International Journal of Science, Environment and Technology, Vol. 3, No 2, 2014, 458 – 472
ISSN 2278-3687 (O)

IMPACT OF CLIMATE CHANGE ON YAM PRODUCTION IN ABUJA, NIGERIA

[1]D.M. Zakari, [2]A.B. Mohammed, [3]N.I. Medugu and [4]I. Sandra
[1]Department of Remote Sensing
Universiti Teknologi Malaysia Johor Bahru, Malaysia
[2]Department of Urban and Regional Planning
Modibbo Adama University of Technology Yola, Adamawa state
[3,4]Department of Geography, Nasarawa State University Keffi, Nasarawa state
E-mails: [1]zahimo@yahoo.com , [2] mbabdul76@gmail.com , [3]Medugu@gmail.com
[4]isandra@nsuk.edu.ng

Abstract: The study was on yam production in federal Capital Territory (FCT). It aimed at establishing the relationship that exists between rainfall, temperature and yam yield. Two sets of data were collected from agricultural development project of federal capital territory on climatic elements (rainfall and temperature) and yam yield for ten (10) years. The Pearson product-moment correlation techniques were used to determine the relationship between rainfall and yam yield and between temperature and yam yield which were 0.10 and 0.07 respectively. The result showed a positive relationship for both. Using the simple step-wise regression analysis for rainfall and yam yield, applying the same techniques on temperature and yam yield the following questions were derived: rainfall and yam yield __ y = 12.46466-0.002x. Temperature and yam yield __ y = 6.936-0.24x. With the use of multiple regressions we obtained 0.14 between rainfall, temperature and yam yield is yield. We also discovered that 14% of the proportion variation of yam yield is explained by rain and temperature. The positive relationship obtained between yam and temperature, between yam rainfalls is in agreement with work done previously by other authors. While that of temperature, rainfall and yam is also positive relationship which also agrees with literatures. We recommend that: a more reliable data should be collected and tried again especially on rainfall. Yam yield should be regressed on other environmental factors. Data on temperature, rainfall, compared to eradicate errors. A longer period of data could be collected for better analysis. However, with respect to our present study we concluded that rainfall and temperature has an influence on yam production.
Keywords: climate change, Yam production, rainfall and temperature.

1.0 INTRODUCTION

Climate change is a relatively new phenomenon to many people in the sense that it is only about now that it is being better understood. It is however an environmental phenomenon that has taken mankind a long time to understand. A discussion on climate change, at the level of introduction such as this, should start by raising important issues which make the subject

*Received Jan 31, 2014 * Published April 2, 2014 * www.ijset.net*

matter the critical one it is in the survival of man and his well-being. Climate change touches very much on many sectors as will be seen later. It affects many factors that determine success or otherwise of many agricultural practices. Perhaps its impact on agriculture is very significant and this is understandable. Agriculture is the first occupation of man and has remained a primary and important one ever since. Without good, man will not survive on earth; and without agricultural resources, many industries will close down.

Climate is the mean atmospheric condition of a place over a long period of time say 35 years. The climate of an area can only be determined by considering the climatic elements such as precipitation.

(Rain), temperature, wind relative humidity, sunshine, etc. The interaction of these elements will determine the climatic type of the area which latter influence man and his activities; it goes further to the suitability of the environment and plant survival, its growth and yield which makes plant environmental factors very important. Climate is studied in relation to agriculture because of its effects and influence on crop yield; what is planted, where it's planted, how it could be planted and when it's planted. Climate is not the only factor which affects agricultural production; there are other factors such as soil is fertility which is also important to plant growth but no matter how fertile or rich a soil is without favourable climatic conditions, the expected yield would be poor.

Although it is unclear which came first, the word "yam" is related to Portuguese inhame or Spanish name which both ultimately derived from the Wolof word yam, meaning "to sample" or to "taste" in other African languages it can also mean "to eat" for instance Doya in Hausa, Isu in Yoruba, an Ji in Igbo.

Yams are primary agricultural commodities in West Africa and New Guinea;they were first cultivated in Africa and Asia about 8000 BC. Due to their abundance and consequently, their importance to survival, yam is highly regarded in Nigeria ceremonial culture and used in vegetable offered during blessing.

Yams are the main stable food crops of the people for years even before diffusion of maize and other good crops. Over the years, considerable importance has attached to the crop.

Agboola (1979) stated that yams are grown principally as a food crops in Nigeria but a large proportion also enter into local and inter-regional market. He further argued that yams are Nigeria's leading root crops both in terms of land under cultivation and in the value of products. To verify this, the 1993 world production of yam put at 28.1 million tones out which 96% came from west Africa the main producers being Nigeria with 71% of the world

production, follow by Cote Divoire with 8.1%; Benin: 4.3% and Ghana 3.5%. in the humid tropical countries of West Africa, yam is one of the most highly regarded food products and is closely integrated into the social, cultural, economic and religious aspect of life. Traditional ceremonies still accompany yam production indicating the high status given to the food crop.

2.0 THE STUDY AREA

The area under study is the Federal Capital Territory Abuja. It refers to all the land located between latitude 8˚25' and 9˚25' North of the equator and longitude 6˚45' and 7˚45' east of the Greenwich meridian, an area covering about 8000km^2 (IPA, 1979). This area is situated in the middle belt region of Nigeria. It is surrounded in the north by Kaduna and part of Niger State, West by Niger State, in the east by Nasarawa State and in the South by Kogi State (Mabogunje, 1977). Politically, the FCT encompasses portion of Niger, Nasarawa and Kogi State respectively with Niger State having the large portion of the land in the territory accounting for 6,328.4 km^2 or 79.1% followed by Nawarawa with 1,313.4km^2 or 16.4%; and Kogi State having 352.2km^2 or 4.5%. Thought the influence of climate is easily recognized in crop production, and there have been various literatures which looked at the influence of climate factors on agricultural production in the tropics. The literature were for various areas and also for different crops as Babatola (1987) who look at maize in Kabba, Adejuwon (1982), who looked at cocoa production in western Nigeria, Oguntoyinbo (1967) assessed cotton in the northern part of the country, also Adebayo (1997) who looked at rice production in Adamawa state. A study of this nature is therefore necessary to fill the gap on the existing knowledge of climate and yam production in the Federal Capital Territory.

3.0 METHOD OF DATA COLLECTION

As earlier said that the source of data used for this project work is from Agricultural Development Project Gwagwalada, Abuja

3.1 METHOD OF DATA ANALYSIS

This section looks at various method employed in the analysis process. The methods are: Arithmetic mean, sample standard deviation, coefficient of variability, simple regression, and correlation analysis, and multiple regression and correlation analysis, each is explained below.

3.11 ARITHMETIC MEAN METHOD

The mean or arithmetic mean of a set of numbers (n), x_1, x_2, x_3 ….. x_n denoted by x is the sum of all these variables divided by the numbers (n) and is expressed operationally as

$$X = \frac{\sum_{j=1}^{n} x_j}{n} = \frac{\sum x}{n} \qquad \text{…… (1)}$$

Where x = mean or arithmetic means

$\sum_{j=1}^{n}$ = Summation (Sigma)

x_j = the variable (observation)

n = total numbers of variables

The method is employed in calculating the mean annual rainfall and temperature for all the available years over the six Area Councils of the Federal Capital Territory.

3.12 THE SAMPLE STANDARD DEVIATION

The sample deviation is a measure of dispersion of a set of sample variable from the mean. It is calculated by obtaining the arithmetic mean and then measuring how each value differs from the mean. It is defined as

$$S = \sqrt{\frac{\sum_{i=1}^{n} (x - \bar{x})^2}{n}} \qquad \text{…… (2)}$$

Where

S = Sample Standard Deviation

n = Total numbers of variables

∑ = Summation of square of all deviation from the arithmetic

j = 1 mean

The sample standard deviation being a basic measure of variability, is used to collate information on variation from the arithmetic means of both rainfall, and temperature over the Federal Capital Territory.

3.13 COEFFICIENT OF VARIATION

The coefficient of variability is an expression obtained by converting the standard deviation to a percentage of the mean. Also in this study the coefficient of variability (%) is employed to show rainfall and temperature totals on monthly and yearly basis in the Federal Capital Territory. It is defined as:

$$CV = \frac{S}{X} \times 100 \quad \text{..... (3)}$$

CV = Coefficient of variation

S = Sample standard deviation

X = mean of the monthly or annual rainfall and temperature totals

3.14 SIMPLE REGRESSION AND CORRELATION ANALYSIS

The simple regression analysis can be a means of estimating the dependence of once observed variable upon another or several variables; it involves numerical relationship between two or more variables, as in the formula below:

$$Y = a + bx \quad \text{..... (4)}$$

Where

Y = Dependent variable

$$a = y - bx \quad \text{..... (5)}$$

$$b = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sum (x - \bar{x})^2} \quad \text{.....(6)}$$

x = independent variable

x = mean of independent variable

y = mean of dependent variable

The regression line of best fit shows the relationship of the variables.

Correlation analysis is used in various ways to indicate the degree of relationship between two or more variables. To determine mutual linear association between two or more variables correlation coefficient methods is scientifically important when many variables are involved; the main value lies in suggesting lines, along which further research can be directed. In complex situation to find the possible cause and effect to explain the casual relationship that have already been assumed. Correlation coefficient looks at relationship between the variables, dependent and independent and can be expressed of the form using the product moment correlation techniques:

$$rp = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sqrt{\sum (x - \bar{x})^2 \sum (y - \bar{y})^2}} \quad \text{..... (7)}$$

Where

rp = product moment correlation ratio

$\sum (x - \bar{x})(y - \bar{y})$ = Summation of the multiple of both variables deviation from their mean

$\sum(x-\bar{x})^2$ = Summation of the square of all deviation from the mean in the independent variable.

$\sum(y-\bar{y})^2$ = Summation of the square of all deviation from the mean in the independent variable.

The correlation coefficient tests the strength of their relationship either positive or negative. The value of r must not be outside the range of -1 and +1. The value r = 1 occurs only when all the data points, lies perfectly on a straight line with a positive slope; r = -1 is also a perfect linear relation in which the line has a negative slope. A value of r close to either of these of extremes corresponds to a tight clustering of data points around a straight line, meaning strong linear relation. The value of r = 0 is interpreted as an absence of linear relation.

3.15 THE MULTIPLE REGRESSION MODEL

The multivariate correlation and regression analysis operates on assumption that the relationship between one variable, the dependent variable y and a host of all other variables X_1(i = 1,2,3….n) called the independent variables may be expressed by an equation of the formula:

$$y = b_o + b_1 + b_2 \ldots. Bxn + \sum \quad \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

where

y = Dependent Variable

b0 = Constant Term

b_1, b_2, b_n = Regression Coefficient

$X_1, X_2 \ldots X_n$ = Independent Variable

$\sum$ = Error term, error that can enter model

The regression coefficient are called partial regression coefficients because they describe the values by which y would charge as a result of a unit changed in any of the values of the independent variables.

4.0 RESULT AND DISCUSSION

These results deal with the interpretation of data on rainfall, temperature and yam yield, and also examine the relationship between the climatic element and yam yield over the Federal Capital Territory (FCT). We aimed at establishing relationship between rainfall, temperature and yam yield, each of the pairs here regress on one another that is rainfall and yam yield, temperature and yam yield the relationship between the two (2) climate element and yam yield were found.

The relationship of yam and rainfall gave a positive relationship and also that of temperature and yam yield also gave a positive relationship with 0.10 and 0.07 respectively for the pairs. The relationship of both rainfall and temperature on yam yield gave 0.14 which is also a positive weak relationship.

4.1 THE RELATIONSHIP BETWEEN YAM AND RAINFALL

Table 4.1 shows the pattern of yearly rainfall over the years in the Federal Capital Territory. A close look at the table reveals that, 2009 received the highest amount of rainfall, while 2005 received the lowest amount. The yam yield over the FCT is uneven; this is due to the area coverage which differs from years to years. This goes a long way to affect the amount of yield, it is also important to state that over ten (10) years the data collected on yam on Federal Capital Territory is reliable.

Using the Pearson product-moment correlation technique to look at the relationship between rainfall and yam yield, a correlation coefficient of 0.10 was obtained. Thus means that 10% of the proposition of yam is explained by rainfall. A positive relationship exists between yam and rainfall over the Federal Capital Territory. The regression equation is Y = 12.46466-0.002x

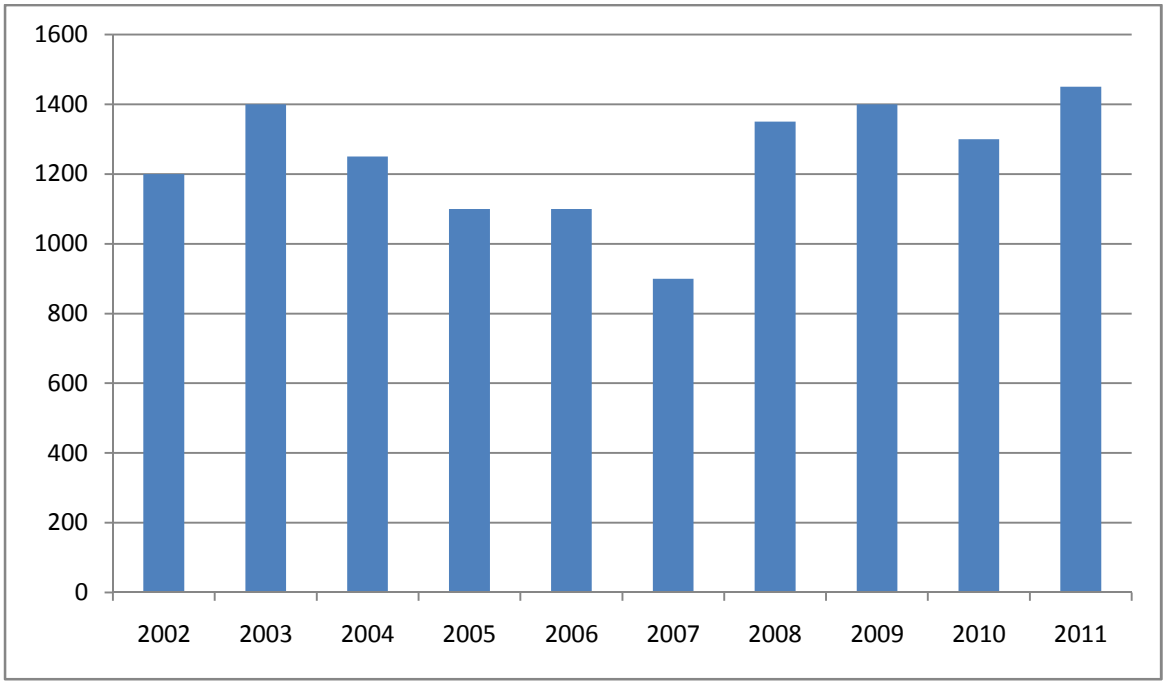

Figure 4.1: The rainfall pattern of FCT From 2000 to 2009

Source: Agricultural Development Project

4.2 THE RELATIONSHIP BETWEEN YAM AND TEMPERATURE

Table 4.2 also shows the pattern of yearly temperature over the years in the Federal Capital Territory. A close look that 2009 also has the highest temperature of 35 degree Celsius the lowest temperature occurred in 2000 and 2003 with a temperature of 32 degree Celsius and 32 degree Celsius respectively. The relationship between temperature and yam yield over the Federal Capital Territory, using the Pearson Product moment correlation technique where yam is the dependent variable and temperature the independent variable. The mean value of yam against the numbers of hectare of land cultivated and the mean value of maximum temperature were used to determine their relationship.

The result of the correlation technique is 0.07 which is a weak positive relationship and 7 percent of the proposition in the variation of yam yield is explained by temperature variation. The regression equation is Y= 6.936-0.24x.

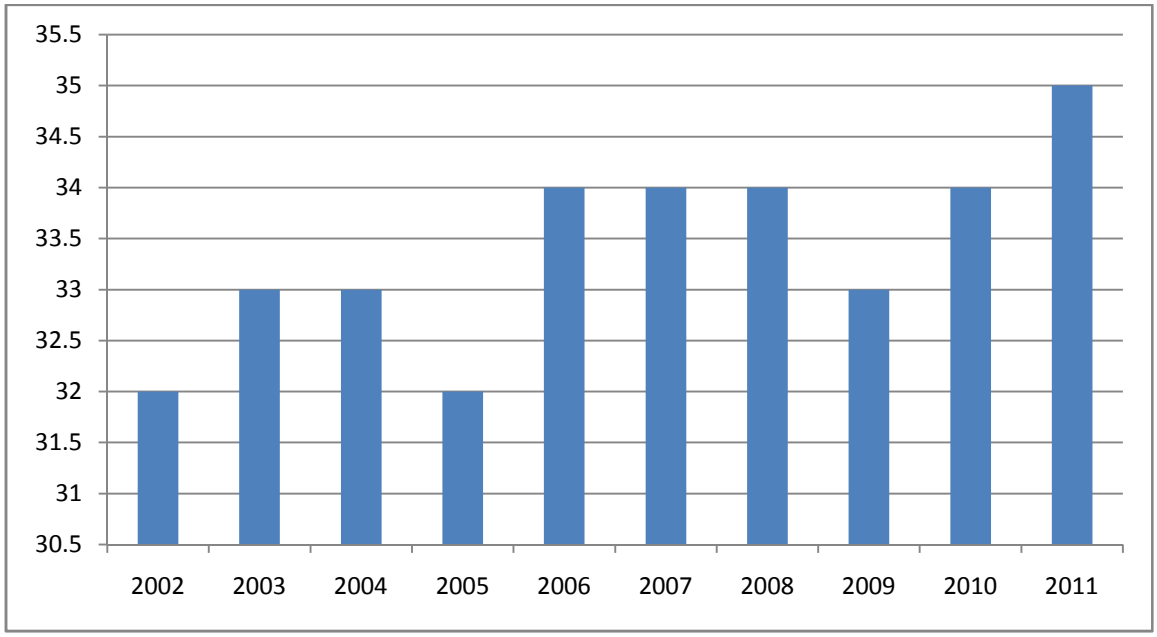

Figure 4.2: The Temperature Pattern of FCT from 2000 to 2009
Source: Agricultural Development Plan.

4.3 THE RELATIONSHIP BETWEEN RAINFALL, TEMPERATURE AND YAM YIELD

The main aim of this investigation is to determine the correlation/relationship between rainfall, temperature and yam yield. Employing the step wise multiple regression analysis to regress yam yield against rainfall and temperature we obtained a correlation coefficient of 0.14.

The variation in yam yield that is explained by both rainfall and temperature over the Federal Capital Territory for ten (10) years is 14% with a correlation coefficient of 0.14 which implies that weak relationship exist between the variables. Fig 4.3 shows the yam yield pattern of FCT from 2000 – 2009.

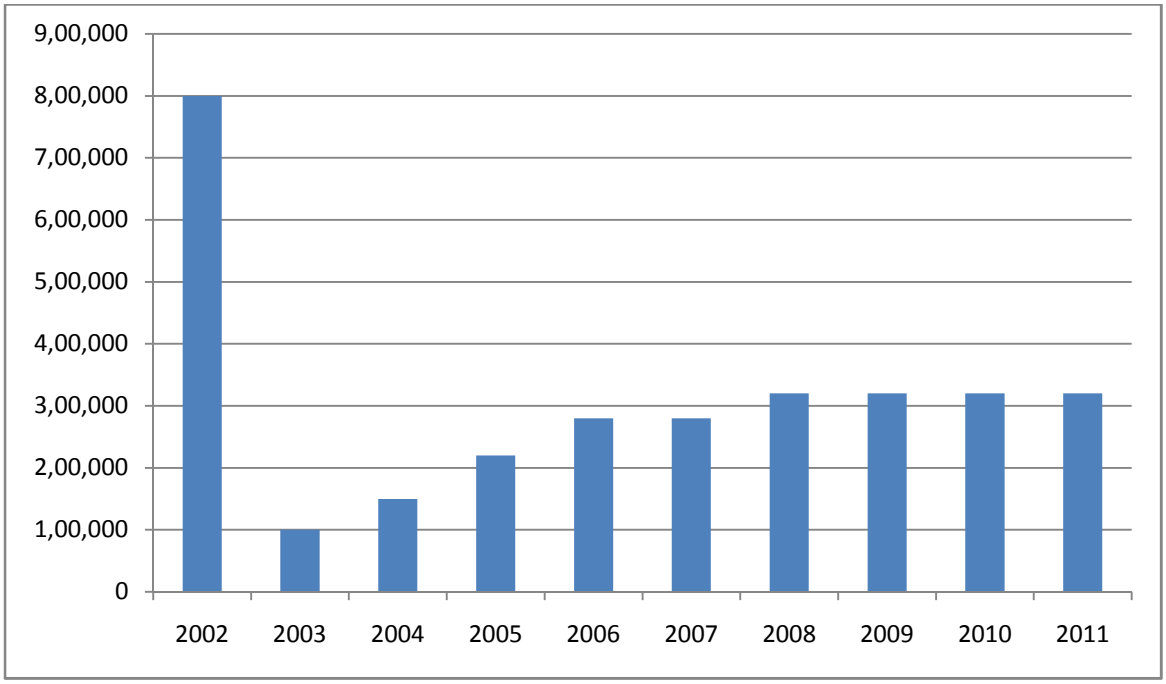

Figure 4.3: The Yam Yield Pattern of FCT from 2000 to 2009.
Source: Agricultural Development Project

However, the cultivated area pattern of FCT from 2000 – 2009 it shown in Fig: 4.4 below

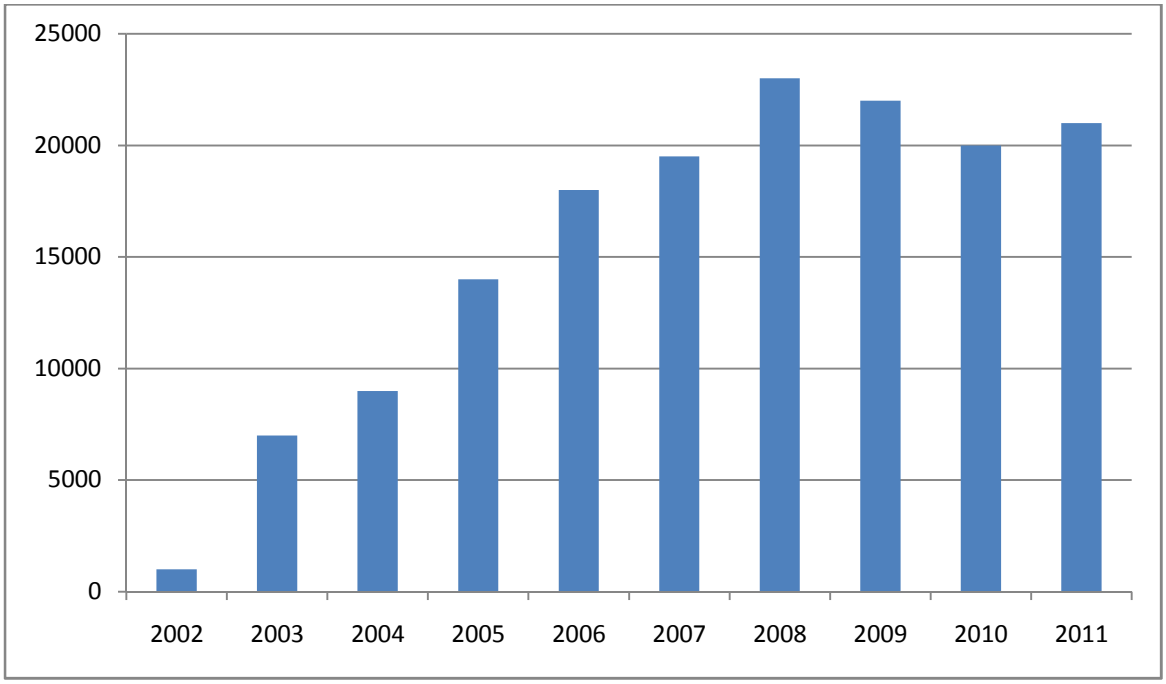

Figure 4.4: The Cultivated Area Pattern of FCT from 2000 – 2009.
Source: Agricultural Development Project.

4.4 DISCUSSIONS OF RESULTS

In the relationship between yam yield and rainfall which has a weak positive relationship means that there is a relationship between the two parameters. This result obtained is in agreement with the result obtained by other people's work such as Adebayo (1997), Bartson and Thomas (1962), Agbeola (1979) and Ogunke (1997) who also look at the relationship of such element on agricultural production and they obtained a positive result or relationship.

The relationship between temperature and also give a positive result, though the relationship is weak relationship. The weak correlation could be as a result of any of the following:

- There is little or low relationship of air/maximum temperature on crop yield
- The source of the data is secondary
- Soil temperature is of more important to yield than air temperature

The correlation between rainfall, temperature and yam yield shows a weak relationship with a correlation coefficient 0.14 meaning that a variation in yam yield is explained 10% of temperature has less influence on yam production and other environmental factors having a great influence on yam. Environmental factors such as soil fe4rtility, seed variety or type etc. so rainfall, temperature and other environmental factors are the controlling factor of yam production.

5.0 CONCLUSION/RECOMMENDATIONS

The result of this study has been able to show the relationship between temperature and yam production and also establish the most important of climate. On the findings of the present result the study suggest that:

- Yam should be regressed on other environmental factors such as soil fertility, technology, soil temperature, fertilizer etc.
- A longer period of data could be collected for better analysis.
- A more reliable data could be collected, which is monitored by a climatologist and analyzed again especially on rainfall.

Data on temperature, rainfall yam should be collected from different zones in FCT and latter compared to eradicate voluminous errors.

REFERENCES

[1] Adebayo, A. A. (1997): "The Agro-Climatology of Rice Production in Adamawa State", a PhD Thesis on Geography Department in Federal University of Technology, Minna.

[2] Adejuwon, E. B. (1982): Man's Environmental Predicament, O.U.P London.

[3] Agboola, S. A. (1979): An Agricultural Atlas of Nigeria. Oxford University Press, London, pp 37-46.

[4] Agricultural Development Project (ADP): Library, FCT Abuja.

[5] Awoderu, B.A. and Esuruoso, O.F. (1974): Reduction in Grain Yield of two Rice Varieties Infected Rice Blast Diseases in Nigeria, Nigeria Agricultural Journal Vol. 11, 170-173.

[6] Ayeni, B. (1994) "Quantitative Methods for Geography Students" Research Support Service, Ibadan.

[7] Balogun, O. (2001): The Federal Capital Territory of Nigeria, A Geography of its Development.

[8] Barry, M.G. and Charley, R.J. (1978): Atmosphere, Weather and Climate. Printed in Great Britain by Fletcher and Sons Ltd, Norwich, pp. 363-364.

[9] Booker, H.R. (1963): The Effect of Sowing Date and Spacing on Yam Pest and Diseases in Nigeria with Observation on the "Vector Aphis Craccivora". Annals of Applied Biology Vol. 52, pp. 125-131.

[10] Bunkill, H.M. (1985): The Useful Plants of West Tropical Africa – Vol. 1, Families A.D, 2nd Edition. Royal Botanic Gardens, Kew-960.

[11] Cliup, C.D. (2002): The Synthesis of Physical Geography. Dodo Press Kaduna.

[12] Dawan, P.D. Etal (2002): Geography of Abuja Federal Capital Territory.

[13] Dawan, P.D. (1969): "Urban Development and Population relocation" A Study of Resettlement Programmes in Abuja FCT.

[14] Ejiofor, M. (1982): Annual Variability Rainfall Maps of Eastern Nigeria. Macmillan Publisher London.

[15] Harper, O.K. (1983): "Agro Forestry Systems and Soil Surface Management of a Tropical ALIFSOL: 11: Water Run Off, Soil Erosion and Nutrient Lost", Agro Forestry Systems, 8:97-111.

[16] Haywar, O. Oguntoyinbo, J. (1987): Climatology of West Africa. USA: Barnes and Noble Books, P.81, Adams Drive, Totowa, New Jersey, pp. 164-178.

[17] Idoga S.O. (2000): Water Resource: Distribution, Use and Management (New York: WILEY).

[18] Jeje, L.K. (1979) Erosion under Ruber Plantation in Araromik Rubber Estate, Ondo State. Paper Presented at the departmental Seminar. April 1979, Department of Geography, University of Ife, Ile-Ife.

[19] Kay, T.M (1987): The Effects of Rainfall on Yam Yield from Different Land use Surfaces. Practices Press USA.

[20] Kure, G.Y. (1999): Settlement and Cultivation in the Summer Dry Climate of the FCT. Year Book of Agriculture, 1996, Ministry of Agriculture, Abuja.

[21] Ogunkeye, O.S. (1997): Climate and Growth of Maize and Cowpea in Ilorin. B.Sc Project Department of Geography University of Ilorin.

[22] Olaniran, O. (1981). Yams DiscoreaSpp in genetic Improvement of Vegetable Crops. G. Kallo and B.O. Berger, Eds-Perganon Press, New York, pp 717-733.

[23] Orkwor, U.B. (1997): Some Implication of Weather Element on Agricultural Practices in Nigeria. Lampi Publisher Kano.

[24] Owueme, B. (1975): The Outline of the Geomorphology of Nigeria in Relation to its Climate-African Geographical Journal 34. Pp. 30-37.

[25] Rajaratwan, U. (1980): Erosion of Granite Terrains under Tropical Rainforest in Australia, Malaysia and Singapore, in Symposium on river Monopoly, General Assembling, Bera, 1967.

[26] Thoroid, C.A (1952): The Epiphytes of Theobroma Cacao in Nigeria in Relation to Incidence of Black Pod Diseases – Journal of Ecology, Vol. 40,126-133.

[27] Dickon A. Okolo "Global Climate Change"

[28] Watson's Proposal, 1993

APPENDIX

TABLE 1: yam yield over the Federal Capital Territory

S/N	YEAR	YAM YIELD	CULTIVATED AREA	YAM YIELD RELATION LAND
1	2002	798,050	55,000	14.51
2	2003	101,200	7,015	14.52
3	2004	135,493	9,045	14.98
4	2005	214,774	14,102	15.23
5	2006	280,970	17,738	15.84
6	2007	269,526	19,798	13.61
7	2008	318,046	22,905	13.89
8	2009	321,739	21,542	14.93
9	2010	325,400	20,310	16.02
10	2011	335,200	20,820	16.09

Source: Agricultural Development Project FCT

TABLE 2: Yearly total and average rainfall, maximum and minimum temperature in FCT Abuja

YEAR	TOTAL RAINFALL	AVERAGE RAINFALL	MASIMUM TEMPERATURE	MINIMUM TEMPERATURE
2002	1197.4	171.1	32	24
2003	2389.5	173.7	33	21
2004	1242.9	124.3	33	23
2005	1084.7	108.5	32	23
2006	1093.4	109.3	34	24
2007	911.7	91.2	34	24
2008	1340.3	148.9	34	24
2009	1401.8	175.3	33	23
2010	1304.6	145.0	34	25
2011	1470.4	163.4	35	24

Source: FCT – Agricultural Development Project, Weather Data Bank PME sub Program

TABLE 3: the relationship between rainfall and yam

YAM	RAIN	Y-Y	$(Y-Y)^2$	X-X	$(X-X)^2$	(X-X) (Y-Y)
14.51	1197.4	-0.442	0.19536	-46.27	2140.9	20.452
14.52	1389.5	-0532	0.28303	145.83	21266.4	-77.582
14.98	1242.9	0.028	0.00078	-0.77	0.5929	-0.022
15.23	1084.7	0.278	0.07728	-158.97	2527105	-44.194
15.84	1093.4	0.888	0.78854	-150.27	22581.1	-33.439
13.61	911.7	-1.342	1080096	-337.97	110204.1	445.504
13.89	1340.3	-1.062	1012784	96.63	9337.4	-102.621
14.93	1406.4	-0.022	0.00048	158.13	25005.1	-3.478
16.02	1304.6	-1.068	1.14063	60.93	3712.5	65.073
16.09	1.138	10138	1.29504	226.73	51406.5	258.018
149.52			6.709		270926.093	427.711
10						
14.952						

TABLE 4: The relationship between rainfall and yam

YAM Y	TEMPERATURE X	Y-Y	$(Y-Y)^2$	X-X	$(X-X)^2$	(X-X) (Y-Y)
14.51	32	-0.442	0.19536	-1.4	1.96	0.6188
14.42	33	-0.532	0.28303	-0.4	0.16	0.2128
14.98	33	0.028	0.00078	-0.4	0.16	-0.112
15.23	32	0.028	0.07728	-1.4	1.96	0.3892
15.84	34	0.278	0.78854	0.6	0.36	0.5328
13.61	34	0.888	1.80096	0.6	0.36	-0.8052
13.69	34	-1.342	1.12784	0.6	0.36	-06372
14.39	33	-1.062	0.00048	-0.4	0.16	0.0088
16.02	34	-0.022	1.14063	0.6	0.36	0.6408
16.09	35	1.138	1.29504	1.6	2.56	1.8208
14.52	334		6.709		8.4	1.992
10	10					
14.952	33.4					

TABLE 5: The relationship between rainfall, temperature and yam yield

S/N	YEAR	YAM Y	RAIN X1	TEMPERATURE X	YS1	YX2	X12	X22	X1 X2
1	2002	14.51	1197.4	32	17374.3	38316.8	1433766.6	1024	38316.8
2	2003	14.52	1389.5	33	20036.6	45853.5	1930710.3	1084	45853.5
3	2004	14.98	1242.9	33	18618.6	41015.7	1544800.4	1084	14105.7
4	2005	15.23	1084.7	32	165120.0	34710.4	1176574.1	1024	34710.4
5	2006	15.84	1093.4	34	17319.5	37175.6	1195523.6	1156	37175.6
6	2007	13.61	911.7	34	12408.2	30997.8	831196.9	1156	30997.8
7	2008	13.89	1340.3	34	18616.8	45570.2	1796404.1	1156	45570.2
8	2009	14.93	1406.4	33	20928.9	46259.4	1965043.2	1084	46259.4
9	2010	16.02	1304.6	34	20899.7	44356.4	1701981.2	1156	44356.4
10	2011	16.09	1.138	35	23658.7	51464.0	2162076.2	1225	51464.0
		149.52	12436.7		33.4981.3	415719.8	15738076.6	11149	412719.8