

# Impact of Climate Change on Rainfall Patterns and Implications for Agricultural Production and Adaptation Strategies

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## Abstract

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Climate change has adversely impacted natural resources, food, security, human health, the environment, physical structures, among others. The impacts are evident in the threats posed by drastic changes in rainfall patterns, temperature, relative humidity, radiation and general alteration in the trends of climatic elements. The purpose of this research was to access data/information on rainfall patterns for the period (1972-2003) and (2016-2017). The data/information were sourced from secondary sources. The data/information sourced were analyzed using descriptive statistics. The result shows that there have been deviations from the patterns of rainfall. The result also shows that rainfall was experienced more in the period (2016-2017) as compared to the period (1972-2003). Adaptation strategies, among others include shifting planting dates and cultivating short cycle seeds. Recommendations, among others, included that there should be shift in the planting dates of some crops, timely planting of crops, planting of short cycled seeds during short periods of rainfall and cultivating “*edible*” cover crops as “*must crops*” during the cropping session.

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**Keywords:** *Climate Change, Rainfall Patterns, Implications, Agricultural Production, Adaptation Strategies*

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### **Background to the Study**

In Nigeria, like other developing countries, agriculture remains the most viable economic sector and considerably contributes towards production and employment (Suleiman, Yakubu and Yusuf, 2018). According to Jifin (2017), agriculture for decades has been associated with the production of basic food crops and animals. At present, agriculture in Nigeria, besides farming includes forestry, fruit cultivation, dairy, poultry, mushroom, beekeeping and marketing, procession and distribution of agricultural products.

In effort to achieve the desired level and targets in agriculture, in terms of adequate food production and provision of substantial support for the local industries, the practice of agriculture requires adequate and fertile land and supply of vital inputs such as improved seeds, among others. The farmers, according to Olaniyi and Ogunkunle (2018) should be assisted by Extension Organizations to access current knowledge of improved sources of information and have a class to all inputs needed for effective production. In the opinion of Mashroofa and Senenvirathne (2014), farmers need information to identify the cost, storage usage of varieties of newly introduced seeds, pesticides and weather conditions in order to obtain maximum yields and best production. There is also the need for favourable climate as an all-important ingredient or input in agriculture (Emedo, Maduka and Oranekwulu, 1995) and (Oga, 2014). The effect of climate, a major requirement in agriculture is important in agricultural production. This is in consideration of the crucial roles of its various elements, especially, rainfall, which is considered a major source of water resource use in agriculture by farming households.

Rainfall, a very essential element of climate has numerous implications for agricultural production (Oga, 2014). This is because its nature (i.e time of commencement in a given period, frequency, amount, duration, intensity and distribution) in a given period, to a high degree determines the types of farming systems, the level of agricultural practice and production.

Nowadays records have shown that the patterns and distribution of rainfall have not been favourable and encouraging. According to Nigeria Meteorological Agency (NIMET), 2016), there has been deviation from the usual pattern of rainfall. The current unfavorable nature of rainfall widely experienced is as a result of global warming and subsequently climate change (Jifin, 2017). This situation does not portend good for agricultural production and this has multiplier effects. Often, it has been observed and even available records have shown that the rains do not commence when it is usually expected. This situation corroborates the position of Anam and Antai (2015). The rains when eventually experienced, may be fair (drizzle), moderate or torrential and in the process may not be adequate for agricultural production or may even be very destructive to agricultural produce and also farm physical structures. This calls for all hands to be on deck in order to come up with various assistances to forestall vagaries of weather conditions.

Consequently, there is need to access data/information on the patterns of rainfall and distribution with which to guide farmers on their farming operations. With the foregoing,

there is also the need to help farmers come up with measures (smart practices) that will enable them adapt to the vagaries of global warming and climate change and these formed the basis of this research effort. The main objective of this research is to access data/information on patterns of rainfall for two distinctive periods (1972-2003) and (2016 - 2017) and attain specific objectives.

### **Statement of the Research Problem**

Currently, among the global topical issues are global warming and climate change. These have impacted, among others, agriculture due to their influence on weather elements, especially, on patterns and distribution of rainfall. Over the years, farmers carried out their farming activities with good background knowledge of the weather conditions of their immediate environment, especially, in relation to the patterns and distribution of rainfall. With this knowledge, they considerably understood their immediate environment and, on this premise, planned their farming activities effectively with minimal loses on the farm. But nowadays, this knowledge appears to have been eroded due to influence of global warming and climate change. This has caused considerable changes in the pattern and distribution of rainfall.

Consequently, farmers can no longer understand the prevailing weather conditions of their immediate environment and this has affected the planning of their farming activities and has equally resulted to some huge loses of their farm produce and other resources. As a result of the inability of farmers to predict the future of rainfall accurately, there are varying amounts of risk and uncertainty in all their farm management decisions. This position is supported by Oladele (2015) and Mohammed (2017). In the latter's assertion, if everything is known with certainty, decisions would be relatively easy. However, in the real world, a more successful farmer is the one with the ability to make the best possible decisions and the courage to make them when surrounded by risk and uncertainty. Sequel to this, farmers need assistance in this regard. This assistance may be in the form of providing them with current basic data/information on these changes and also suggest smart practices (adaptation measures) to enable them cope with the effects of global warming and climate change. The data/information provided on changes on rainfall patterns and distribution will provide guidance for the farmers and enable them to effectively plan their farming activities and subsequently minimize the effects of the present vagaries of weather conditions as they concern their farming activities and water management. This is in agreement with the position of Thomas and Sanyaolu (2017), who asserted that seeking information on agro-meteorological services will help to minimize losses associated with the effect of climate change. They also assert that this type of research, if carried out routinely, will provide, among others, seasonal rainfall predictions and early warning messages and preparedness attempt to face crop or cropping seasons, probably in future.

The main objective of this research was to access data/information on rainfall patterns between the periods (1972-2003) and (2016-2017). Specific objectives included: to determine the number of raining days in each of the months of the years 1972-2003; to determine the amount of rainfall in each month of the period 1972-2003; to determine the number of raining days in each of the months in the years (2017-2018); to determine the amount of rainfall in

each of months of the years (2017-2018); to make recommendations. This research tends to provide solution(s) to the following research questions; what was the number of rainy days in the months of the period (1972-2003), what were the amounts of rainfall in the months of the period (1972-2003), what was the number of rainy days in the months of the period (2016-2017) and what were the amounts of rainfall in the months of the period (2016-2017).

### The Study Area

#### Materials and method

The materials used for this research were sourced from the Agromet Unit of the National Root Crops Research Institute (NRCRI) Umudike.

Umudike is located about 8km East of Umuahia town along Umuahia – Ikot Ekpene road with latitude 05°29'N, longitude 07°33'E and at an altitude of 122m above the mean sea level (Emeka – Chris, 2011). Umudike is 140km north of Port Harcourt International Airport and 135km south of Enugu Airport and only 80km east of Owerri Airport in Imo State. It is within the subequatorial climatic belt characterized by two major seasons; the wet and dry seasons. The wet season starts in April and ends in September with a peak in June and July, while the dry season lasts from October to March. However, recent global climatic change has affected the durations of these seasons. Rainfall is high in the area, with an annual average of about 2,217.86mm. Relative humidity is also high and generally over 70%, while mean annual temperature is about 27°C.

#### Data Collection and Analysis

The basic data required for this research was rainfall data for some weather elements for the period (1972 – 2003) and (2016 – 2017). The source of the data is the Agromet Unit of the National Root Crops Research institute (NRCRI), Umudike. The data was analyzed using descriptive statistics.

### Results and Discussion

#### 1. Determination of the Number of Raining Days in the period 1972 - 2003

**Table 1:** Summary of Monthly Distribution of Raining Days, Amount of Rainfall (mm) and Temperature (°C) for the period, 1972 – 2003

1972 - 2003	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct.	Nov.	Dec.	Total
Number of Raining Days	1	2	8	12	19	18	22	22	21	27	5	1	158
Rainfall amount (mm)	13.6	30.8	123.9	188.9	265.2	285.9	294.2	308.6	341.2	250.9	54.7	26.9	2184.8
Mean of Air Temp °C	27	28	28	28	27	26	26	25	26	26	27	26	

**Source:** Agromet Unit of National Root Crops Research Institute, Umudike, Abia State

The information as reflected in Table 1 shows that all the months of the period 1972 - 2003 experienced rainfall. The months of May – October recorded more number of days of rainfall. The month of October recorded the highest number of rainy days for the period.

### 1. Determination of Amount of Rainfall in the period 1972 – 2003

Table 1 shows that all the months of the period (1972 – 2003) recorded some amount of rainfall. The months of May – October recorded high amounts of rainfall. The month of August recorded the highest amount of rainfall of 308.6mm for the period.

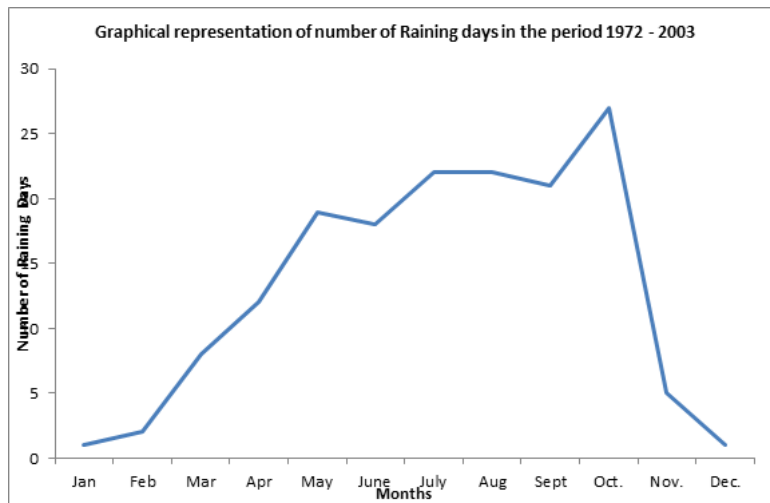


Fig. 1: Frequency of Rainfall in the period, 1972 - 2003

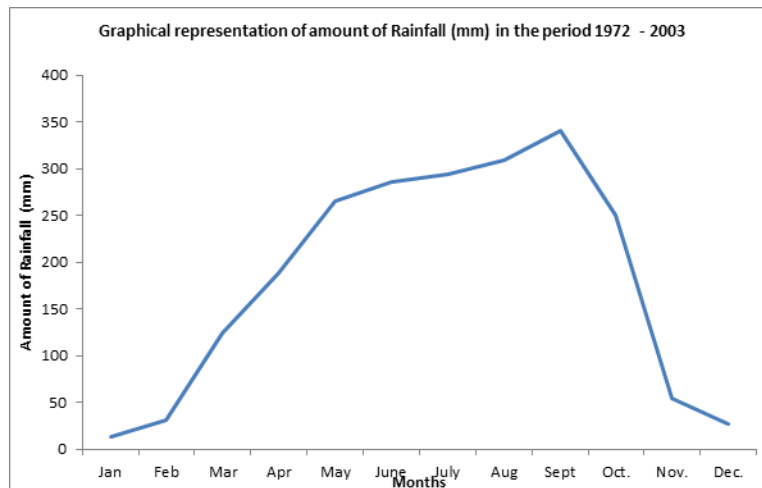


Fig. 2: Pattern of Rainfall in the period, 1972 – 2003

**Table 2:** Summary of Monthly Distribution of Raining Days, Amount of Rainfall (mm) and Temperature ( $^{\circ}\text{C}$ ) for the year, 2016

2016	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct.	Nov.	Dec.	Total
<b>Variables</b>													
Number of Raining Days	0	0	10	8	16	16	15	22	15	7	2	1	112
Rainfall amount (mm)	0	0	266.6	129.3	277.8	324.9	265.1	308.3	312.8	273.4	45	4.1	2207.3
Mean of Air Temp $^{\circ}\text{C}$	28.5	30	29	29	28.5	26	26.5	26.5	26.5	27.5	28	30	

**Source:** Agromet Unit of National Root Crops Research Institute, Umudike, Abia State

**Table 3:** Summary of Monthly Distribution of Raining Days, Amount of Rainfall (mm) and Temperature ( $^{\circ}\text{C}$ ) for the year, 2017

2017	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct.	Nov.	Dec.	Total
<b>Variables</b>													
Number of Raining Days	2	0	4	8	11	15	18	10	12	12	7	0	99
Rainfall amount (mm)	51	0	74.4	114.5	138.8	274.4	710.4	130.1	264.7	215.4	39.8	0	2013.5
Mean of Air Temp $^{\circ}\text{C}$	28.5	29.5	29.5	28.5	28	27.5	29.5	26	26.5	27.5	28	29	

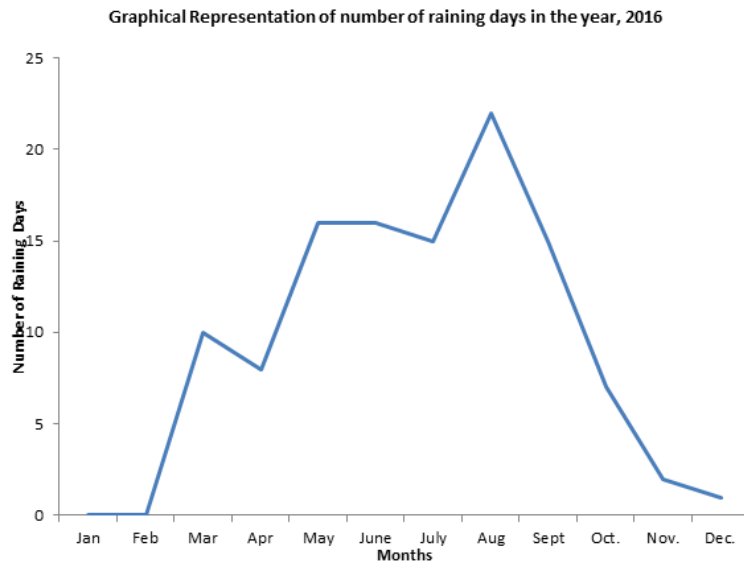
**Source:** Agromet Unit of National Root Crops Research Institute, Umudike, Abia State

**1. Determination of the number of rainy days in the period (2016 – 2017)**

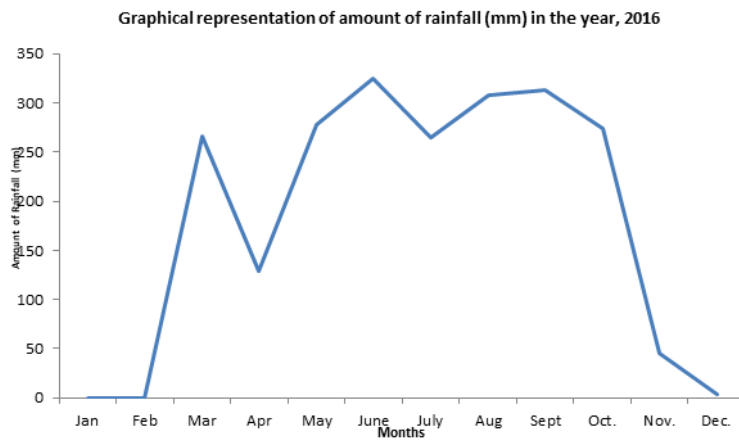
Information in Table 2 shows that rain fell in all the months of the year, 2016 (10 months of rainfall). For the year, 2017, rainfall was not experienced in the months of February and December and also (10 months of rainfall) but with much varied intensity and frequency. The month of August recorded the highest number of rainy days contrary to popular opinion.

**2. Determination of amount of rainfall for the period (2016 – 2017)**

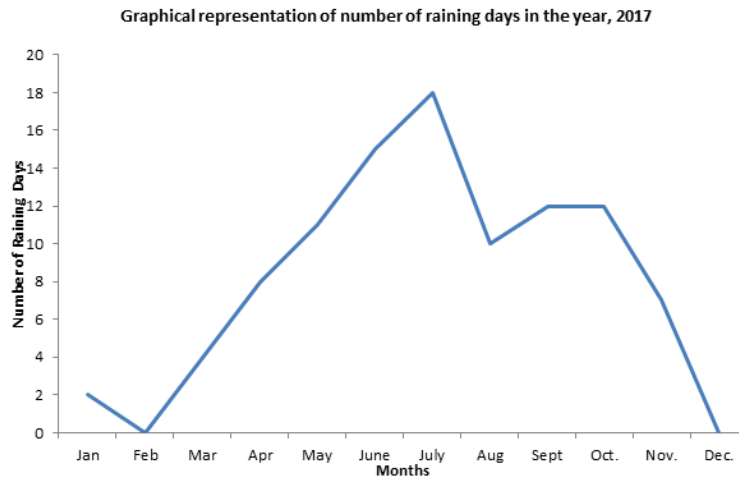
Table 3 shows that the months of February and December did not record any amount of rainfall. The months of June, July and September recorded high amounts of rainfall. The highest amount of rainfall (710.4mm) was recorded in the month of July in the year, 2017. See Table 3 and Figure 6.



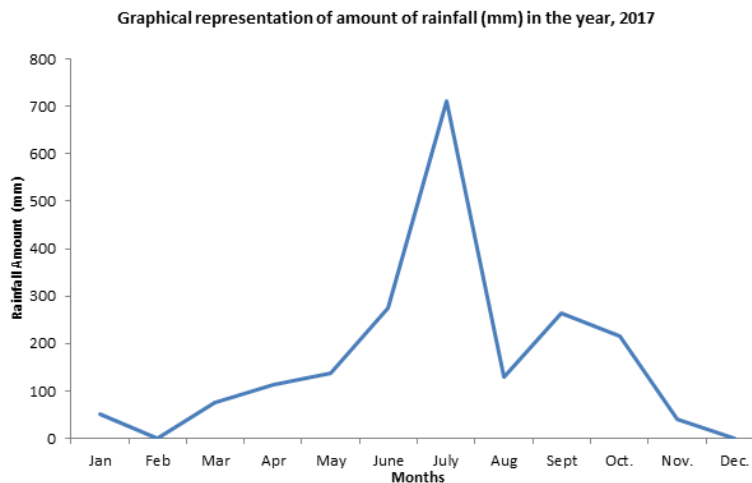
**Fig. 3:** Pattern of Rainfall in the year, 2016



**Fig. 4:** Pattern of Rainfall in the year, 2016



**Fig. 5:** Pattern of Rainfall in the year, 2017



**Fig. 6:** Pattern of Rainfall in the year, 2017

**Implications for Agricultural Production**

Considering the patterns of rainfall in the period 1972-2003 as shown in Figures 1 and 2, rainfall commenced early in the years concerned and continued to rise gradually up to the month of October where it peaked. This trend provided a regular pattern to some extent considered favourable which enabled farming activities without much problems. The implication to this regard was that farming activities were carried out with some level of convincing assurances. This agrees with the position of Emedo, et al, (1995) that regular pattern of rainfall guarantees the production of both food and cash crops. The patterns of rainfall as reflected in the period 2016 - 2017 and as shown in Figures 3,4, 5 and 6 provide pronounced contrast as compared to the patterns in the period 1972-2003. In the year, 2016, rainfall started early in the year and rose drastically in the month of March and thereafter dropped in the month of April, see Figure 3.



It commenced again in the month of May and continued to rise and fluctuated up to the month of September and dropped very sharply after the month of September. In the year, 2017, the pattern of rainfall can be considered very poor as compared to the pattern in the year, 2016. Rainfall commenced early in the year, 2017 in the month of January, dropped in the month of February after which it started to rise poorly up to the month of June after which it rose very sharply in the month of July and thereafter dropped very sharply in the month of August. See Figure 6. After this sharp drop, it rose a little in the month of September and after this month, started to drop gradually up to the month of November, see also Figure 6. This situation agrees with the position of Nwaiwu *et al*, (2014) that climate change has caused drastic changes in rainfall pattern.

The implications, with the foregoing, are that seeds of crops of short cycle should be cultivated between the months of February and May. Crops that may not require much water to thrive should be cultivated between the months of March and June. Also crops that require much water to thrive should be cultivated between the months of May and September. The prevailing situation may not guarantee the usual two periods of cropping for some crops, for example, the two periods of maize cultivation in a year (i.e. early maize and late maize). As well, the implication is that crops, such as rice, may not thrive well due to poor fluctuations in the pattern of rainfall, especially, between the months of September and October during which it requires water for the last lap of its cycle. Within these months, there have been sharp drops in rainfall. The implication is that upland rice should be supported with irrigation, especially, during the period of water shortage (April-June) and (September to November). Such crops as cassava and yam suffer on the farm during the months of June and August due to excessive rainfall resulting to great flood which stay up to 3 - 4 days before it recedes and in the process cause rotting of these crops. During this period flood also destroys and carries away farm produce and structures. This situation agrees with the position of Dembele, Akinbile and Aminu (2019) that climate change affect agricultural production. In the case of livestock, especially, poultry and pigs, should be provided with adequate shade to prevent heat stress and sufficient water provided for them between the months of February and June. See Figure 6.

### **Adaptation/Adaptation Strategies**

According to Iduma, Owombo and Adesina (2014) adaptation refers to actions and adjustments put in place to main the capacity to deal with stresses induced by current and future external charges. On the other hand, adaptation strategies are those measures engaged to heap maintain the capacity to deal with stress induced by current and future external changes.

Adaptation to climate change refers to any adjustment that occurs naturally within ecosystems or human systems in response to climate change that either moderates, harm or exploits beneficial opportunities in response to actual or expected climate related environmental changes (Intergo 2007) Fourth Assessment Report. It is obvious that farmers are innovating through indigenous adaptive measures. Though efforts are presently being channeled into more scientific ways of adapting to climate change, these are not yet accessible or available to the farmers who are the end users of such innovations (Agwu and Irohibe, 2013).

Results of some research on the type of adaptation measures employed by farmers in some African countries shows that, though, farmers may not have the financial capacity to use some adaptation strategies that can bring about significant increase in their production, they may employ the use of some adaptation strategies that can bring about significant increase in their production, they may employ the use of some adaptation strategies within their financial power, though, the level of use might not be optimal.

According to the results of the research carried out by Dembele, Akinbile and Aminu (2019), most farmers engage the following measures as adaptation strategies in some African countries:

**1. Timely planting of crop seeds**

This means sowing seeds of crops at the appropriate time/period when the conditions are suitable for them. The exercise should not be before or after the actual time of sowing the crop seeds. Delay in this exercise should be out of place. Most farmers engage this strategy and in order that this measure be effective, the farmers should adequately understand the seasonality of crops produced as they have been producing the same crops over the years.

**2. Planting of short cycle seeds of crops**

Farmers should cultivate this type of crop seeds in the face of current vagaries of weather and climate. Short cycle crop seeds are of those crops that do not stay long on the farm. In other words, they thrive and mature within a very short time, say, between 2-4 months on the farm land, especially during periods of water scarcity. Most annual crops dominant this group of crops.

**3. Rotation of crop land**

This practice may seem similar to shifting cultivation. It actually involves moving from one piece of land to another when the former's fertility status has reduced. In this regard, land is not left uncultivated for a long time but for about 2-3 years during which fast growing and maturing leguminous plants are cultivated on the land, to among others, protect the soil from erosion, enrich the soil and to absorb nitrogen elements or compounds left untapped by previous plants and in the process reduce the emissions of some greenhouses gases (GHGs) into the atmosphere which cause global warming. After the period of abandonment, the farmer can then revert back to the initial piece of land for better result of production.

**4. Use of Agro-meteorological and management information:**

This involves helping farmers to access and use information on the day-day changes of the environmental conditions. This will help them adapt to changing environmental conditions. Farmers need to have access to land this kind of information be it climatic information, forecasts, adaptive technology innovations, or markets through extension and information systems. Some professionals, such as agricultural extension personal need to share knowledge with farmers on cropping and management systems that are resilient to changing climate conditions such as agro forestry, intercropping, sequential cropping and no-till agriculture. These, no doubt, will guarantee successful adaptation.

### **5. Shifting planting dates of crops' seeds**

Prior to the realities of climate change and its effects, especially in relation to agricultural production, farmers understood the patterns of rainfall which were considered relatively regular and this guided farmers in the cultivation of the farm land and cultivation of certain crops at the right time. Climate change, at present, has caused irregularity in the patterns of rainfall and has affected the usual planting dates of crops' seeds. Consequently, farmers should understand the present trend of rainfall and judiciously follow it such as to know when it will be appropriate (time) to cultivate certain crops. To be precise, farmers should shift-planting dates of crops' seeds to when favourable environmental conditions will be suitable for such activity.

### **6. Irrigation Practices**

Water is very essential for crop production. To this regard, water is not always available for this operation and even when available, may not be sufficient to support crop growth and development. There is no doubt that agricultural production in some places is rainfed (i.e. source of water) and climate change has impacted the time of commencement of rainfall and its pattern such that rainfall pattern has drastically changed. As a result, the rains do not come when expected and this has caused shortage of water supply to the farms for crop use and has equally affected the planning of farm operations. Consequently, farmers should source water from rivers, streams, lakes, ponds and even boreholes, as the situation may warrant in order to provide water for crop plant use during periods of water scarcity.

### **Conclusion**

Climate change has caused some drastic changes in the patterns of rainfall and impacted other weather elements and human endeavours among which is agriculture and calls for adaptation measures. As a result, the main purpose of this work, was to access data/information on rainfall patterns for the (1972 – 2003) and (2016 – 2017) and attain some specific objectives.

The practice of agriculture is influenced by various factors, especially, climate. The effect of climate in agriculture is felt through one of its potential elements, rainfall. Nowadays, the nature of rainfall in relation to agricultural production has not been encouraging due to climate change. Consequently, there is need to access data/information on the pattern of rainfall for some periods. In order that agriculture may continue to support related human endeavour and livelihood, there is need for adaptation strategies to the effect of climate change. Strategies to be engaged in this regard, in the opinion of this research are, among others, shifting the planting dates of some crops, cultivating short cycle seeds, constructing water channels on the farm for irrigation purposes and disseminating information on weather changes to farmers.

### **Recommendations**

- i. Creating more awareness on the realities of global warming and climate change
- ii. Farmers to shift planting dates of some crops following the pattern of rainfall
- iii. Cultivating short cycle seeds
- iv. Farmers through co-operative efforts should construct water channels (irrigation) for use on the farm during periods of water scarcity.

- v. Local weather stations should be established in rural localities to help support Nigeria Meteorological Agency (NIMET) in their activities of providing information on current weather changes to farmers, especially, as they concern patterns of rainfall.

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