* (2007), is a change in the state of the climate that can be identified e.g. by using statistical test, by changes in the mean and/or the variability of its properties that persist for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use.

According to the World Meteorological Organization (WMO, 2015), variation in the mean state and other statistics of the prevailing climate

variables on temporal and spatial states beyond normal weather is climate variability. It is used to denote changes in climate variables over a given period of time as compared to long-time statistics of respective climate variables. Climate variability is measured by calculated deviations, which are termed as anomalies (WMO, 2015).

Human activities such as fossil fuel burning and deforestation have altered the global climate resulting in increased temperature variability amount, intensity and distribution of precipitation and sea level rising (IPCC, 2007). According to some report, this anthropogenic effect is expected to continue in the foreseeable future; with changes in ecosystem service which affects people. Nasarawa State, Nigeria, had experienced adverse effect of climate change and variability. The overall natural resource base of the State is highly degraded. Its initial potential together with the current global warming aggravates the vulnerability of the people to climate change impacts. Various reports agree with the flooding that have occurred in different parts of the State is indicative of susceptibility of the State to climate change and variability.

Nasarawa Broadcasting Service (NBS) News Bulleting (2012) indicated that the most significant climate change in Nasarawa State is due to flooding and post-harvest loss of crops. Thus, people in Keffi Local Government Area of Nasarawa State are facing a variety of shocks and become vulnerable. Sometimes farmers' perception about climate change has no evidence from weather monitoring stations (Maddison, 2006). In most cases of Keffi, people perceived decline in rainfall and increase in frequency of drought, but it is not confirmed from weather station. Research report from Oxfam (2010) indicated that observations on meteorological station lack correlation with local farmers' perception. This could have resulted due to the fact that farmers assess rainfall in relation to the needs of particular crops at particular times; small changes in the quality, onset and cessation of rain over days or even hours can make a big difference, whereas meteorological data is more likely to measure totals and larger events.

Agriculture is extremely vulnerable to climate variation. Higher temperatures eventually reduce yields of desirable crops while encouraging weed and pest proliferation. Changes in precipitation patterns increase the likelihood of short-run crop failure and long-run product decline. The overall impacts of climate variation on agriculture is expected to be negative although there will be gains in some crop in the region of the world threatening global food security (Nelson *et al,* 2009).

Objectives

The following are the objectives of the study:

i. Examine the trend of rainfall in Keffi Local Government Area from 2000 - 2016.

ii. Examine the trend of temperature in Keffi Local Government Area from 2000 -2016.

iii. Determine the relationship between rainfall and temperature in Keffi Local Government Area.

iv. Examine the effects of rainfall and temperature on crop yield in Keffi Local Government Area.

The Study Area

Keffi is within the central part of Nigeria, located between latitude 8°90'N to 9°00'N and longitude 7°75'E to 8°00'E (Fig. 1). Keffi has an area of 138km^2 and a population of 92,664 at the 2006 census. Keffi is bounded in the west by Karu Local Government Area of Nasarawa State and Federal Capital Territory, Abuja, in the north by part of Kaduna State, in the south by Nasarawa Local Government Area and in the east by Kokona Local Government Area. Keffi town consist of 10 political wards namely; Rimi, Liman Abaji, Tudun Kofar, Yara, lya I, lya II, Goriya, Jigwada, Sabon Gari and Gangaren Tudu wards.

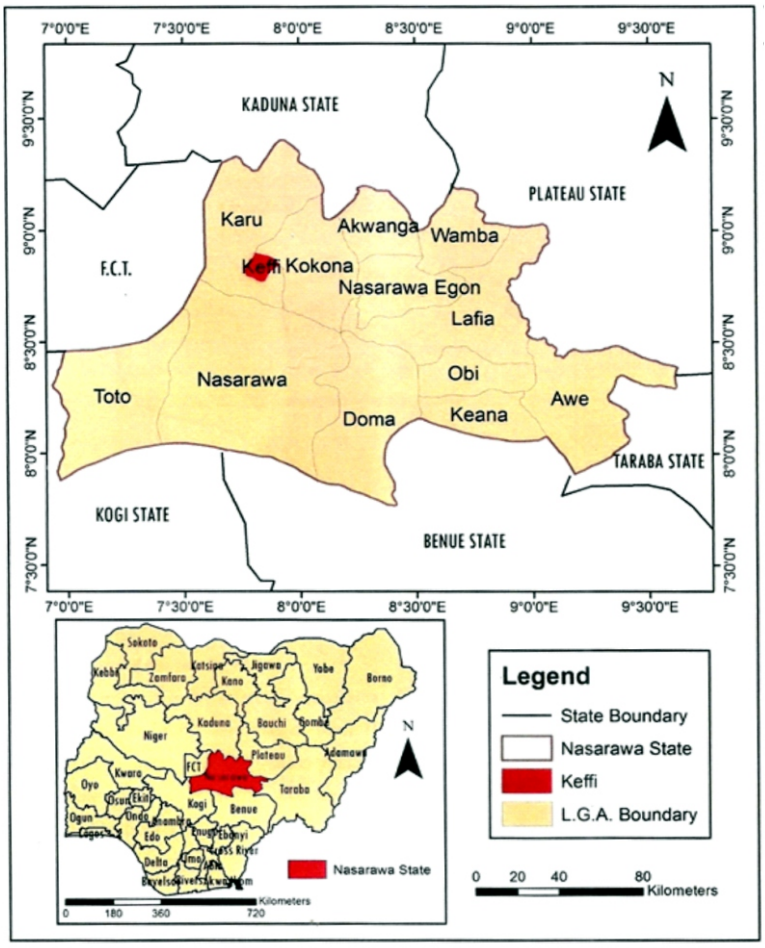

Figure 1: Map of the study area.
Source: NAGIS, 2018.

Materials and Methods

Nature and Sources of Data

The study utilized the use of secondary data in the analysis of the effect of rainfall and temperature variations on agricultural production in the study area. Climate data constituting of annual rainfall and temperature for Keffi Local Government Area were obtained from Nigeria Metrological Agency (NIMET) Lafia, while data on the selected crop yield was obtained from the National Programme for Food Security, Nasarawa State Ministry of Agriculture, Lafia (Table 1).

Data Analysis

The data for this study was be processed and analyzed quantitatively. The quantitative data will be analyzed using both descriptive and inferential statistics with the aid of the Microsoft excel and SPSS statistics software version 17. The inferential statistics that were employed in this study was a correlation and regression analysis. The findings of the study are presented in forms of tables, charts and graphs.

Trend Analysis

The Microsoft Excel function of linear trend as well as line chart was used to analyze the trend of climate variability in the district. The line charts, trend lines, trend equations and the degree of variations were used to determine the nature and direction of the trend of the variable under investigation i.e. temperature (maximum and minimum) and annual rainfall.

Regression Analysis

To measure the effect of key climatic variables (temperature and rainfall) in the selected crops yield while controlling the influence of the other confounding (independent) variables as irrigation, regular weeding, soil types, use of agro-chemical and crop variety, the hierarchical multiple regression model was used. Hierarchical multiple regression is used to measure changes that occurred in the dependent variable with change in the independent (Predictor) variable.

Results and Discussion

Rainfall trend in Keffi Local Government Area

Figure 2 shows the detailed account of the rainfall variability trend in Keffi LGA. The annual rainfall amount indicates a decreasing trend, irrespective of the increase in temperature over the period under consideration. From the graph, it can be observed that there was a sharp decrease in annual rainfall from 1414.5mm in 2001, to 1192.7mm in 2002. This decrease was however quickly followed by a sharp increase in the years 2003 by 1406.8mm. A careful observation of the trend graph indicates that the increase was only temporal, as the year 2004 recorded a decrease in rainfall at 1305.0mm. A careful look at the graph indicates a fluctuating increase and decrease in annual rainfall between the years 2005-2007, at 1290.7mm, 1319.9mm and 1279.6mm respectively. Hence, we can conclude that the variation in rainfall recorded for these three years was almost the same. The year 2008 however, recorded a very steep decrease in annual rainfall at 1141mm. A sharp increase was recorded for the year 2009 at 1595.7mm. This increase however was not steady as it was quickly accompanied by a decrease in 2010 and 2011 at 1438.3mm and 1261.4mm respectively. The trend graph further indicate an almost the same amount of rainfall between the years 2011-2015, at 1261.4mm, 1321.2mm, 1297.8mm and 1322.3mm, while a drastic decrease was recorded in 2016, at 1198.1mm.

Hence, It is obvious from the graph that there has been an experience in the number of variation in rainfall in Keffi LGA over the period of time under consideration (2001-2016), with the highest rainfall recorded in the year 2009 at 1595.7mm, while the least amount of rainfall was recorded in the years 2007 and 2016 at 1141mm and 1198.1mm respectively.

The trend equation and trend line of the annual rainfall indicates a gradual decreasing trend (0.656x). This by implication simply implies that the annual rainfall pattern over the period of 2001-2016 is at gradual and steady rate.

The general decrease in annual rainfall may be due to the fact that some years recorded low rainfall which might have gradually influenced the overall trend. For instance, from the trend graph, it can be observed that the annual rainfall recorded in the area had the following data: 2002 (1192.7mm), 2005 (1290.7mm), 2007 (1279.6mm), 2008 (1141mm), 2011 (1261.4mm), 2014 (1297.8mm) and 2016 (1198.1mm). This by implication simply implies that even though annual rainfall decreased over the time period, the rate of decrease was gradual. The gradual declining records of rainfall in some periods of the years under consideration may be of invaluable benefits to some crop production, especially those crop that do not require excessive rainfall. It is also important to stress that the decrease in the amount of rainfall in the area of study may be due to the low temperature recorded, due to the decrease in evapotranspiration rates. Low temperature ensures an appropriate amount of moisture in soil, which tends to have positive effects on crops.

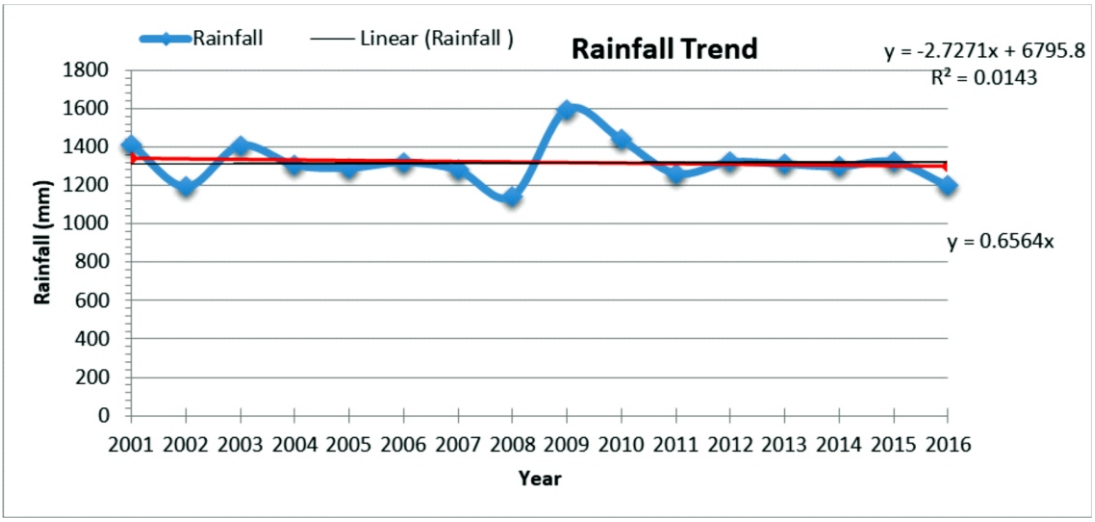

Figure 2: Annual rainfall trend in Keffi LGA.
Source: field work, 2018.

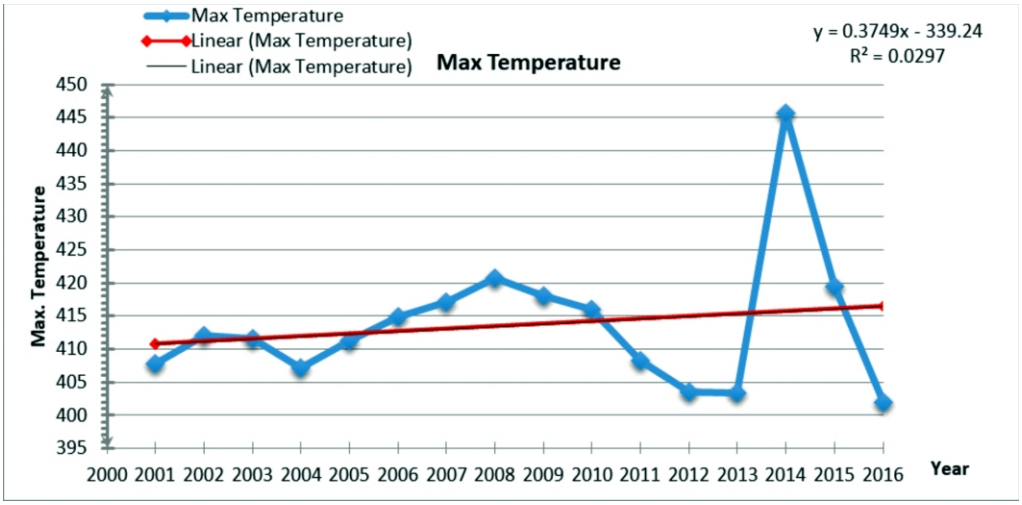

Figure 3: Maximum temperature trend in Keffi LGA.
Source: field work, 2018.

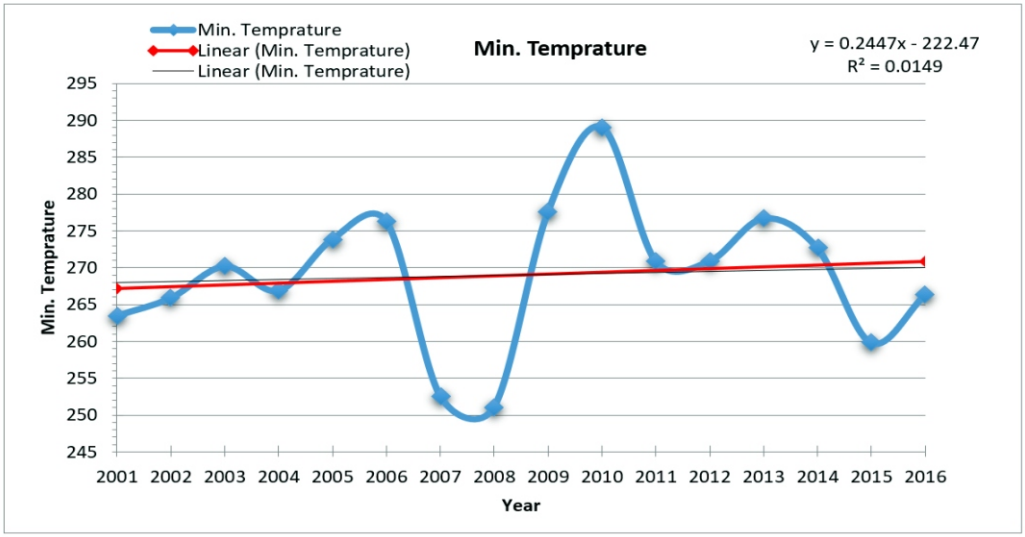

Figure 4: Minimum temperature trend in Keffi LGA.
Source: field work, 2018.

Maximum Temperature in Keffi Local Government Area

In determining trend, the temperature variable was subjected to trend analysis with the aid of Microsoft excel function of trend. From the trend graph in Figure 3, it is quite evident that the maximum temperature has been on a constant variation over the period of study. This oscillate behaviour is most notably within the first eight years (2002-2008) of the period under study. However, the period between the years 2009-2013 experienced a steady decrease in maximum temperature. The time series trend reveals that the year 2014 recorded the highest maximum temperature, at 445.6°C. The preceding years 2015-2016 however, recorded a steep decrease in maximum temperature at 259.8°C and 266.3°C respectively. The trend equation shows a gradual increasing trend (0.206x) implying a gradual increase in the average temperature over the period of 2001-2016.

Minimum Temperature in Keffi Local Government Area.

Figure 4 depicts the minimum temperature trend in Keffi Local Government Area. A careful look at the figures suggests a cyclical trend in minimum temperature in the area of study over the time span. A gradual and steady increase in maximum temperature was recorded within the periods of 2001-2006 at 263.5°C, 265.9°C, 270.2°C, 273.9 and 276.3°C respectively. However, it is important to note

that within these periods; only the year 2004 recorded and slight dip minimum temperature, at 266.9°C. A steep decline in minimum temperature was recorded for the year 2007 and 2008, at 252.6°C and 251.1°C. The year 2009 and 2010 recorded an astronomical increase in minimum temperature, with the 2010 having the highest record of minimum temperature at 289.1°c. A slight constant decrease occurred in 2011 and 2012 at 270.9°C, respectively, while the preceding year (2013) recorded a minuet increase in minimum temperature at 276.7°C. The year 2014 and 2015 recorded a dip in minimum temperature, preceded by a slight increase in 2016 at 266.3°C. The trend equation and trend line indicates a gradual increase in minimum temperature (0.133x) in Keffi Local Government Area over the period under study.

The implication here is that an increase in minimum temperature to crop will affect photosynthetic activities of crops which may in the long run affect the yield of crops.

Relationship between Rainfall, Temperature and Crop yield in Keffi Local Government Area

The relationship between rainfall, temperature and sampled crop was examined through correlation analysis as shown by the result extract in Table 2. The result by interpretation indicates a weak positive relationship between rainfall and cassava yield (0.028) in the area of study. The results further reveal a weak negative relationship between maximum temperature (-0.222) and cassava yield in the study area. The relationship between the sample crop (cassava) and minimum temperature was also tested. From the result extract in the table above, there is a weak negative relationship between minimum temperature and cassava yield.

Effect of rainfall and Temperature on Crop Yield in Keffi Local Government Area

In order to evaluate the effects of rainfall and temperature on crop yield in Keffi Local Government Area, a multiple regression analysis was done. Regression analysis is a set of statistical processes for estimating the relationships among variables. A regression analysis was employed because it helps one understand how the typical value of the dependent variable (or criterion variable) changes when any one of the independent variables is varied, while the other independent variables are held fixed.

The result extract in Table 3 depicts the effect of the variation in rainfall and temperature on cassava yield in the area of study. The coefficient of determination (R^2), which is the proportion of the variance explained in the dependent variable (cassava yield in this case), that is predictable from the independent variable(s) (Rainfall, Maximum and Minimum Temperature), was arrived at 0.111.

Table 1: Average Rainfall and temperature data with crop yield (2001-2016)

Year	Rainfall (mm)	Max Temperature (T ºC)	Min. Temperature (T ºC)	Cassava (mt)
2001	1414.5	407.7	263.5	669.2
2002	1192.7	412.1	265.9	655.9
2003	1406.8	411.6	270.2	643.6
2004	1305	407.1	266.9	618.4
2005	1290.7	411.2	273.9	393.4
2006	1319.9	414.9	276.3	246.8
2007	1279.6	417.1	252.6	271.5
2008	1141	420.7	251.1	246.8
2009	1595.7	418.1	277.6	253.7
2010	1438.3	416	289.1	201.4
2011	1261.4	408.3	270.9	189.2
2012	1321.2	403.5	270.9	149.4
2013	1311	403.3	276.7	137.8
2014	1297.8	445.6	272.7	205.7
2015	1322.3	419.4	259.8	137.9
2016	1198.1	401.9	266.3	294.6

Source: Nigerian Metrological Agency and National Program for Food Security

Table 2: Correlation analysis of Rainfall, Temperature and Crop yield

Crop (mt)	Rainfall (mm)	Max Temperature (T °C)	Min. Temperature (T °C)
Cassava	0.028	-0.222	-0.172

Table 3: Regression analysis of Rainfall, Temperature and Crop yield

Variables	R-Square (r^2)	Unstandardized Coefficients		Standardized Coefficients	Sig.(P-value)
		B	Std. Error	Beta	
Constant	0.111	3426.803	2726.594		0.233
Rainfall		0.371	0.599	0.203	0.547
Max. Temperature		-4.681	5.234	-0.245	0.389
Min. Temperature		-6.122	6.806	-0.294	0.386

a. Predictors: (Constant), Minimum Temperature, Maximum Temperature, Rainfall
b. Dependent Variable: Crop Yield (Cassava)

This thus implies that 11% of the variation in cassava yield is explained by the variation in rainfall, minimum and maximum temperature between the periods of 2001-2016 in Keffi Local Government Area. It is important to further state that the magnitude of effect by the predictors (rainfall, minimum and maximum temperature) varies. Rainfall had a non-significant effect as indicated by a level of significance (P-value) of 0.547 which is greater than 0.05 (P-value > 0.05) level of significance and a coefficient value of 0.371. This by extension implies that for every unit (mm) decrease in rainfall over the period of investigation, cassava yield decreases by 0.371mt.

In the same vein, maximum temperature had a non-significant effect at 0.389 level of significance which is > 0.05 level of significance. With a coefficient of -4.681, it thus implies that a unit increase in maximum temperature resulted to a negative effect on cassava yield in the study area, as yield decreased by -4.681mt per unit increase in temperature (1°c). Similarly, minimum temperature had a positive non-significant effect on cassava yield as indicated by 0.386 level of significance, which is > 0.05 level of significance. The result further reveals a coefficient of -6.122.

Conclusion

The study established that there is a minimal variability in rainfall and temperature characteristics, which translates into proportional variability in cassava yield in Keffi Local Government Area. Data were collected over a period of sixteen (16) years from the Nigeria Metrological Agency and National Program for Food Security, Abuja. The data were analyzed using correlation and regression analysis with the aid of the SPSS statistics package version 17, while the trend function was done with the aid of Microsoft Excel. The result shows an increase in minimum and maximum temperatures, coupled with unreliable rainfall distribution over the investigated period. The study identified poor yield with non-significant positive effect of rainfall, maximum and minimum temperature on cassava yield. To ensure that the negative effect of rainfall and temperature variability on crop yield is reduced and cassava production generally enhanced in Keffi Local Government Area, access to weather information by crop farmers can enhance adaptive strategies of farmers. This can reduce the adverse effects of climate variability on their activities. Therefore, efforts should be made to provide a forecast of the weather on a regular basis through the electronic media such as radio stations in the Local Government Area, to update farmers on the weather dynamics to enable them plan well for their farming activities. Agricultural Extension Officers (AEOs) should be deployed to guide farmers through routine visits, sensitization programs on variability in rainfall and temperature characteristics, use of farm inputs and monitoring of crop-climate relationship in the area in order to achieve improved crop yield.

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