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Article: **Appraisal of Seasonal Rainfall Prediction and Utilization: A Case Study of Kano State, Nigeria**

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Appraisal of Seasonal Rainfall Prediction and Utilization: A Case Study of Kano State, Nigeria

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Abstract

This work evaluates the accuracy of seasonal rainfall prediction by the Nigerian Meteorological Agency by comparing it with the actual amount of rainfall received. It also measures the perception of the farmers regarding such prediction in the case of Kano State using data collected for the years 2009-2015. A total of eighty structured questionnaires were administered to the respondents in selected areas including Mariri, Hotoro, Zaria road and Gwarzo using purposive and snowball sampling techniques. When comparison between the predicted and the observed amount of rainfall received in the study area was made, the outcome showed a high level of variation throughout the years under study. The results further revealed that the majority of the respondents were not aware of convectional rainfall levels or assumed that the modern prediction method is unreliable. The current study recommends massive sensitization of farmers about the modern rainfall prediction methods considering the erratic nature of the weather and the changing climate, particularly in this era of global climate change.

Keywords: forecasting technology, global climate change, Kano, Nigerian Meteorological Agency, West African Region

Introduction

Despite the recent developments in weather forecasting technology, reliable information about meteorological data still requires accuracy particularly in the developing countries. Climate conditions in Nigeria and other developing countries are almost the same, though it affects each area disproportionately. The assessment of seasonal rainfall system will not only provide tremendous assistance to the farmers, but it would in no small measure enhance sustainable agriculture and resource management in the country (Ayoade, [1993](#)). Therefore, accurate and reliable information about rainfall is very essential for the farmers. According to Omogbai ([2010](#)) various studies on seasonal rainfall have been carried out that

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explain the relationship between rainfalls over West Africa, especially in the Sahel regions. Owen and Ward (1989) envisage that onset and cessation dates of the rainy season are essential to the success of farming activities in Nigeria. Multi-year and decadal predictions of weather also influence a farmer's investment decisions during growing seasons. Knowledge of local weather and climate no doubt improve the harvest, adequate planning subsequently influences the individual farmer yields. Determining the onset, cessation, time of growth, and information of the dry spell patterns within rain-season are equally useful for land preparation and planting activities Iloeje (1979).

Accordingly, (NIMET, 2016) prediction showed that many parts of Nigeria are likely to experience less than normal rainfall which is attributed to the effect of strong El Nino that has persisted since 2015. Generally, many farmers in Nigeria considered climate change as a scientific advancement while others looked at it as a traditional phenomenon and as a way out for superstitions, thus, climate change has varied explanations (Kemausuoret al., 2011). However, despite the advancement in scientific prediction of seasonal variability of climate over Sahelian regions in which most parts of Nigeria are covered, seasonal planting problems still persist. This study is an attempt to evaluate seasonal rainfall predictions and its application among various farmers in Kano state who rely on seasonal rainfall regime for survival.

Study Area

Kano could be found in the northwestern part of Nigeria. It is the second largest city in the country after Lagos and Ibadan respectively. According to the National Population Census (NPC) of 2006, Kano stands out to be the most populous city in the northern part of Nigeria, with a population of about 9,383,682 million. The entire location of Kano could be found between latitude 12° 00'N and longitude 8° 31' E of Greenwich meridian. It occupies an area of about 683 km square, with a distance of 19km from east to west and about 15km from north to south (see fig.1.). Kano state features a Tropical Savannah climate; it enjoys an average of 980mm (38.6in) of annual precipitation that is experienced from the months of June through September. Rainfall may not be enough to sustain farming but is supplemented with the local and semi-modern irrigation systems.

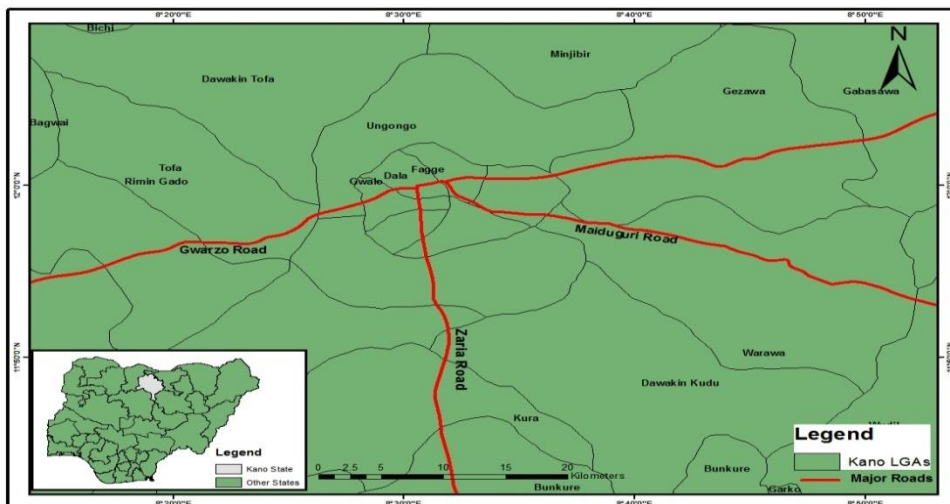
Economic / Industrial Activities

Farming activities in Kano involve subsistence and commercial agriculture and they are mostly carried out abundantly in the outlying districts of the city. Mostly, food crops are cultivated such as; millet, cowpeas, sorghum, maize and rice for

local consumption, while groundnuts and cotton are produced for export and industrial use. During the colonial period, groundnuts were produced in pyramids in Kano and are exported to many countries in Europe and other areas. This constituted one of the major sources of revenue for the country. Kano is a major producer of hides and skins, sesame, soya bean, cotton, garlic, gum Arabic and chili pepper. Apart from this, Kano also was the second largest industrial center after Lagos in the country. It has large industries that produce textile, tanning, footwear, cosmetics, plastics, enamelware, pharmaceuticals, ceramics, furniture and other allied industries. It also produces agricultural items, soft drinks, food and beverages, dairy products, vegetable oil and animal feeds among others (Ibrahim & Bamikola, [2007](#)).

Figure 1

Kano State Map Showing LGAs



Source: Kano State Urban Planning and Development Authority (KNUPDA)

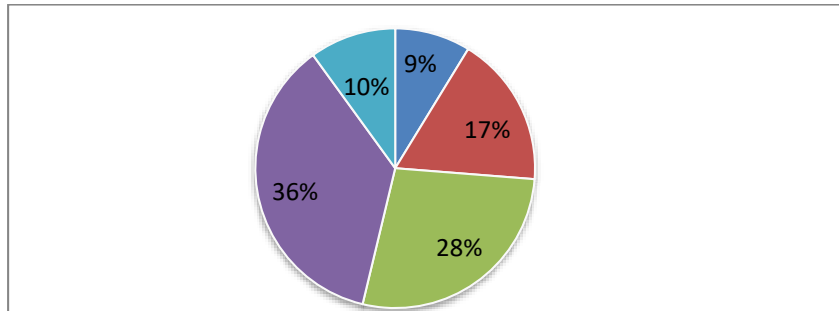
Methodology

Socioeconomic Characteristics of Respondents

During the interviewing sessions, it was discovered that the highest numbers of respondents (farmers) are those between the ages of 41-50 years and above who constituted about 36.3%. The lowest and intermediate age group falls within 20 and 40 years respectively. Going by this age grouping it is obvious that majority of the respondents are therefore in their productive years and they have full energy and are capable of engaging actively in farming (see fig.2.).

Figure 2

Age of Respondents Engaged in Farming Activities

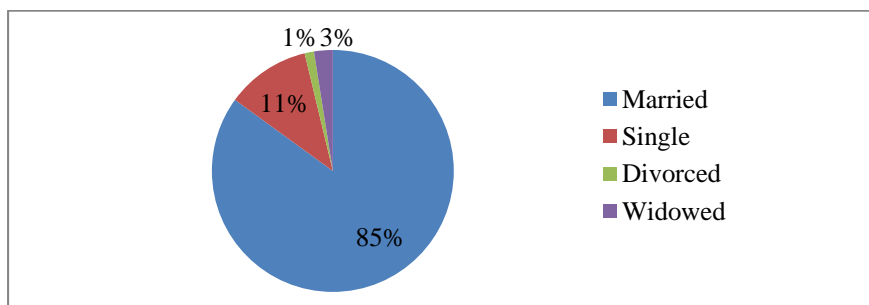


Source: Authors' compilation.

Accordingly, figure 3 illustrates the sex of the sampled respondents. Male farmers have the highest percentage with 92.5% while female farmers have the lowest percentage with only 7.5%. This is due to cultural practices in the study area, where males engaged in farming activities dominate. Women play an inferior role in farming activities as they are restricted to weeding, threshing, and harvesting and at times clearing of land and other minor engagements. As being a normal practice in Nigeria's Kano state, families engaged in farming use both family members and animals for irrigation, harrowing, planting and harvesting, thus a large family is needed and maintained. The marital status of the respondents here indicates that the number of the married farmers is very high which constitutes 85% of the total, followed by those farmers who are single with 11.3% of the total respondents, while those farmers who are widowed and divorced constitute of about 4% of the respondents.

Figure 3

Marital Status of Farmer



Source: Authors' compilation.

In rural Kano like any other part of the rural Northern Nigeria, early marriage is very common and widely practiced. The fact that most of the farming activities require human labour, most farmers are married, have many wives and children. This interprets that the more children they have (mostly males) the more they can engage in lucrative farming and the more wealthy they are in this practice (see fig.3).

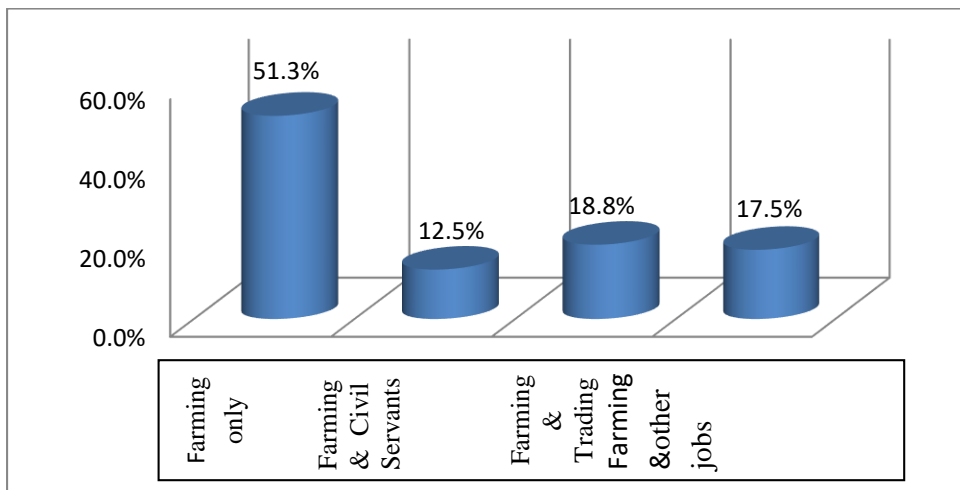
The educational qualification of the respondents is analyzed as those who attend primary schools have the highest percentage with 38.8%, followed by those that have Islamic education with 37.5%, while tertiary and secondary education are 11.3% and 12.5% respectively. It shows that the majority of the farmers have attended primary and Islamic education. In Northern Nigeria priority is given to Islamic education than western education. The policy of the Government which encouraged rural people to acquire basic education resulted in large number of the rural populace attending primary schools which are often found in each and every locality.

However, many of the respondents engaged in other trade apart from farming, their submissions are discussed herein (see fig.4). The highest percentage of the respondents engaged in farming are represented by 51.3%, while those that engaged in farming along with civil service work are represented by 12.5%. The reason behind this is that most of the farmers that obtained informal education or none at all are seriously engaged in farming than those who received formal education as they become civil servants and thus take less priority in farming.

Apart from the above discussion, farmers (respondents) have developed different kinds of agricultural practices. This is represented in table 1. It can be seen that the majority of respondents 37(46.3%) of the total were engaged in rain fed agriculture during the rainy season, and had carried out this for twenty five years or more. While only 9(11.3%) of the respondents were engaged in both rain fed and dry seasonal agricultural activity. Those who were engaged in both rain fed and irrigation farming are those who have access to regular water supply mostly from irrigation canals or river channels and were 11(13.8%). The presence of Tiga, Challawa and Kadawa Dams facilitated the practice of both rain fed and dry season farming. In other words, Kano state has been endowed with many dams and streams over year round farming system. This shows that none of the respondents practiced dry seasonal agricultural activity only.

Figure 4

Respondents that Engaged in Farming and other Occupations



Source: Authors' compilation.

Table 1

Years of Experience in Agricultural Production

| Years | Frequency | Percent (%) |
|--------------|-----------|-------------|
| 1>5 years | 09 | 1 11.3 |
| 65-15 years | 23 | 2 28.8 |
| 116-25 years | 11 | 1 13.8 |
| 1 <25 years | 37 | 4 46.3 |
| Total | 80 | 100.0 |

Source: Authors' Compilation.

Farmers in Kano state in general engaged in different crops production but they specialized in both food and cash crops such as sesame, millet, chili pepper, beans, soya bean, cotton, garlic, and gum Arabic among others. Table 2 shows the type of crops produced by the respondents. Majority (62.5%) were engaged in food crops production while 22.5% cultivate cash crops while only the remaining 15% practice both cash and food crops production in the area.

Table 2*Major Crops Planted by the Seasonal Farmers in Kano State*

| Crops | Frequency | Percent (%) |
|------------|-----------|-------------|
| Cash crops | 18 | 22.5 |
| Food crops | 50 | 62.5 |
| Both crops | 12 | 15.0 |
| TTotal | 80 | 100.0 |

Source: Authors' Compilation.

With respect to awareness and reliability of NIMET's prediction, table 3 shows results of majority of respondents (67.5%) who do not have any idea about NIMET seasonal prediction and reliability. However, 8.8% of the respondents claimed that they have knowledge of NIMET prediction and they perceived it as highly reliable, while 23.8% of the respondents perceived the prediction as unreliable. Going by this finding, it can be inferred that majority of the respondents have no idea of the prediction and others considered it as unreliable and believe that only nature determines the operations of weather elements and prediction over it, as it is beyond human control.

Table 3*Shows Rating of Seasonal Rainfall Prediction*

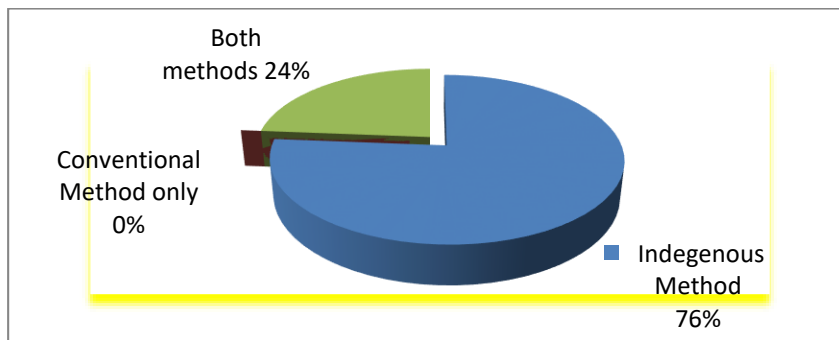
| Perception | Frequency | Percent (%) |
|-----------------|-----------|-------------|
| Highly reliable | 07 | 8.8 |
| Unreliable | 19 | 23.8 |
| No idea | 54 | 67.5 |
| Total | 80 | 100.0 |

Source: Authors' Compilation.

The results presented in figure 5 show the method that the respondents adopted in forecasting rainfall. A majority of respondents use indigenous method of forecasting with 76.3%, none of the respondents use conventional method alone, but 23.8% use both indigenous and conventional method of forecasting.

Figure 5

The Seasonal/Time Forecasting Methods Adopted by Farmers



Source: Authors' compilation.

Interpretations:

Indigenous methods of forecasting help in planning for sustainability and these involve several indications such as:

- i. Variation in tree phenology such that certain trees/plants reveal some changes as a result of effect of seasonal cycle on biological phenomenon (Jiri, [2015](#))
- ii. Appearance due to changes in animal behaviors. Some pastoralists predict some weather/climate conditions such as when animals show change in plumage like birds' camels, foxes and other wildlife (Acharya, [2011](#)).
- iii. Distress and discomfort may be predicted as an impending danger like flooding or drought (Kagunya et al., [2016](#)).
- iv. When flying ants are seen during rainy season, this indicates a warning of plentiful rainfall in the year.
- v. Appearance of many termites or other insects undergoing modification of their reproductive and feeding behaviours is an indication of weather changing to near rainfall onset.
- vi. When a swarm of worms is found on trees during October it suggests abundant rainfall in the upcoming season (Kagunya et al., [2016](#)).
- vii. When frogs start to make noise, it signifies the onset of rainfall. The more the noise the more rainfall in the coming rainy season.
- viii. Observation of Celestial Bodies; if there is change in the pattern and constellations of different celestial bodies such as the Sky, the Sun, the Moon and different Stars; this indicates that clues to search on weather and climate

are readable among indigenous people (Shoko & Shoko, [2013](#); Elia et al., [2014](#)).

- ix. Winds: variation in the nature of wind has been used by traditional societies in the tropical countries as an indicator of weather changes since times immemorial to show; direction, strength, duration and force of winds that blow at different seasons and, these are used as sources of information for predicting the weather (Jiri et al., [2015](#)).

The result presented in table 5 shows the source of information about seasonal rainfall prediction of the respondents, which the majority of the respondents claimed to have been derived from radio or television announcements, with 42.3%, while 30.72% got their information from Agricultural Extension Workers. Other respondents sourced their information through print media and bulletin of NIMET which constitutes 26.88%.

Table 4

Media Print Information on NIMET Seasonal Rainfall

| Information | Frequency | Percent (%) |
|--------------------------|-----------|-------------|
| Radio/Television | 11 | 42.30 |
| Print media | 04 | 15.36 |
| Bulletin of NIMET | 03 | 11.52 |
| Agric. Extension Workers | 08 | 30.72 |
| Total | 26 | 100.0 |

Source: Authors' Compilation.

The information in table 5 presents how some of the respondents rated the NIMET Seasonal Rainfall Predictions (SRP), only 7(6.8%) farmers considered the SRP excellent, while 09 (47.4%) of the respondents rated the SRP as good, while, only 03 (15%) respondents said that the prediction was fair. This shows that conventional method of weather prediction is widely accepted by some farmers in the study area.

On the other hand, the opinion of the respondents on whether agricultural activity was affected by rainfall predictions or not was also determined because most of the respondents believed that agricultural activities are always affected by rainfall predictions. For instance, 7(89.5%) have this belief while the remaining 2 (10.52%) of the respondents did not believe that rainfall prediction had an impact on agricultural activities. It can be concluded that, farmers benefit from the seasonal rainfall predictions for their agricultural activities (see table 6).

Table 5*NIMET Seasonal Prediction Rating in the Study Area*

| Scoring | Frequency | Percent (%) |
|-----------|-----------|-------------|
| Excellent | 07 | 36.8 |
| Good | 09 | 47.4 |
| Fair | 03 | 15.8 |
| Total | 19 | 100.0 |

*Source: Authors' Compilation.***Table 6***Impact of Rainfall Prediction on Agricultural Practice in the Study Area*

| Respondents Confirmation | Frequency | Percent (%) |
|--------------------------|-----------|-------------|
| Yes | 17 | 89.5 |
| No | 02 | 10.5 |
| Total | 19 | 100.0 |

Source: Authors' Compilation.

Findings and Discussion

Our findings from this work show the evaluation of rainfall characteristics as indexes where farmers responded more to traditional prediction and utilization than to modern methods in the choice. They are: the onset, cessation, and length of rain as well as the total amount of annual rainfall is also in the study area, that is, Kano State LGAs before they embark on annual farming. In the first place, data of mean annual rainfall in Kano state was displayed in figures 5-12 for vivid clarification, while comparison between predicted and actual values of rainfall characteristic in Kano areas was shown (see appendix A) as well as the onset and cessation for the year 2009-2015 was equally portrayed in the graphs (figures 5-12). The length of growing (crops) was also determined from the analysis. The onset and the cessation dates marked the growing and end season as well as the number of rainy days that were considered as shown in details. The analyses are presented here-in figures.

The results presented from the year 2014 (fig.11) showed the predicted and actual values of rainfall characteristics in Kano from 2009-2015. The rainfall characteristics were all displayed in figures. The prediction model is based on strong telecommunication system across Nigeria by the NIMET, while the actual values were computed using Ilesanmi's (1972) methods of seasonal rainfall

prediction. The result in 2009 for seasonal rainfall predictions values provided, varies remarkably with the actual value in that year with about 387.7mm surplus as recorded. This was due to early onset and late cessation observed in Kano, while in 2010 the values presented in SRP by NIMET are 783mm while the actual value observed is about 1080.5mm, this situation, unexpectedly increases the amount of rainfall in the study area that experienced flood disaster. For onset and cessation date the margin of error still within or plus or minus 2 weeks of NIMET criteria was recorded to be 13 days. The analysis in 2011 show that the predicted values significantly vary with about 490mm, that is unprecedented. However the onset date started earlier than the predicted date while the season retreat date also differed but with small margin.

Further analysis in table 3 shows prediction in 2012 and was based on ENSO – neutral conditions in 2012 growing season, the result also shows that the onset begun early and both predicted and observed values almost agreed to each other. Likewise the cessation date was with observed with little variation although it falls within the margin of error between 1-6 days as predicted by (Nigerian Meteorological Agency, [2011](#)).

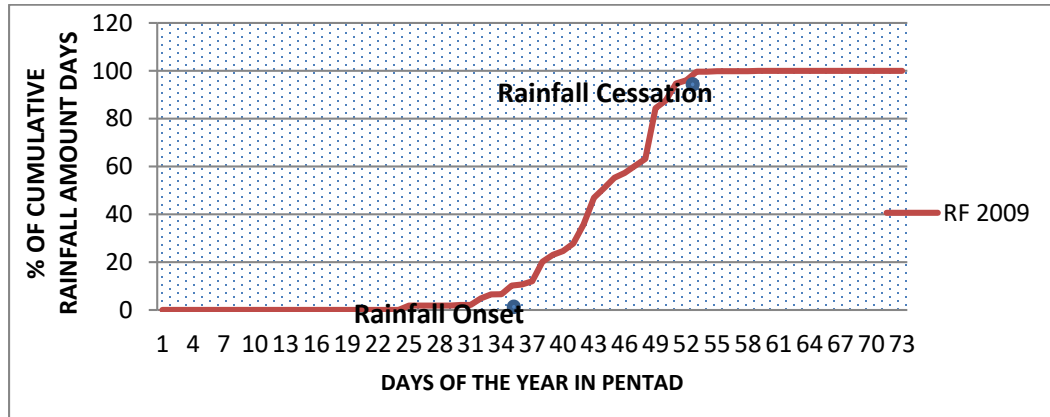
The analysis of 2013 compares the observed and predicted length of the rainy season presented in table 3, which shows disagreement, but for onset and cessation there is a slight variation of 5 days which falls between the margin errors. The analysis confirms that both Nigerian Meteorological Agency, ([2011,2016](#)) and Ilesanmi's ([1972](#)) methods are reliable. According to Ogungbenro ([2014](#)) fairly accurate determination of cessation of rains might not only facilitate cessation of a dependable duration of the rains at a given location but also helps in crop varieties that will mature at the end of the growing season. However 2014 record shows that seasonal rainfall predictions values provided were different from the actual value observed in that year with about 445.0mm surplus of rainfall despite the late onset date which is around 25th June, the variation shown is way wide.

The length of rainy season is about 107 as against 159 predicted by Nigerian Meteorological Agency ([2016](#)). Furthermore in figures, there are agreements between actual and predicted dates for the onset, but the values for the rainfall differed from one another, with almost 119mm difference in the areas throughout the years. The dates on comparison of rainfall amount to the length of the growing season as well as the total number of rainy days, which are presented in figures 9 - 12 and in table 4 in the appendix respectively. From the three variables it is clear that the variability is way visible across the years, particularly in 2012 when the variation is unprecedented for the total amount of rainfall, but for the duration of

growth, little variation was observed between the predicted and actual length of the rainy season. However for the rainy days, there is a very clear difference using the threshold values which were less than 0.3mm, were not considered as rainy days. 2015 recorded highest difference within the period under study (see fig.12).

Figure 6

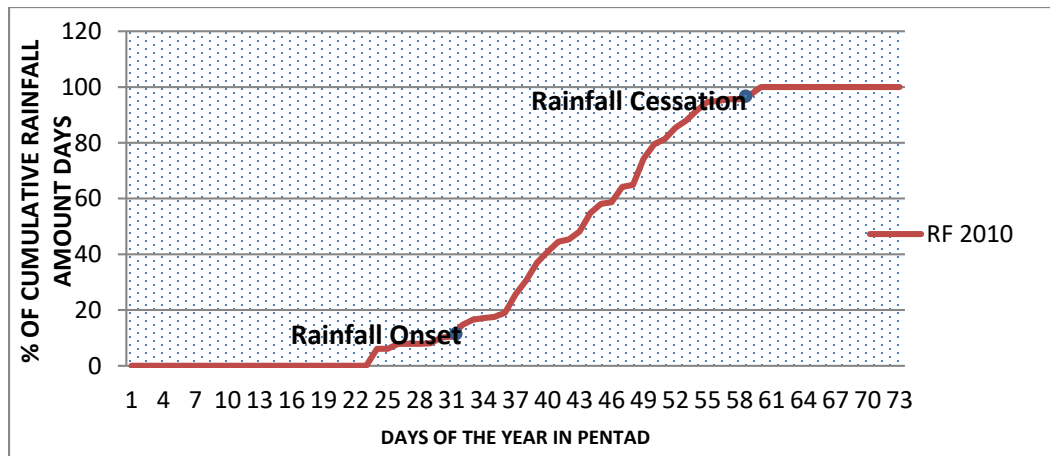
Mean Rainfall Onset and Cessation Dates in Kano (2009).



Source: Authors' Compilation.

Figure 7

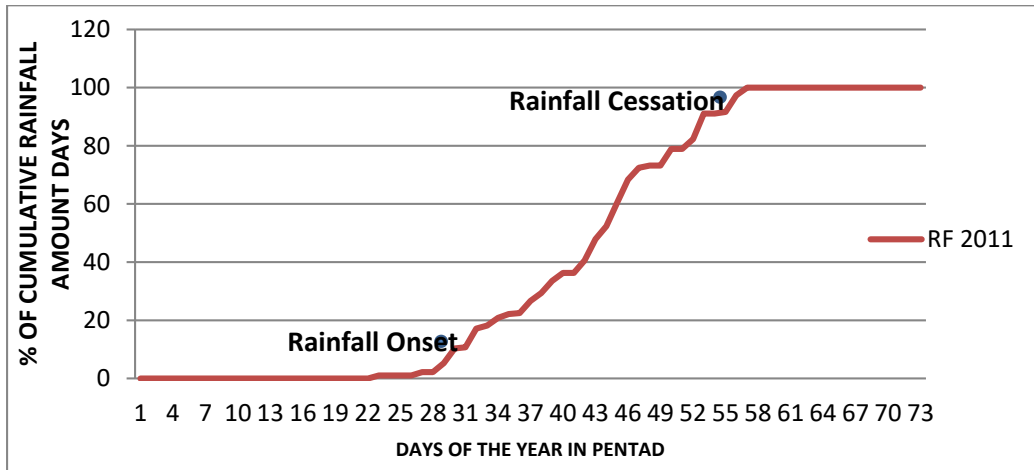
Mean Rainfall Onset and Cessation Dates in Kano (2010).



Source: Authors' Compilation.

Figure 8

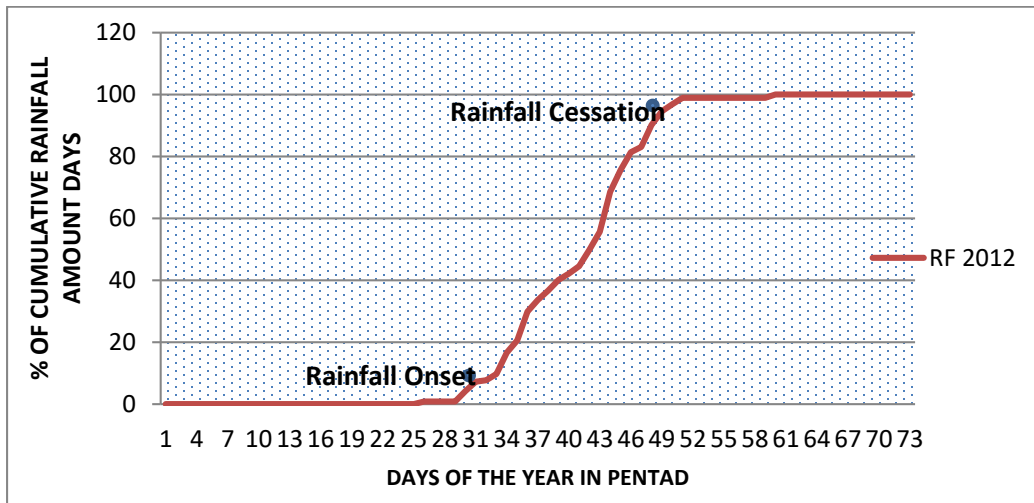
Mean Rainfall Onset and Cessation Dates in Kano (2011).



Source: Authors' Compilation.

Figure 9

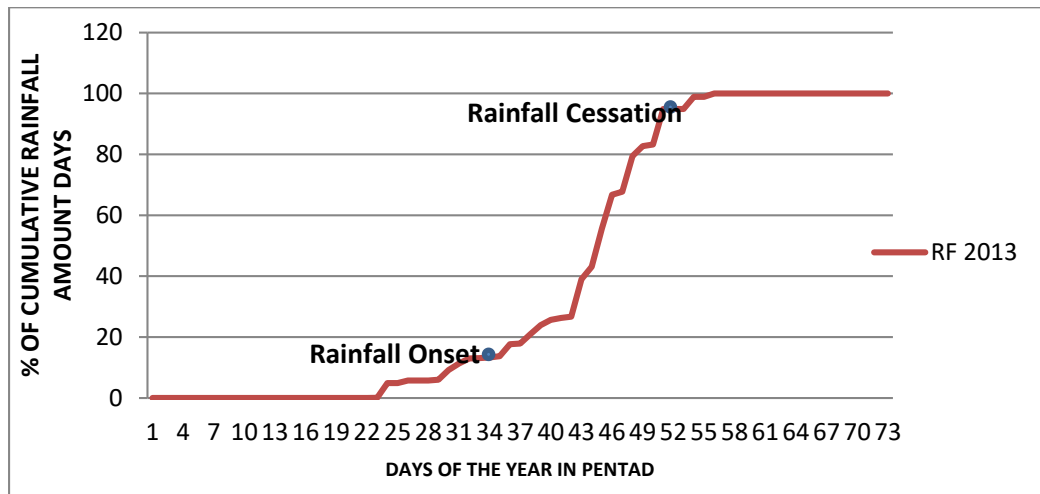
Mean Rainfall Onset and Cessation Dates in Kano (2012).



Source: Authors' Compilation.

Figure 10

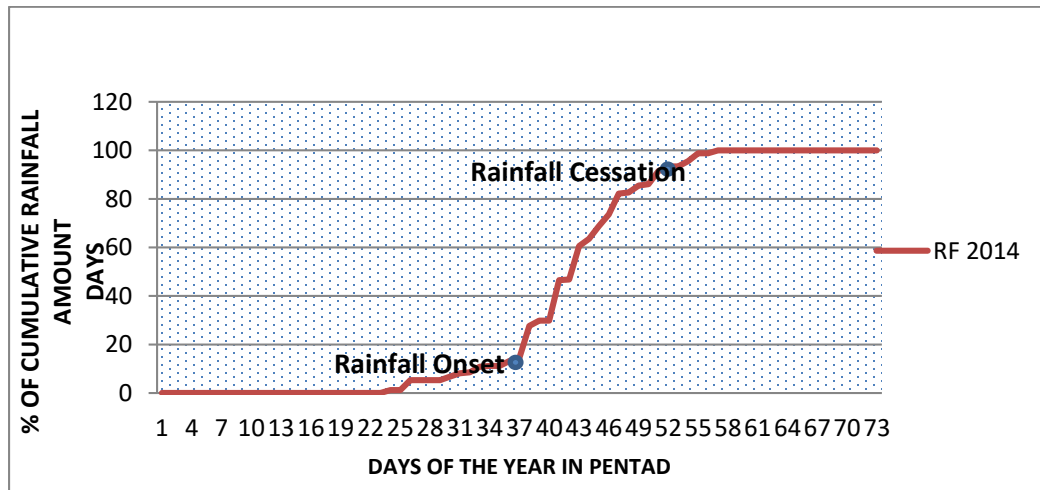
Mean Rainfall Onset and Cessation Dates in Kano (2013).



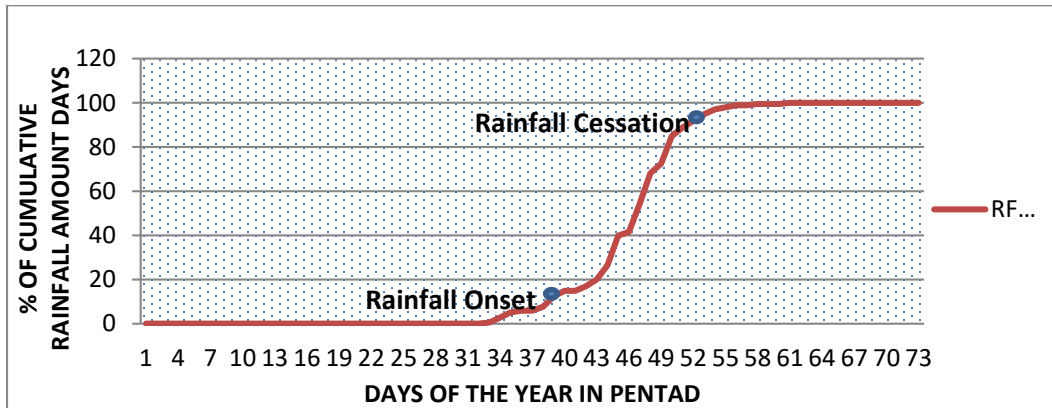
Source: Authors' Compilation.

Figure 11

Mean Rainfall Onset and Cessation Dates in Kano (2014).



Source: Authors' Compilation.

Figure 12*Mean Rainfall Onset and Cessation Dates in Kano (2015).**Source: Authors' Compilation.*

Conclusion

Despite the recent development in weather forecasting technology, reliable information about meteorological data still requires more additional development particularly in the developing countries. Weather prediction and its attendant dues over Nigeria are almost the same in the tropical areas, as they are affected by weather elements and phenomena. From this study it was gathered that the evaluation of seasonal rainfall effects do not only provide tremendous assistance for city farmers in Kano State (northern farmers) but it shall enhance, sustain agriculture and resources management in Nigeria as a whole.

Recommendations

It is crystal clear that from the foregoing discussion on climate and weather impacts agricultural production in this country in general and particularly in Kano. No doubt therefore, farmers in the study area should continue using information that they are provided by Seasonal Rainfall Prediction (SRP) season, while indigenous knowledge of it still plays a significant role for them to utilize. The study shows that despite the scientific and technical improvement of NIMET weather observation techniques for prediction, many challenges remain with regard to the long-term weather predictability. This has been confirmed with the level of disagreement in 2012 and 2014 between the predicted and observed amount of rainfall. This situation requires more scientific explanation for the end users. The

study also affirms the capacity of NIMET on Seasonal Rainfall Prediction that such information can be reliable and utilized when the need arises. The study also recommends that NIMET should not relent in their dispensation efforts on weather information to farmers in the study area in terms of good timing for farming and should provide them with regular updates through agricultural officers. Above all, the study recommends Ilesanmi (1972) method as reliable in determining dates of onset and cessation.

Lastly, NIMET again needs to provide the farmers' rainfall prediction which is a valuable tool and could be used for future reference.

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Appendix A

Source: Ilesami, O.O. (1972) as modified by the Author

| Year | Prediction | Actual value | Dates of onset Prediction | Actual Dates | Error days+ /- | Date of cessation prediction | Actual dates | Error days +/- | Length of the Season prediction | Actual length of season | Rainy days prediction | Actual rainy days |
|------|------------|--------------|---------------------------|-----------------------|----------------|------------------------------|----------------------|----------------|---------------------------------|-------------------------|-----------------------|-------------------|
| 2009 | 803mm | 1184.7mm | 8 th June | 24 th June | +16 | 16 th Oct | 22 nd Oct | +6 | 136 | 120 | 89 | 47 |
| 2010 | 783mm | 1080.5mm | 12 th June | 25 th June | +13 | 7 th Oct | 25 th Oct | +18 | 117 | 122 | 83 | 60 |
| 2011 | 745mm | 1225.6mm | 8 th June | 27 th June | -13 | 16 th Oct | 12 th Oct | -6 | 130 | 138 | 90 | 49 |
| 2012 | 799mm | 1689.5mm | 10 th June | 5 th June | -5 | 16 th Oct | 22 nd Oct | +6 | 129 | 139 | 68 | 50 |
| 2013 | 981mm | 918.7mm | 28 th May | 9 th June | +12 | 16 th Oct | 27 th Oct | +11 | 142 | 140 | 78 | 49 |
| 2014 | 931mm | 1376.0mm | 25 th May | 25 th June | +31 | 27 th Oct | 10 th Oct | +17 | 159 | 107 | 114 | 46 |
| 2015 | 949mm | 830.1mm | 8 th June | 8 th June | 00 | 12 th Oct | 7 th Oct | -5 | 126 | 121 | 128 | 32 |