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Climate Change Effect on Rainfall Pattern and Implications for Maize Production in Afikpo North Local Government Area of Ebonyi State, Nigeria

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Abstract

Climate change has impacted rainfall and its distribution. It has impacted also human's livelihood and this calls for measures to help improve on the situation. The purpose of this study was to generate data/information on the current pattern and distribution of rainfall in Afikpo North Local Government Area (LGA) of Ebonyi State for the year, 2020. The study employed simple random and purposive sampling procedures. The LGA is made up of twelve (12) Autonomous Communities (ACs). Ten (10) ACs were randomly selected which represent about 80% of the total ACs. Field Assistants (FAs) were required for the field work and two (2) FAs were purposively selected from each of the 10 ACs to give a total of 20 FAs who helped record relevant parameters. A self-designed recording instrument was used in the field work and data generated were analyzed using descriptive statistics. The result shows that the rains commenced early in the year and were not evenly distributed in the first four months of the year. The result also shows that much rainfall which were fairly distributed were experienced in the months of June, July and September. Recommendations, among others, are that farmers should be convinced to commence actual maize cultivation from the month of May and provide water through irrigation practices to make up during periods of water shortage.

Keywords: *Climate Change, Rainfall Pattern, Implications, Maize Production*

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Background to the Study

In the wake of the concern for food security and sustainable development, one of the crucial issues is the right of rural communities to a clean environment that enables them to have a sound basis for their livelihood and their living conditions (Akpaeti, Udo and Bassey, 2014). In the beginning, man's greatest need was to preserve his life and that of his posterity (Eze and Ogbonna, 2011). This caused him to evolve ideas that helped him improve his conditions. Naturally, man has been endowed with creative power that places him a little higher than other living organisms. It is this intelligence, the creative power that made him realize the importance of agriculture. Agriculture, hence, became the oldest industry.

The primitive man or early man lived on wild animals, leaves, roots, seeds and fruits but with increased population, food supply was not sufficiently stable or obtained (Eze et al, 2011). Crop production began when domestication of plants became essential so as to supplement natural supply. Agriculture, no doubt, is an art as well as science of crops and animal husbandry. It can also be referred to as the controlled production of plants, animals and materials which are of essential benefits to man. As an art, it requires certain field activities which need skill, constant practice and technical know-how. Being a science, it requires the study of the nature and life activities of crops and animals. To this perspective, there is the need of environmental factors. This is because the knowledge of the nature of these factors will be of immense assistance in the understanding of the study of the nature and life activities of crops and animals. The understanding of the nature of the environmental factors will also lend support in the art of carrying out field activities as well as managing the field aspect. The good knowledge and understanding of their environment will also help farmers to be adequately guided in the planning and efficient execution of their farming activities. Currently, climate change has caused changes (deviations) in the usual patterns of the environmental factors, especially rainfall, which are of immense assistance in the production of crops and animals. And it is to assist in proffering solution to the above discouraging situation that prompted this study.

Statement of the Problem

The environment plays a leading role in the adaptation of crops and farm animals to particular agricultural zones (Akinyosoye, 1999). The environmental factors mainly responsible can be divided into climatic, physical and biological factors. It should be borne in mind that, for any agricultural plant or animal to survive in any environment, it must be adapted to all the conditions prevailing there. In most cases, one factor plays a major role in determining the degree of adaptation of a crop or animal. This is why different agricultural crops and animals are found in different parts of the world. Owing to the variation in environmental conditions, crops and farm animals which are adapted to temperate zones are completely different from those of the tropics.

The understanding of the nature of the environmental factors will lend support to the farmers in the act of performing field activities. This will also help farmers to be adequately guided in the planning and efficient execution of their farming activities. But today, this knowledge and understanding of their immediate environmental conditions, especially rainfall pattern and

distribution, appears to be a "mirage" to the farmers as a result of the impact or effect of climate change. Climate change has caused considerable changes in the nature and patterns of the environmental factors and subsequently makes it difficult these days for the farmers to understand and follow in the planning of their farming activities (Oga and Oga, 2019). This situation has caused considerable loses of both farm and farmers' resources. Consequently, there is need to assist the farmers understand the present pattern and distribution of the environmental factors e.g. rainfall pattern and distribution. This will be in the form of providing for them data and information on the current pattern and distribution of these factors. This will then help and guide them on the future planning and execution of their farming activities. This position is in agreement with Asumugha, Mbanaso, Ironkwe, Nwosu and Okonkwo (2014) who asserted that agro-meteorological information is indispensable for the planning, development and utilization of the natural resources of any nation or community. It will equally help to avert losses of resources on the farm. This is also in agreement with the opinion of Asumugha, et al (2014) who asserted that agro-meteorological information help in reducing agricultural losses due to unfavorable weather and climatic conditions.

With the foregoing, this study tends to address the following research questions:
What was the time of commencement of rainfall prior to the realities of climate change and currently; what is the frequency of rainfall in relations to the above pattern or situation; and what is the amount of rainfall (or duration of rainfall in hours) in the study area.

The main objective of this study was to generate data/information on the pattern and distribution of rainfall for the period the study covered. The specific objectives were: To determine the time of commencement of rainfall in the year 2020; to determine the frequency of rainfall for the same period; to determine the duration of rainfall in hours for the period 2020 and to determine the intensity (moderate or heaviness) of rainfall.

Methodology

This study was conducted in Afikpo North Local Government Area (LGA) of Ebonyi State of Nigeria in the year, 2020. The LGA covers an area of 240km and lies between latitude 45^0 East and longitude 60^0North (EBADEP, 2013). In terms of vegetation, it is located in the high forest zone of Nigeria. This zone has an average width of about 130km and sometimes referred to as the rainforest belt. Rainfall varies from about 150 – 200cm in this zone. The actual vegetation shows a varied combination of different types of plants. It is an agrarian LGA with a good number of the populace engaged in one form of agricultural production or the other mainly at the subsistence level. The crops cultivated in the LGA include: maize, rice, yam, cassava, cocoyam, potatoes, vegetables, among others. Besides cultivation of crops, animals are reared especially the small ruminants (sheep and goat) and fishing is also practiced. The pattern of agricultural production is mainly affected or defined by the influence of the annual weather condition of the LGA based on two distinct seasons; the dry and wet season. The dry season starts about the month of November and terminates around the month of March, while the wet season starts in the month of April and ends in the month of October with the average annual rainfall of about 134mm (Ebonyi State Agricultural Development Programme (EBADEP), 2013).

Afikpo North Local Government Area (LGA) is made up of twelve (12) Autonomous Communities (ACs). Ten (10) Autonomous Communities were randomly selected for the field work and Field Assistants (FAs) were needed to assist in the work. Two FAs were purposively selected from each of the 10 Autonomous Communities to give a total number of 20 FAs who assisted in examining and recording the parameters considered relevant to the field work. The data generated were analyzed using descriptive statistics

Roles of Rainfall as Environmental Factor Affecting Crop Growth and Development
According to Eze and Ogbonna (2011), the roles of rainfall as environmental factor affecting crop growth and development are as follows:

Rainfall/Precipitation
Rainfall, which also may be referred to as precipitation is one of the climatic factors that influences global crop production. Rainfall or precipitation is the main source of water (moisture in the soil). Moisture in the soil aid in dissolution of nutrients made available to the plant. Water is the transport medium in plants. During transportation, essential nutrients are carried from the soil to sites in the shoots (i.e. upper parts of the plant) where they are used for growth and development or even stored. Water also causes rigidity of plant cells and hence provides mechanical strength to the plant. It is, as well, a component of major chemical process such as photosynthesis. In water stress condition, stomata closure results in reduced rate of exchange of CO_2 and photosynthesis. On the other hand, respiration rate increases in water stress situation resulting to high sugar levels in plants. Water decreases temperature in the soil and in plants. There is greater potential for crop production in those areas receiving adequate rainfall than in areas with very limited amount of precipitation. However, crop production in the areas with limited rainfall can be improved if additional water is supplied by irrigation.

Aspects of Rainfall Important to Crop Production
According to Eze et al, (2011) the aspects of rainfall important to crop production are as discussed below:

Amount/Total Precipitation:
This is the total amount of rain that falls over an area in a given period of time. Crops differ in their requirement for the amount of rainfall in their life span. Some crops need little water especially the arid crops like Sorghum (Guinea Corn) while some other crops will only perform well where there is plentiful of water, an example is rice which is almost a hydrophyte. The precipitation must be enough to satisfy a given water requirement, where this is less, the crop optimum yield is never attained.

Duration/Distribution
This is the length of time a given amount of precipitation is received in a given area. It is possible to have a long period of rainfall in a part of a county or region than in the other. For instance, an area may receive about 250mm of rain in 25 days whereas in another area the same amount of rain is received in 12days or even less. In situations like these, it will be said

that rainfall in the former is better or evenly distributed than in the later. Each crop has its lifecycle and therefore, the rainfall duration must meet up with the crop requirement, otherwise yield will be low. This also limits the area a crop can be grown. Rainfall duration in the North is always short compared to the south of Nigeria.

Intensity

This is the total amount accumulating during any given rainfall period. This shows how heavy the rain is. It also refers to its strength i.e. whether it is drizzle, moderate, torrential, etc. When the intensity is small i.e.drizzle, a little amount is received and very little part of it penetrates into the soil. This is as a result of the fact that the water is held on the surface of leaves and on the soil surface only to be lost rapidly by evaporation. On the other hand, a very intense rain (torrential) can fall so fast that a large proportion is lost through run off. A slow soaking rain (or moderate) is therefore the best as high proportion of it infiltrates into the soil for crop use. Heavy rains (torrential, as the case may be) can cause water logging and roots of many arable crops do not withstand long periods of water logged condition.

Humidity

The humidity of an area commonly measured in relative humidity is the amount of moisture in the atmosphere. The relative humidity is a measure of the percentage of vapour in terms of the percentage necessary to saturate the atmosphere at a particular temperature. It is very important in the sense that the range available at any given time moderates the temperature and moisture effects. Under very dry condition, the temperature effect is amplified. Under very high relative humidity, evaporation is slowed down and therefore, the loss of water is reduced. The relative humidity also indirectly affects crop production through its influence on pest and disease build up. High relative humidity favours pest and disease build up.

The Maize Crop

According to Akinyosoye (1999) maize is a grass and it belongs to the large family called *Gramineae*. The botanical name is *Zeamays.* It is grown throughout the tropics and in the temperate regions of the world.

Maize is cultivated throughout the tropics wherever the rainfall is adequate. It is one of the most important food crops of West Africa and is planted mainly by small-scale farmers. Maize is an essential part of the diet of many West African people. The maize plant can be fed to farm animals such as cattle, sheep and goats when it is young and fresh. The grains are used in the preparation of animal feed since they provide a rich source of carbohydrate, protein and oils.

The maize plant thrives when the environmental conditions are favourable. A rainfall of 75 – 150mm per annum is usually considered adequate (Akinyosoye, 1999). Maize is a warm-seasoned crop and is influenced by temperature, length of growing season, length of day, amount, distribution and efficiency of rainfall is critical from 15 – 20cm of rain or irrigation is essential in the pre-flowering period (Eze, *et al*, 2011). Generally, large quantities of water, well distributed are needed for high maize yields, maize uses water relatively efficient. Prolonged heat and drought during pollination period often result in desiccation of leaf tissues, pollen grains and poor seed setting.

The grain usually becomes mature four (4) to six (6) weeks after fertilization. A fairly high percentage of maize is harvested in the mature state for human consumption, while the remainder is left until it is dry. According to Akinyosoye (1999) in the more humid parts of West Africa, there are two wet seasons and two crops can be raised in one year (i.e early and late maize). Early maize is grown during the first rainy season (March – July) and late maize is grown during the second short season (August – November). A higher yield is usually obtained from the early maize crop. It is important to note here that with the advent of global warming and climate change, especially in Africa, these schedules may not hold (Eze et al, 2011). Efforts should be geared up towards fresh determination of time of planting for maize because of its sensitivity to this particular factor.

Time of Planting– Accordingto Eze et al (2011), the optimum time of planting for early maize depends on the various ecological zones of Nigeria and was scheduled as shown in Table 1 below:

Table 1: Schedule for Time of Planting for Early Maize in the Various Ecological Zones of Nigeria

	Ecological Zones	Time of Planting of early maize
1.	Forest zone	Mid March to First Week in the month of April
2.	Derived – Savanna	First to third week in April
3.	Southern Guinea Savanna	Last week of the month of April to mid month of May
4.	Guinea Savanna	Last week in the month of May to first week in the month of June
5.	Sudan Savanna	First to second week in the month of June

Source: Eze et al; (2011)

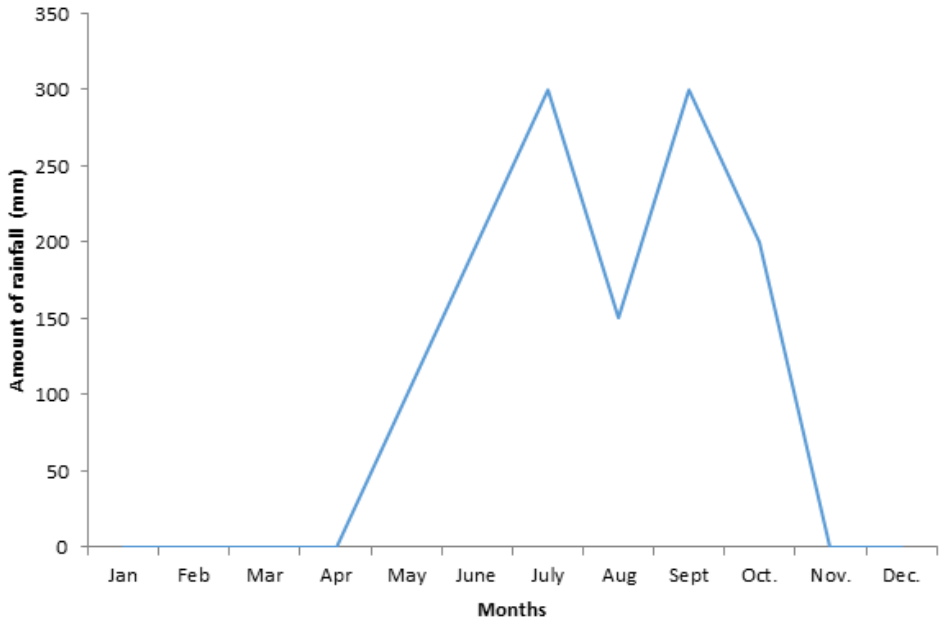
Following the above schedule in Table 1, this study is concerned with the planting time (Mid March to First Week in April) of maize in the forest zone where the study area is located.

Results and Discussion

Time of Commencement of Rainfall (2020)

The month rains started in the year, 2020 was noted and recorded. The results are shown in column 2 of Table 1. Long before now, about 3 – 4 decades ago, available records show that the usual time of commencement of rainfall in the South East Region and where the study Area is located was in the month of April. This is in agreement with the opinion of (Oga, 2014), see Figure 1, which was designed with available records and information in (Oga, 2014). This timing of rainfall encouraged and guided farmers in the planning and execution of their farming activities. With this background information, the result shows that there has been deviation in the time of commencement of rainfall. Nowadays rainfall starts early in the year between the months of January and February contrary to popular opinion, see Figure 1 compared with Figures 2 and 3. This situation corroborates results of the field works of Oga, *et al*; 2012, 2016, 2019 and beyond.

Figure 1: Showing hypothetical usual pattern of rainfall prior to the realities of global warming and climate change



Source: Designed with information in (Oga, 2019)

Frequency of rainfall

The number of times of rainy days in each of the months of the year, 2020 was noted and recorded and the mean determined for each month. The results in Table 1 show that rainfall was experienced early in the year and fell in almost all the months of the year. The result also shows that the rains were not evenly distributed especially in the first four months of the year. From the results, there were much rainfall in the months of June, July and September. The month of September recorded the highest frequency of rainfall.

Duration of rainfall in hours

In each day of rainfall in each of the months for the period covered, duration of rainfall in hours was determined using wrist watches and wall clocks. The monthly mean of this was also determined. The results in column 4 of Table 1 for the period covered show that there was high increase in hours of rainfall in the month of September and this was poor in the month of March. Generally, the result revealed that there were long hours of rainfall, especially between the months of May and October. There were "inverse relationships" between frequency and duration of rainfall in hours for the period covered.

Intensity of rainfall

In each day of rainfall in each of the months for the period covered, intensity of rainfall was determined by observing the moderate or heavy nature of rainfall. The monthly means of these were determined. The results in columns 5 and 6 show the moderate and heavy nature

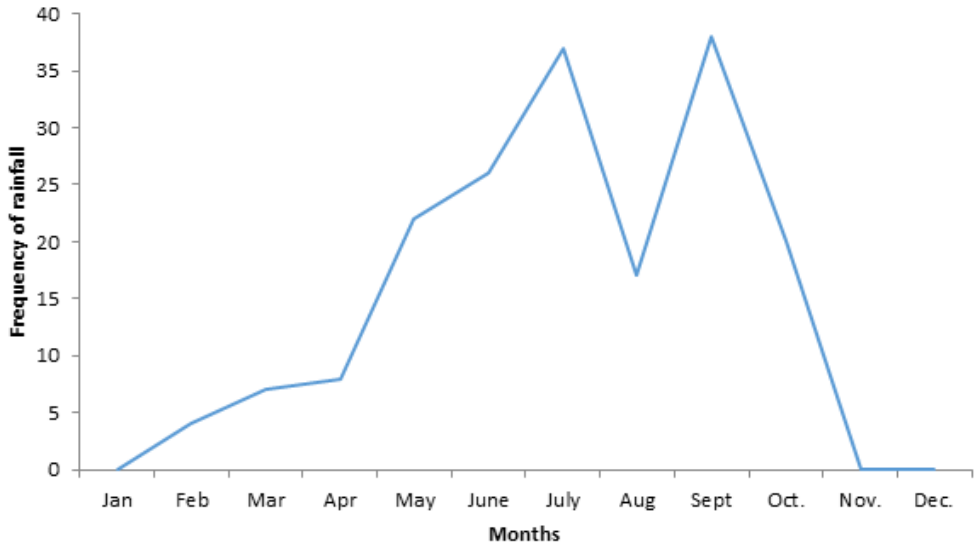
(intensity) respectively of rainfall. Moderate rainfall was experienced more in the month of June, July and September and the month of September recorded the highest. Heavy rainfall was more in the months of June, July, August and September and the month of July recorded the highest number of heavy rainfall.

Table 2: Monthly summary of rainfall in terms of Frequency, duration, among others in the year, 2020

SN	Months of the year	Rainfall		Frequency of rainfall	Duration of rainfall in hours in each month	Intensity	
		Yes	No			Frequency of moderate rainfall in each month	Frequency of heavy rainfall in each month
1.	January		√	-	-	-	-
2.	February	√		4	15	3	1
3.	March	√		7	14	3	4
4.	April	√		8	21	6	2
5.	May	√		22	45	15	7
6.	June	√		26	55	17	9
7.	July	√		37	49	24	13
8.	August	√		17	31	8	9
9.	September	√		38	68	26	12
10.	October	√		20	37	12	8
11.	November		√	-	-	-	-
12.	December		√	-	-	-	-

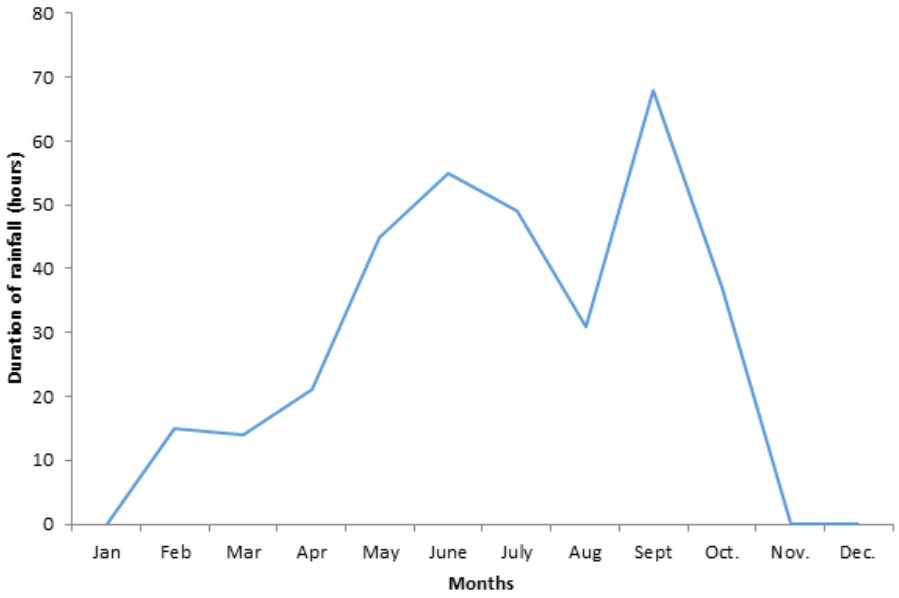
Source: Field work, 2020

Fig. 2: Pattern of rainfall in the year, 2020



Source: Designed with information from field work, 2020

Fig. 3: Pattern of rainfall in the year, 2020



Source: Designed with information from field work, 2020

Implications for Maize Production in the Study Area

The implications for maize production in the study area take leave from the nature of maize as a crop in association with the role of rainfall as environmental factor affecting crop production. Afikpo North Local Government Area, which is the study area is located in the forest vegetation zone which has the time of planting of maize as shown in Table 1 to be from mid-month of March to first week in the month of April. Information available from literature point to the fact that maize plant thrives when the environmental conditions are favourable and that large quantities of water and well distributed are required for high maize yields. But it is pertinent to point out here that the foregoing information is in contrast to the results obtained from the field work carried out in the study area for the period covered in relation to rainfall pattern and distribution. The implication to this regard is that early maize cultivation may probably commence early in the year due to commencement of rainfall early in year contrary to popular opinion. See Figure 1 compared to Figure 2. The implication again is that if the crop is to be cultivated early in the year due to early rainfall which may not be adequate, its cultivation could be supported with adequate irrigation if high yield is to be expected.

Another implication is that actual maize cultivation may have to be shifted from the month of April to the month of May from when much more rainfall is being experienced and better distributed than in the first four (4) months of the year when rainfall was not much and also not evenly distributed. See Table 2 and Figure 2. Further implication is that farmers in the study area need to be convinced and to be ready to start proper maize cultivation from the month of May rather than in April to enable the maize crop enjoy adequate water supply for about three months i.e. May – July and this will guarantee high yield. This position is supported with the

results of the field works carried out by (Oga *et al*, 2012, 2016, 2019 and beyond) in the study area on same weather parameter or element.

Again available information from literature in relation to maize cultivation, show that there is usually "August break" i.e. a trough period during when much rainfall is not usually experienced and this permits the cultivation of late maize from the later part of August to last week in the month of November (3 months). During this period much rainfall is expected to last for about three months to adequately support the growth and proper development of late maize. Although the trough was fairly experienced in the period covered but partly. This situation is in contrast to the result of the field work as shown in Table 2. Rainfall in the period covered, after the "August break", fell for about two (2) months: September to October and dropped sharply after the month of October, see Figures 2 and 3. The implications to this regard are that late maize may not be cultivated or may suffer due to inadequate rainfall which the crop plant requires to thrive. Farmers may have to provide water to make up for the shortage in water supply or suffer losses of the crop and subsequently hunger, short supply for the market, among other implications. This position is in agreement with Dembele, Akinbile and Aminu (2019) concerning the effects of rainfall on grain production as a result of climate change.

Conclusion

Climate change has caused changes in rainfall pattern and distribution. It has also impacted human's livelihood and this calls for measures to improve on the situation. There is need therefore to provide information and knowledge on weather changes, especially as it concerns rainfall pattern and distribution for guidance on the improvement of the situation. The purpose of the study was to generate data and information on rainfall patterns and accomplish specific objectives. The result shows that there has been deviation from the usual pattern of rainfall and demand improvement measures to help guide farmers in planning their farming activities. Some of the measures are shift in planting date of some crops e.g. maize and embarking on irrigation projects.

Recommendations

1. Creation of more awareness on the realities of climate change
2. Farmers should shift planting dates of some crops as the situation demands
3. Establishment of local weather stations to help farmers with weather information
4. Construction of water channels for irrigation activities to assist in water supply

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