RAINFALL VARIABILITY AND CROP YIELD

"A Case Study of Kontagora Farming Community"

BY

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CERTIFACATION

This is to certify that the research work entitled RAINFALL VARIABILITY AND CROP YIELD, A CASE STUDY of KONTAGORA FARMING COMMUNITY" was carried out by MAL MUSA ANGO ABDULLLAHI (M. TECH/SSSE/97/164) of the Department of Geography, FEDERAL University of Technology, Minna under my supervision and it is hereby approved:

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DEDICATION

This project is dedicated to my beloved mother, Khadijat (may her gentle soul rest in peace, amin).

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ABSTRACT

This research attempts to establish the relationship between variability in rainfall and crops yield in Kontagora farming community with expected advanced concrete suggestions for ameliorating the effect of flood and drought in the area.

The main aim of this research is to determine the extent to which different variable rainfall years have affected crops yield of the peasant farmers in the study area.

The data and analysis of this research has been collected from the Niger State Agricultural Development Project (Gidan gona) Kontagora, station.

The work has established that variability in rainfall becomes more consistent after the 1982/83 drought years and that 1983 and 1993 has adversely affected the yields in crops through late planting, forced harvesting and crop failures. It has been established that flood or drought years affected crop yields through destruction of failures.

The effects of poor yields include out migration, increase in the rate of theft, and changes of occupation.

It is suggested that resettlement schemes, dam construction, disaster Relief committee and more generous agricultural loan schemes should be under taken to minimize the physical and ameliorate the socio-economic effects of flood and drought in the area.

As a long –term solution to the effects the following are recommended: the state government or federal government should embark on massive sinking of bore holes, desalination, canalization and drilling purposes in the areas prone to draught or even floods.

Above all there should be research into adaptation of improved short – term varieties of crops such as cassava, maize, beans and sorghum etc that will alleviate the effect of variability in rainfall. And enlightenment campaign against settling along river valleys and flood terrains.

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INTRODUCTION

1.1 BACGROUND

Deficiency in soil moisture is a feature of rainfall variability, which requires continuos diagnostic and prognostic studies in West Africa sub-region that has been visibly scarred by its effects as an exacerbating factor in the desertification process within the past two decades. In spite of recent technological and scientific advances, weather is still the most important variable in agricultural production.

Recent studies and research in relation to aspects of hydrology and meteorology in Nigeria since the period of Sahelian draught which began in 1969 concentrated upon the socio-economic aspects of environmental degradation, such studies as on drought, desertification, desert encroachment and meteorological aspects, their causative mechanisms and factors and, possible methods of abatement and control (Ojo, 1985, and Adefolalu 1986, 1990). On the other hand, studies on aspects of environmental hydrology in Nigeria have not been widely documented (Ayoade and Oyebande, 1982). However, climate variability and subsequent rainfall deficiency has negative consequences which disrupt the economy, society and the environment. This may occur over a wide range of time scales from a season to years to decades. This could be associated to drought which is the direct cause of famine, which kill hundreds of thousands of people and disrupt the society and livelihood of millions of the most valuable of the world's inhabitants.

Rainfall variability is more pronounced in areas with well-defined wet and dry seasons as in most parts of Nigeria in particular and the tropics in general. This can be expected every year owing to seasonal changes in atmospheric circulation

patterns. Lower than normal rainfall results in drought conditions which when aggravated lead to dry conditions and when temperatures are extremely high severe decication occurs which lead to wilting of crops. Such exceptional dry weather dominates the northern Sahel belt of Nigeria to which Kontagora, Niger State belongs.

Of all climatic fluctuations the short-term variability is becoming increasingly important. The high degree of precipitation variability that has plagued different parts of Nigeria particularly, the Northern Sudano-Sahelian region has been of great public concern where precipitation in these areas has become unreliable. The consequence precipitation deficiency is injurious to agriculture, when periods with lower than normal rainfall are prolonged. Thus, sensitivity to precipitation variation for agriculture, and pastoral normadism in this section of Nigeria has major socio-economic impacts because variation in annual, seasonal and monthly precipitation are sharply reflected in the total crops yield each year.

The term rainfall variability is associated with a sustained period of abnormal and normal water or moisture supply, which translates the different amount of rainfall recorded in a region that is not consistent over successive periods. However, there is expected clearly sustained period or figure that is spread normally over the year or season as required moisture deficit. Plant response to moisture requirements and even drought situation has shown that sometimes the amount of recorded rainfall is quite irrelevant. A year with perhaps normal (or above normal) total annual rainfall, but characterized by delayed onset or premature cessation (or both) of the rainy season is worse for plants than one with definite short fall in total amount but with normal dates of onset and cessation. Also, shortened rainy season with above normal rainfall implies high intensity

precipitation, which could be bad for arable lands with topsoil, washed away and even crops destroyed by erosion and flood. Hence, precipitation effectiveness is to be associated with those and other factors perhaps least should be the total rainfall amount.

1:2 STATEMENT OF RESEARCH PROBLEM

In spite of recent technological and scientific advances, weather is still the most important variable in agricultural production (Ayoade, 1977). Problems of ecological disaster such as drought, desertification, flood, and erosion have been on the increase in Nigeria. From obvious indications, governments and organizations are contented with palliative measures in the way of relief materials and assistance but countries that are well of with rhetorical undertones which border on political considerations even in the provision of such aids whose events albeit genuinely motivated can never result in any lasting solution to the problem (Adefolalu, 1976a, 1983a, 1993). In Niger state there have been problems of water shortage as a result of deficiency and variability in the normal yearly rainfall, drought, pollution, land wasting and declining agricultural productivity; government instead of addressing the root causes of the problem and finding solutions resorted to ceremonial tree planting exercise and award of various degree of contracts of water provision that are wide spread and abandoned throughout the state.

There is a definite shortfall in documented studies on both atmospheric circulation patterns and geo-environmental indicators of deficiency and variability of rainfall in the entire sahel sub-region. This is due partly to insufficient data base even if there is the will or desire to tackle the problem from principle (Obasi, 1987). And the abundant knowledge and tested theory on the role of atmospheric

circulation and its variability in relation to climate and its anomalies e.g. drought and flood, government do concentrate on exploitative natural resources monitoring with respect to capital investment (Bourn et –al, 1991). For example, in the Nigerian situation, which has been expatiated upon by Adefolalu (1986b); poor execution of well defined programmes to rehabilitate the deforested and the degraded of the geo-environment even when reliable data are available (Berry, 1984).

The years 1973 and 1983 widely accepted as drought years in Nigeria, rain started late and ended earlier than usual especially in the northern parts of the country. And the situation where most of the people depend on agriculture for their livelihood and where there are few other resources on which to fall back the variability in rainfall might constitute an economic disaster in the area under study.

Most of the crops grown in the study area, which include, cereals and legumes (specifically, sorghum, maize, rice, groundnuts, beans and soya-beans) require moderate (between 700-1000mm) rainfall. For the purpose of the study it has been ascertained and believed that some years before and subsequently now, rainfall variability has and may adversely affect crop production and yield in the study area if remedies are not put forward. It is for these reasons that the present research is thought to be relevant in generating empirical relationship, which will quantify some of the enumerated effects.

1:3 OBJECTIVES OF THE RESEARCH

In view of the foregoing, the main aim of this research is to determine the extent to which variability in rainfall have affected crop yield for the peasant farmers in the study area.

The specific objectives apart from the determination of abnormal years, i.e 1973, 1975, 1986 are:-

(i). To determine the level of crop production in the normal years preceding 1973, 1975, and 1986.

ii) To compare crop yields of the deficiency years. (Specifically 1983 and 1993)

iii) To determine the yield in 1973, 1975 and 1986.

iv) To make constructive recommendation for the future amelioration of deficiency and variability of rainfall on agriculture.

1:4 JUTISFICATION OF THE STUDY

The problem of rainfall variability could be attributed to both the natural/general circulation of the atmospheric motions and anthropogenic factors which aggravates the green hours effect (global warning) and the fragile ecological balance in the drought prone sudano- sahelian belts of Nigeria. Adefolalu (1986) confirmed that, while sahel-type of vegetation (shrubs and dry grass land) was non existent up to 1950, it has now spread southward to latitude 10°N in Nigeria with trends in desertification of Sahel proper suggesting an increase in areas to be covered by "tree less" desert conditions in Sahel.

The only way this conditions would be arrested before it is more pronounced for government to do their utmost best is the area of tree planting, and development of shelter belts which in the past were embarked upon. Therefore, an intensification of a practical approach to conservation and preservation of the land- scape and water resources in a multi-purpose initiative is necessary.

The resource (financial) base is compared to the losses in life and 'property being incurred as a result of short falls or variability, drought, desert encroachment, erosion and floods. The import bills on subsidy for rice importation

at the wake of the 1983 drought and 1997/98, inflation run into billions of Naira in hard currency. While the equipment and other imported items during Green Revolution Programme must have consumed all over 4.0 billion naira between 1979 and 1983. In 1981 alone, 0.99 billion naira was spent on the eleven (11) river basin development authorities, which up to date did not meet and tackle the problems of food shortage and water resources management and rehabilitation.

The area of the research, which is Kontagora farming community in Niger State, is a purely agricultural area. The farmers of the area have been contributing immensely towards self-sufficiency in food production in Niger State and Nigeria in general. It is believed that the type of investigation pursued in this study is justifiable to highlight the degree of the contribution and problem in the study area particularly those associated with rainfall variability and drought.

1.5 SCOPE AND LIMITATION OF THE STUDY

Rainfall figures, onset, cessation dates of the rains and lengths of the rainy season (LRS) will be estimated for Kontagora in (1973 –1987) 15 years and (1988-1997) 10 years. Using the data, which will be given quality control checks from the Kontagora rainfall records obtainable from Niger State Agricultural Development Project and Minna Meteorological Station. Due to limited resources available for the research and time constraint, the study shall be limited to Kontagora farming community.

1.6 THE STUDY AREA

The study area shall include- Kontagora farming community. The community shall comprise of Tunnga Wawa, Usubu, Kwangwara, Rafin Karma, Masuga, Farin Shinge, and other villages.

MAP OF KONTAGORA LOCAL GOVERNMENT SHOWING KONTAGORA FARMING COMMUNITY.

Fig. Kontagora Local Government Map Showing Kontagora Farming Community

Source:-(Niger State Ministry of Works, Lands and Survey)

Longitudinally it is located at 5°. 22'E and latitude 10°. 24'N. The extent of the study area is about 724km^2 with a population of about 32,000 (local government source). Thus, the density shows that the area is relatively sparsely peopled.

Some villages are scattered within the area. The largest villages are; Kawo, Liwoji, Tunganwaya, Rafin-gora and Doguwar Fadama with population figures above 4,500 each. The largest population of the inhabitants is shared between the local tribes of Kambari, Bassa, Dakarkari, Kamuku and Hausa. While about 18% is comprised of nomadic Fulani and southern tribes (Igbo and Yoruba).

MAP OF NIGER STATE SHOWING THE 25 LGA'S

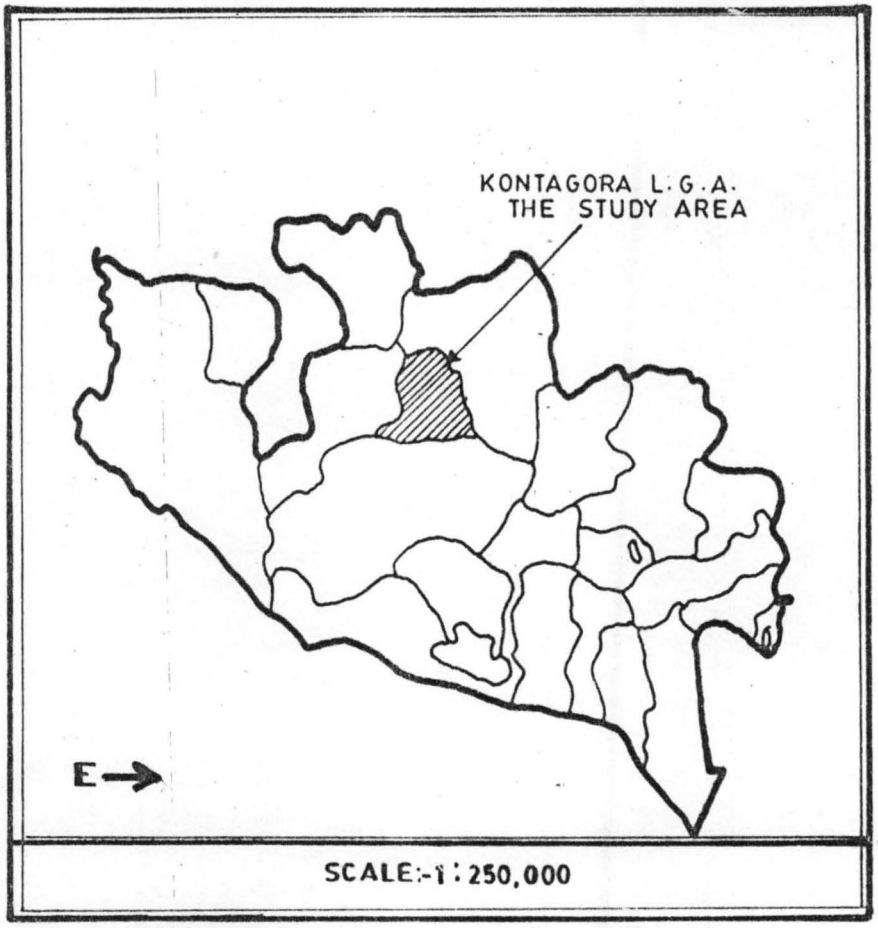


Fig. Niger State Map Showing the 25 Local Government Areas.

(Source: Niger State Ministry of Works, Lands and Survey)

CHAPTER TWO

2.1 GENERAL OVERVIEW

Studies on environmental hydrology and meteorology concentrated on socio-economic effects of environmental degradation, such studies was directed to drought desertification, desert encroachment, and other related fields (Have 1945, Lamb 1972, 1974 and 1982, Miles and Folland 1974, Charney 1975, Oguntoyimbo and Richards 1977, Nicholson 1979, Gregory 1982, Ojo 1985, Nicholson and Entabasi 1985, Adefolalu 1983, 1986, 1988 and (1990). The most serious drought occurred in Sudan. Growing season rainfall as little as half of normal and un-relented August heat devastated crops, raising the spectre of famine. In some farming areas of Northern Sudan the drought was severe as in 1984, when thousands of people died. Dryness also affected the marginal growing areas of the Sudan's eastern neighbour; Eritrea, whose consecutive summer with below normal rainfall caused much concern. Most areas received 75 – 90% of normal rainfall, while several areas including northern Senegal, southern Mauritania, eastern Chad, West, central and east central Sudan and northern Ethiopia recorded less than 50%.

There are lots of empirical studies in Nigeria aimed at estimating some meteorological parameters, which are not commonly measured. These include water balance (Ojo 1969, Obasi 1972) and assessment of evaporation (Garnier 1956, Davies 1966, Ojo 1969, Adeleke 1971 and Adefolalu, 1988).

A lot of studies have been done to relate crop yields to weather parameters. The technique, for rice yield in India is a common one (Robertson in W.M.O. Technical notes No.144). The technique was multiple regression analysis and long term records of yield and weather data just to establish relationships between

yields and certain weather factors at specific times in the life cycle of the rice crop. He therefore suggested that, this technique provides encouraging results because similar techniques were used in developing equation for other rice growing areas in India with positive results.

Ekpo (1989) noted that regression models have been extensively used by different people provided that the data are base range for climatic variables only. But for this research study the choice of data for each analysis depends on the relationship between the crop being investigated and the prevailing climatic element with regards to the environmental setting where the analysis is conducted.

Among the first of such models was the one constructed by Thompson in the 1960s to assess the influence of selected weather factors and technology in the production of specific grain crops in Mid-west of the United States of America (Thompson 1962, 1969, 1975). For example his 1962 wheat model was based on data from six states in mid-west of U.S.A. involving two climatic variables i.e rainfall and temperature. Various results from several people who modified his model showed that about half of the residual variants were explained by the climatic components alone.

Warrick (1984) observed that these regression techniques carry the advantage of involving weather predictors such as monthly or weekly precipitation (rainfall), He stressed that the statistical empirical methods draw upon historical climate and yield data series for the determination of model parameters.

Perm and Carter (1988) observed that the relationship (between climatic variable and yield) may vary from region to region and from crop to crop. But they also asserted that empirical statistical models relate a sample of seasonal crop productivity data to weather data for the same period. Using statistical techniques

such as correlation coefficient(r) and, or regression analysis, these relationship could be quantified.

2.2 VARIABILITY OCCURRENCE:

Variability of rainfall distribution over areas has been a scourge of mankind – even i.e. areas or regions with copious rainfall. Historically speaking even droughts are not uncommon, nor variability becomes a unique phenomena to the Sahelian region. Because, according to many authors it is a recurrent climatic phenomena in Africa particularly in Sudano-Sahelian zone. Most peasant farmers and herdsmen can recount tales of lean years due to deficiency in rainfall of local droughts and even disaster e.g. famine and floods, years such as the early 1970s when animals and crops perished.

According to Kowal and Adeoye (1973), areas which normally receive appreciable amounts of rainfall sufficient to raise crops do suffer sometimes from shortage or abnormal distribution of rains resulting in partial or total crop failure, Sanford (1978) describe such areas as areas of induced shortage of some economic goods brought about by inadequate or badly timed rainfall.

Therefore due to lack of strict index for variability of rain, one can summarize this condition as basically a derivation from a rainfall regime whose effects are adverse on people, animals and plants of a particular climate zone. In this area (Kontagora farming community) of study what determines the variability of rainfall is the totality of how dry or wet the preceding year was, how late this year's rain is established, how early it ceases, how well the rain received is distributed in addition to how large the amount of rainfall is.

It is a common knowledge that availability of water has been man's major concern throughout history. Water has been man's means of survival and at times

his enemy. At various places and at different times people migrated from place to place in search of water or in order to run away from drought, flood and erosion. In his effort to provide and acquire a safe and comfortable environment for sustainable development man, has since then continued to intensify research in areas of drought, flood mitigation, erosion control, water resources development for irrigation, navigation, domestic and industrial water supplies.

The establishment of many meteorological stations towards the middle of the 20th century provided climatic record to more adequately describe the areal extent of rainfall distribution and variability. Therefore using rainfall data from various well established stations-Fisher (1975) summarized historical evidence indicating that drought and famine conditions prevailed in different parts of present day Northern Nigeria in the year 1830 –1837, 1847, 1855, 1873, 1888 and 1889-1890. And Abdulmumin (1984) has extended three more episodes, which cover large areas in sub-tropical zone in 1918, 1942, and 1973. Supporting the opinions of other authors Abdulmumin confirmed that since 1972 only two years 1974 and 1975 yielded higher rainfall than normal in many years in Africa.

2.3 REASONS FOR VARIABILITY

Global changes in air pressure and general circulation as stressed by lamb (1973) dates back from twenty to fourty years. According to him, Sahelian rainfall has been predicted to decline by a change in global pressure belts. The argument is based on the theory that reduced pressure gradient from the equator has resulted in the tropical maritime air mass which brings moisture to the northern part of Nigeria sweeping less far north and consequently disposing a higher proportion of its rain –near the equator.

If the atmospheric circulation system changes, an area normally under – ascending convective systems comes under descending stable system, it will experience reduced rainfall no matter what the surface vegetation cover is. Although, according to Abdulmumin (1984), desertification does not under estimate the importance of large-scale vegetation clearing in changing the micro-climate of an area.

2.4 EFFECTS OF RAINFALL VARIABILITY

Environmental effects compounded by certain human activities which include the global warming as a consequence of ozone depletion that results from the release of chloroflourocarbous, Nitrate oxides, methane, carbon monoxides and other green house gases, vegetation clearance etc., are so serious that only with massive efforts and a return of normal rainfall will the agricultural lands and crop yields ever recover their desired level. According to Apeldorn (1978), the soil of most of the drought affected areas have become so hardened and eroded that young plants even if sprouted, cannot survive or facilitate the expected yields, as the lands have become increasingly patched and subject to erosion.

Hydrologically, many streams have drastically reduced their volume rate of flow. For instance, Niger River was reported as being at its lowest for 30 years in 1972 (Thomas and Bonne, 1973) and its lowest for sixty years in 1973 (Ald, 1973). River Kontagora which was normally flowing throughout the year in the past, now only collects at deep valleys along its course during dry periods (season) but only for the advantage of damming it at Kawo in order to facilitate dry season farming and domestic consumption.

2.5 DROUGHT AND RAINFALL

From the early 1960s onwards, the Sahelian region suffered a progressive decline in rainfall which culminated between 1968 and 1973 in a drought so severe that it starved flocks and herds, even human, and damaged soil and natural vegetation. Though, rains returned to some areas in 1974, the 1973 drought has persisted in others and re-invaded West Africa in 1977.

However, due to relatively abundant rainfall after that drought episode – although a periodic drought spells still persisted, the Sahel never recorded the normal rains with most places recording rainfall averaging only about 70% of the long term mean.

Meteorologists attributed rainfall deficiency as condition of absolute and partial drought. An absolute drought is defined as a period of at least 15 consecutive days, non of which is credited with 0.2mm or more of rainfall, while a partial drought is a period of a least 29 consecutive days, the mean daily rainfall of which does not exceed 0.2mm (Mackintosh, 1963). Thus, deficiency is said to occur when the rainfall received in a year or season is less than a specific percentage of the long term annual or seasonal average required for crop cultivation. This condition does not allow crops to grow at optimum rates and occurs anytime the daily supply of moisture from the soil or falling precipitation (rainfall) fails to meet the daily water needs of crops. A slow drying of the soil takes place and crops fail to grow at their optimum rate, thus resulting in less than optimum crop yields (Akoh and Okunode, 1995).

In adequacy of soil moisture or water below soil surface for nutrient in take by plants is not a function of rainfall, but its spread, distribution and reliability (seasonality) is a great determination for crop production in the research area

(Kontagora farming community). Therefore, the occurrence or non-occurrence of the three set of parameters is decisive on possible management through the degree of wetness and water equivalent to avert drought for best result (Joseph, 1995).

Agricultural drought relates to seasonal vegetation development, a situation when the demand for water by plants is not met. This may occur even when total annual rainfall amounts do not change but temporal distribution could be such that plants receive less rain at the time of maximum demand. This aspect is thought to be related to significant drop in agricultural yield, which was a function of spatial and temporal variations of precipitation patterns during the 1973 monsoon season.

Also drought is a function of weather producing system in West Africa. In the tropics anomalous patterns of precipitation (annual amounts, seasonal, variable distribution in time and space etc) between 1970 and 1990 have aroused much interest. Various studies have given the causes of such anomalies in west Africa as ranging from the failure of the monsoon and atmospheric synoptic scale features to the increasing albedo effects due to the denuded surface vegetation which will result in lower thermal heating needed for convection (Charney et al, 1977, Adefolalu 1984b).

Being a seasonal wind system, the climatological features of the monsoon suggests that there are two rainfall seasons –dry and wet in general. It is dry from mid October to mid-April, while the wet season cover the other half of the year. Bulk of the rains (80 percent of the annual total) is received during the later season when monsoon-trough-induced waves (the Africa waves) are dominant in the rain forest of Sudan savanna zones (4-12^0 N latitude).

As confirmed by Lamb (1979) there has been continuing southward decline of the monsoon influence to an overall equator ward treat from about 22.5^0 N in

1950 to about 20^0 N three decades later (Flohn et al, 1974). The dwindling total yearly rainfall since the early sixties in the sub-region is no doubt related to this decline especially in the Sahel (Menakaya et al, 1980). It is interesting to note that apart from the fact that the pole ward extent of bad weather stops at about 200-400km south of the east west axis of the surface. Inter-Tropical Discontinuity position its wind confluence zone at both the 900 and 850hpa levels –known as monsoon trough (MT) may hold due to the success of future prognostic efforts.

CHAPTER THREE

3:0 RESEARCH METHODOLOGY

The methodology for data collection included library studies, field studies, questionnaire, survey, and statistical analysis.

3:1 LIBRARY RESEARCH:

The Researcher consulted the existing publications, which include weather records and relevant literatures on drought, desertification, and precipitation effectiveness. The aim is to first show the relationship between rainfall variability and crop yield and secondly, to highlight the effect of rainfall variability in other areas at other times.

3:2 CLIMATOLOGICAL /METEOROLOGICAL DATA

Data on rainfall, from 1973-1987 and 1988 –1997 of Kontagora in the study areas shall be used. These data are available at the meteorological station, Minna Airport, Niger State Agricultural Development Project and the climatic change center F.U.T Minna. Annual mean and monthly rainfall data for Kontagora will be collected for the period of 18years and 10 years respectively. These will be useful for computation of onset, cessation and length of the rainy season (LRS). These three (onset, cessation dates of the rains and the length of rainy season) if based on mean monthly rainfall data, rainfall values will give the effective period which determines the rainy season for particular year. It is unlike the practice of defining certain threshold values of mean annual rainfall. Although there may be uncertainty of the actual day/date during a particular month when the commencement of the rainy season is supposed to start, the uniformity or consistence of monthly records for the years would give the values required to determine the variabilities as it spread over the actual wet periods.

As its name connotes, cessation-means the effective termination date of the rainy season. It does not imply the last day of rainfall, but rainfall can no more be assured. So, values estimated from monthly rainfall data when less than 600mm of rain was received may be inappropriate. But from the estimate of realistic onset (S_t) and cessation dates (c_d), the effective length of the rainy season (LRS) may be written as LRS-$c_d - s_t$).

It is important to note that optimum crop yield is not just a function of the hydro-neutral zone, it is also in areas where effective actual Evapotranspiration (ET) is high. However, for drought prone semi arid zones potential Evapotranspiration increasingly exceeds precipitation while actual Evapotranspiration decreases that adequate control measures to enhance the later, crop yield will decrease in the study area.

If adequate water is not been made available plant growth will be stunted and yield will be negligible. Water deficiency must be very well quantified to determine the required water demand of plants to ensure high crop yields.

3:3 STATISTICAL TECHNIQUES

For the analysis of the data, the Researcher shall make use of the following methods: simple mean, percentage, 'r' correlation.

The mean and percentages are to show the crop yields between deficiency years and the normal years. While pearson's product of moment correlation by co-efficient (r) is to show the degree of association between two set of paired variables to be used as rainfall distribution and crop yields. To show whether crop yields are very much dependent on rainfall distribution (either way period of short-falls and abundance or normalcy).

3:4 FIELD TECHNIQUES

(A) QUESTIONNAIRE: A questionnaire is one of the main instruments used for the collection of data for this research. The steps taken to ensure its effectiveness include extensive reading carried out by the researcher on some related topics in consultation with the supervisor. After this, an acceptable questionnaire was established.

Although the researcher used controlled 'closed questions, a provision was given for unexpected responses. With the closed controlled questions the researcher hoped to guard, to a certain extent against irrelevant answers, and thus, ensure reliability in the responses obtained from the exercise. The questionnaire was also prepared in such a way to cover aspects of farmer's planting time, harvesting time the yield per hectare, and storage facilities. It is self-administered to farmers on their farms.

The simple random sampling will be used. Fifty farmers (ten from each of five communities Kontagora, Tungan Kawo, Rafinkarma, Liwoji, Rafingora) shall be sampled. For this purpose two hypothesis were postulated i.e. 'Null' and Alternative' hypotheses. This is to demonstrate the probability that change alone might not yield the given data. The two hypotheses are formulated so that if null hypotheses are rejected as a result of the statistical test to be applied it will then be logical to adopt the alternatives. Meaning that changes alone yielded the given data. The two hypotheses are rejected as a result of the statistical test to be applied it will then be logical to adopt the alternatives. Meaning that changes alone yielded the possibilities in crop yield. The rejection level is put at 0.05 probability level or 5%.

(B) FIELD OBSERVATION: The Researcher will personally visit the farms to see for himself in order to give a first hand information on the sizes of the farm-lands that experienced low or significant yields as a result of the variability in rainfall. Some of the farmers also estimate the area of their farmland in 1973 – 87 and up to 1997. This gives room for comparison in crop yield and rainfall variability. The statistical tools to be used are the actual periods, yields and farms, and data analysis with person's product moment of correlation (R), standard deviations and co-efficient of variation. These statistical tools shall be used to compare crop yields spanning from 1980-1987 and 1992 – 1997. However data on crop yields shall be collected through questionnaire survey during the field work which will cover a period of six months (April – September).

The climatic data is also collected for a period of 18 years (1970 –1987). This shall be used to show the average rainfall distribution in the study area between the two-recorded episodes.

Furthermore, the result of the research shall be in the form of rainfall graphs and tables. Therefore rainfall graphs for Kontagora shall be drawn for a period of 10years (1988-1997) to show the monthly and annual rainfall of the study area and corresponding yields for each year on the following crops-sorghum, maize, rice, beans and groundnuts.

CHAPTER FOUR

PRESENTATION AND ANALYSIS OF DATA

This chapter is devoted to the analysis and interpretation of data collected from the climate change center (FUT Minna) and Niger State Agricultural Development Project (ADP) Kontagora through the use of questionnaire, survey, field work and primary sourcing.

It is this same chapter that deals with analysis on how rainfall variability affect crop production in Kontagora farming community.

4:1 RAINFALL VARIABILITY AND CROP YIELD

It is obviously normal to assert that the availability of rainfall and its distribution throughout the year is the most important single characteristic of climate determining the potential for growth of plants, unless irrigation is used. The effect rainfall has on crops is very tremendous, because the length of the growing season is determined by the onset and end of the rains.

There is possibility for triple or double cropping where rainfall is prevalent where as when rainfall is seasonal it permits single cropping, as it is the case in this part of the country. But agriculturists and modern day farmers are intensifying their efforts to introduce some varieties that would take only few days to mature (precisely fourty to fourty-five days). However this has not been very effective because of the unsteadiness in the on-sets of the rains.

Therefore it is not the total amounts that matter but its equitable distribution over the growing season. Apart from the general clearing of the bush that is done very close to on-set of the rains, the first rain here marks the beginning of farming activities. In order to be use to crops, the rains for particular year must be well distributed without long break and must allow the ground to retain enough water

for plants to grow to maturity without interruption. In contrast to above assertion is the delay in planting and, or reduction in the size of farm and increase in capital expenditure.

Tilling of the land commences with the first rain. Any delay of the first rain therefore affects the tilling and subsequent farming activities either in drought or not. The delay caused in planting is the most critical here because an abnormal distribution affects the yield and size of farmlands to be cultivated by individual farmer as it limits the length of farming period during its occurrence.

Farming is the people's major economic activities and is only consolidated by rearing of livestock with petty trading in the dry season.

The most dominant crops grown in this part of the state include maize, guinea-corn (sorghum), millet, groundnuts, beans and rice. These crops are grown on subsistence bases, although a varying proportion is devoted for cash cropping.

The most dominant agricultural system is the crop rotation whereby a different crop is grown on a piece of land to be exchanged next year with another type i.e. a leguminous crop (beans or groundnuts) to grain crop (millet or maize). Sometimes as is always the case in Kontagora town where the population is dense mixed cropping is practiced. The intensification of the mixed cropping system has exhausted and diminishes the fertility of the soils of this area.

4.2 CLIMATE

GENERAL CLIMATE – Climate Type

The climate of the study area is a sub-humid type classified as the tropical wet and dry (Aw) by Koppen (1971). The two seasons are very dependent on the two prevailing air masses over the country at different time of the year: the dry tropical continental air mass of the Sahara origin and humid maritime air mass originating

5	0.0	0.0	100.48	6.50	241.19	75.67	161.56	264.23	179.49	73.09	0.0	0.0	1102.22
6	0.0	3.0	0.71	0.83	57.13	89.88	320.42	160.42	326.37	43.19	2.07	0.0	1004.03
37	0.0	0.0	30.07	0.0	131.33	198.13	170.09	198.18	103.21	58.08	0.0	0.0	989.09
88	0.0	0.0	0.0	21.24	70.3	158.04	238.37	190.24	214.24	24.38	0.0	0.0	916.81
89	0.0	0.0	0.0	40.05	118.41	127.32	146.75	318.38	168.19	71.07	0.0	0.0	990.17
990	0.0	0.0	0.0	41.5	175.8	92.2	161.4	159.1	294.9	45.5	0.0	0.0	967.4
991	0.0	0.0	0.0	38.27	160.23	112.5	163.0	148.24	261.6	54.0	0.0	0.0	937.84
1992	0.0	0.0	0.0	34.0	31.0	57.0	191.2	115.3	176.6	40.8	0.0	0.0	645.9
1993	0.0	0.0	24.50	0.0	71.8	78.3	166.1	127.0	117.7	37.3	0.0	0.0	627.7
1994	0.0	0.0	0.0	42.0	67.9	92.0	71.6	218.9	543.7	173.7	0.0	0.0	1209.6
1995	0.0	0.0	27.7	12.1	44.1	128.4	156.0	210.0	590.8	121.5	10.5	0.0	1301.1
1996	0.0	0.0	0.3	21.8	217.9	205.8	211.7	434.8	383.7	134.4	0.0	0.0	1610.4
1997	0.0	0.0	19.0	28.8	80.6	231.0	170.9	254.5	166.0	46.2	8.0	0.0	1006.1
								6,555.11	6,758.4				30,023.08

Source:- Niger State Agricultural Development Project Kontagora 1998.

from the Atlantic Ocean. The two air masses, nearly opposite in direction met at a zone of discontinuity stretching east-west across West Africa known as the Inter tropical Discontinuity (ITD). It migrates northwards and southwards following the Earth Revolution. It reaches the southern limit at latitude 5^0 N in January and its Northern limit in vicinity of latitude $20 - 24^0$ N in August. The ITD as explained above reaches the study area (lat. 10^0 .24' N) between April and May and it recedes in October.

The climatic parameters of significance to crops include rainfall, temperature and Evapotranspiration, as well as the spatial and temporal variations of these elements within the region. However rainfall amount and its temporal variations constitute the most significant sets of climatic variables, which directly affect the amount, reliability and timing of available water for agricultural crops in the study area; (Udo, 1970).

In the study area generally, temperature does not constitute the major constraint to agriculture, since its suitable for the growth of most tropical crops. The highest temperature is usually recorded in April 34^0 c and the lowest in August 27^0 c. Therefore the variation in the distribution of rainfall in the area is the greatest climatic determinant for growth and cultivation of crops.

4.3 RAINFALL CHARACTERISTICS

(a) Mean Annual Rainfall and its Duration.

Figure 3 shows the mean monthly rainfall for 28years-recorded at Kontagora Agricultural Development Project (Gidan Gona) from 1970 to1997. (See attached paper).

From the figure it can be seen that the rainfall of this area is concentrated in a short wet season. For instance, if we consider a humid month to be that when the total

rainfall is 75mm (Olofin, 1984) or more, then the number of humid months for the 28years period in each year was 5 months for 16 years, 6months for three years, 7 and 8 months for one year respectively. On the other hand, if we consider a month with less than 25mm of rainfall as critically dries, then the number of critically dry months for the same period was five months. While 3 months of four years, 2months of eleven years and one month of nine years were sub-humid with April (14 years) and October (9years) taking the highest distribution. The wettest months were August and September, as shown in figure 3.

(b) Temporal Variations in Rainfall.

Jackson (1977), believes that a variation of about ± 30% is normal for the tropical wet and dry climate. Thus, a mean rainfall of 1082.08mm for the study area implies a range of any values between 925.03mm, while the average duration of 6 wet months means any length between 5 and 7 months.

The normal variations in the amount and duration of rainfall according to Olofin (1984) results in three rainfall regimes as follows:

(i) A wet regime when the amount of rainfall is larger than normal, the duration is longer and the rainfall pattern is steady.

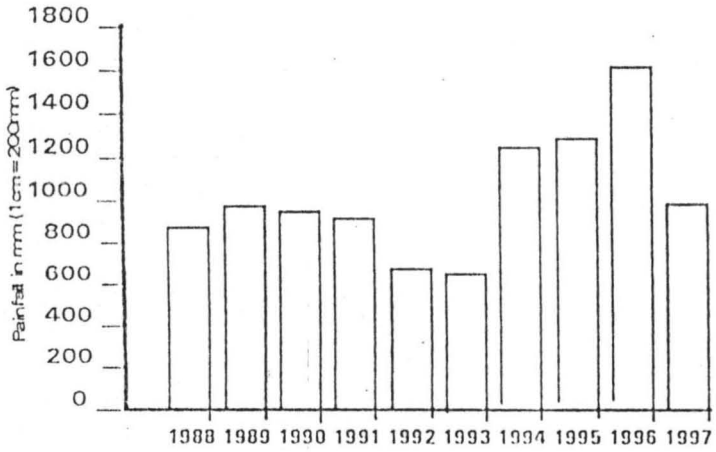
(ii) A moderate regime when the amount and the duration of rainfall are approximately the same as the mean value and the rainfall pattern is fairly steady and

(iii) A dry regime when either the amount and duration of rainfall is less than the mean value with erratic rainfall pattern or both the amount and duration of rainfall are less than the mean value.

Normal variations have been noticed in this area in the past. However, the variation is mostly negligible although for each season there is condition of uncertainty as regard to which regime may occur.

Apart from the normal variations there are short-term variations, which are greater than the ± 30% stated or above. It becomes disastrous when two or more extremely dry years follows each other consecutively as can be noticed in 1982-83 and 1992-93. When this does happen a condition of drought is said to exist (see graph attached): -

GRAPH



Source: Niger State ADP, Kontagora 1998

Many authors have shown the occurrence of drought conditions in this part of the country as highlighted in my literature review. Consequently to that effect was the relative drop in yields per crop for the study area where it was only 94.22 thousand tons in 1972, 294.4 thousand tons in 1982, 143.2 thousand tons in 1983, in 1992 it was 231.21 thousand tons.

Thus, the above four years apart from 1973 had a spread of rainfall with average of 7 months but the duration was far shorter compared with the long term mean. See table below: -

YEAR	AMOUNT OF RAINFALL (IN mm).	START OF RAIN	END OF RAIN	DURATION DAYS
AVERAGE	791.19	20^{th} –30^{th} April	1^{st} –8^{th} Oct.	164.5
1972	1165.75	25^{th} – 31^{st} March	1^{st} –10^{th} Oct.	183
1973	748.0	20^{th} –30^{th} April	20^{th} – 30^{th} Sept.	156
1983	623.3	27^{th} –31^{st} March	1^{st} – 8^{th} Oct.	158
1993	627.7	25^{th} –31^{st} March	1^{st} –13^{th} Oct.	161

Source: Gidan Gona (ADP) Kontagora, 1998.

4.4 TEN YEARS CLIMATIC PERIOD IN KONTAGORA (1988 – 1997).

Table two shows the monthly and annual rainfall summary for ten years period i.e. from 1988 – 1997 at Niger State Agricultural Development Project (Gidan Gona) Kontagora. From the table it could be seen that the annual rainfall ranges from 627.7mm in 1993 to 916.81 in 1988 and 1610.4mm in 1996. From the same table and figure 2, it could also be seen that the rainfall was concentrated in a short wet season. Thus, the period of humid months is usually four to five months (considering the fact that humid months average 75mm) but in 1992 it was only 3 months as shown in table.

Table 2:

YEARS	MONTHS WITH >75mm	MONTHS HAVING BTW 75 AND 25mm	MONTHS <25mm
1988	4	1	2
1989	5	2	0
1990	5	2	0
1991	5	2	0
1992	3	4	0
1993	4	3	0
1994	4	3	0
1995	5	2	2
1996	6	0	2
1997	5	2	2

Source: - Niger State ADP, Kontagora, 1999.

The variation of rainy season for the years was inconsistent with about ± 40% which is far greater than the ± 30% stated earlier. This was even further compounded by 1992 and 1993 since they are of the same characteristics. However that of 1993 was more erratic. Generally, taking the ten years period in consideration there was a depreciable drop in annual rainfall regime with below 1000mm (5years) probably because of the sudden reduction in the previous year (1987) with 989.09mm, until 1994 when it suddenly picked up with 1209.6mm recorded. Therefore based on the indices of the definition of drought put forward in chapter 2, either meteorological, hydrological or even Agronomic sense, drought conditions existed in Kontagora and its environs during 1988, 1992 and 1993. The total rainfall was well below the expected range. Although the timing was approximately the same as normal, the

spread of rain days per month was minimal and erratic thereby affecting the deficit in the soil.

4.5 CHARACTERISTICS OF RAINFALL IN 1973. 1975, 1980, 1983 AND 1996. RAINY SEASON WITH THOSE OF NORMAL YEARS.

When one observe the characteristics of rainfall in those years with the normal years, one can ascertain that 40% and 50% of the respondents believed that rainfall was abnormally recorded. Another 30% and 20% of the farmers observed that it was slightly inconsistent with normal years. Although 20% and 10% of the respondents maintained that the rainfall characteristics and growing season was just normal other 29% and 10% described these years as more than normal and took the risk of planting in the Fadama lands respectively. That action alone cost some of them replanting or re-cropping and harvesting earlier than normal while others totally lost as the case may be.

The researcher further selected two years (1983 and 1993) out of those abnormal regimes to put the response of the farmers in tabular form so that they could be answered through questionnaire interview. See table 3 for details.

Table 3- RAIN CHARACTERISTICS IN 1983 AND 1993 COMPARED WITH NORMAL YEAR (FARMER'S PERSPECTIVE).

Comparison of 1983 and 1993 Rainfall with normal years.	Number of Respondents (%) 1983	Number of Respondents (%) 1993
Very much less than normal	50	40
Slightly less than normal	20	30
Like normal	20	10
More than normal	10	20
Total	100	100

Source: Questionnaire survey, 1998.

The criteria employed by the respondents to determine normal and abnormal year depended on total rainfall and their farm output.

4.6 EFFECT ON PLANTING.

In 1983 and 1993 cropping season rainfall started earlier in March, but it was very little to saturate the soil in 1983 and in 1993. The rain ceased by April to recommence in May but hardly enough to revive the drying crops. It was discovered that farming activities could not start well until May. However about 5% of the farmers normally plant in March/ April, but 26% and 8% of the farmers planted their crops in 1983 and 1993 respectively, while 70% and 86% of the farmers planted theirs in May/June. This imply that majority of the farmers planted their crops late in 1983 and 1993.

Furthermore in 1993 as stated, rainfall started in March but planting did not commence until in June due to the sudden break (in April) between the first rain and the subsequent ones. The first rain only caused premature germination and sprouting of vegetation or plants, which later on wilted. Thus, some farmers planted two or more times before their crops could survive. Even though rainfall was generally on the increase in 1994 some farmers were reluctant to plant early in March/April. However the trend of the rainfall for that year in Kontagora was far from normal as can be seen from the table below:

Table 4:PLANTING TIME

TIME	NORMAL YEARS	1983	1993
MARCH-APRIL	75	26	8
MAY-JUNE	20	70	86
JULY	5	4	6
TOTAL	100	100	100

Source : Field survey, 1998.

4.7 – CROP FAILURE

Generally, the degree of failure of the crops varies. This point is illustrated in the table below:

Table 5: EFFECT OF VARIABILITY IN RAINFALL TO CROPS

CROP	FAILED MOST % 1983	FAILED MOST 1993	THRIVED MOST % 1983	THRIVED MOST % 1993
GUINEA-CORN	4	10	70	58
MAIZE	25	18	5	8
RICE	45	36	1	4
G/NUTS	15	14	15	20
BEANS	11	22	9	10
TOTAL	100	100	100	100

Source :- Field survey 1988.

During the 1983 and 1993 rainy season crops with long growing cycles usually late maturing with more soil moisture requirements suffered most. Out of the fifty responding farmers 45% and 36% were of the opinion that the crop with the highest rate of failure was rice in 1983 and 1993 rainy season, while 25% and 18% of the farmers maintained that it was maize that failed most. Another 11% and 22% said that it was guinea -corn (sorghum) that also failed most. The remaining 15% and 14% of the farmers believed that it was groundnuts that failed most during those rainy seasons.

On the whole 70% and 58% of the farmers believed that guinea- corn thrived most in the 1983 and 1993 growing seasons. This is not surprising, because it does not require too much ground moisture but rather, a long and moderate concentration of moisture deficit in the soil sufficient to allow its maturity. But about 15% and 20% of the farmers agreed that groundnuts thrived most during the periods. Another 9% and

10% of the respondents stated that beans thrived most in 1983 and 1993 rainy seasons, respectively. It is also not surprising that 1% and 4% of the farmers were of the opinion that rice was worst affected in both years because it needs more rain to grow and mature. Another 5% and 8% believed and maintained that maize thrived most.

Thus, rice and maize were the most adversely affected, while beans and groundnuts seem not to have been adversely affected at all.

4.8 RAINFALL VARIABILITY AND CROP YIELD

Due to some failure in crops in 1983 and 1993 deficiency years one might expect the farmers to increase their farm sizes and other farming techniques. Therefore the researcher carried out a field investigation through questionnaire survey to find out whether the farmers if their farm outputs for 1983 and 1993 have been affected by these deficiencies in rainfall. The mean for crop yield in 1983 is 32.62 ton/ha with deviation from the mean 39.84, while the mean of 1993 is 40.48ton/ha with its standard deviation at 25.79. A casual look at these figures shows that there is no too much difference between the crop yields of 1983 and 1993. These were subjected to a test of significant difference. To this end, the researcher postulated two working hypotheses. The rejection level is put at 5% significant level or 0.05 probability level. The working hypotheses are: -

(i) Null hypothesis: There is no significant difference between the data sets, i.e. there is no difference in the proportions of crop yields between the two years. This is to demonstrate that chance alone might yield the difference in given data.

(ii) Alternative hypothesis: - There is a difference between crop yields in the two sets of data. This will indicate that chance alone can not yield the result in the two data sets.

In order to test the strength of the association a measure of relationship was under taken. For this purpose the Pearson's product moment co-efficient of correlation (r) technique is used. The measure is suitable because it shows the degree of association between two sets of paired variables.

The correlation (r) between the two sets of data found to be 0.03, which signifies a small variation between the two sets of crops yield. Therefore the correlation (r) vary small between them.

Finally a test of internal variation for such years was undertaken using the co-efficient of variation percent (CV%) as can be seen in the table below:

Table 6:

Parameter	1983	1993
Crop yield (Ton/ha)	32.62	40.48
Standard Deviation	39.84	27.79
Co-efficient of Variation (%)	122.13	63.71

r----------0.03 Source:field survey 1998.

The result show a moderate internal variation in crop yield which is characteristic of peasant holdings. Both variations are similar but the 1983 set of data has a higher value (122.13%) than the 1993 set with (63.71%).

4.9 EFFECTS ON HARVESTING.

The abnormality of the 1983, 1986, 1992 and 1993 rainfall also had a devastating effect on the maturity of crops planted. While some failed to germinate as

a result of less maturity, others were forced to ripen before full maturity and some were completely destroyed, which led to drastic reductions in yields and very poor quality. However the degree of crops failure depended on the distribution of rainfall within the growing season, increase in farm lands per hectare in particular locations in this area and on the level of variable tolerance of individual crops, as well as the agricultural system, inter cropping and other kinds of alternative strategies (e.g. mulching), that are open to the farmer during the course of the year are very relevant here.

The pattern of rainfall also affected harvesting in 1983, for example, the normal period of harvesting in this area is October/November, whereby crops like guinea-corn, millet, rice and maize are all harvested. But in 1975, 1983 and 1988 this pattern of harvesting changed based on the data collected from questionnaire survey . However, in 1983 and 1988 only 26% and 18% of the farmers harvested their crops during this period while more than three quarters (73% and 81%) of the farmers were forced to harvest their crops between September and October which was earlier than normal time. This early harvest during 1983, 1975 and 1988 farming season were due to early stoppage/cessation of rainfall that forced ripening and wilting of crops. Thus, during the floods of 1986 most (67%) of the farmers have to bear the lost of considerable tons of rice and maize to flood water because they are damaged and washed away.

4.10 SOCIO-ECONOMIC RESPONSES AND THE SEARCH FOR ALTERNATIVE SOURCE OF FOOD.

The first socio-economic response by an individual farmer to drought and floods was a drastic reduction in selling and consumption of food. The respondents drastically cut the quantity of foodstuff earmarked for sale because of drought or

floods. The immediate effect of this was the rise in food prices. The prices of some crops like guinea-corn, rice, beans, and even garri rose by 100%(see the table below):

Table 7: Prices of Commodities affected by the 1983 drought

CROPS	PRICE BEFORE DROUGHT	PRICE DURING DROUGHT	PERCENTAGE INCREASE	UNIT OF MEASUREMENT
G/CORN	45K	=N=1.50	233%	1Mudu
RICE	=N=1.20	=N=4.00	233%	1 mudu
MAIZE	40K	=N=1.60	300%	1Mudu
MILLET	45K	=N=1.20	180%	1mudu
GARRI	50K	=N=1.00	100%	1Mudu
BEANS	80K	=N=2.80	250%	1Mudu

Source: Field survey: 1998.

Due to this sky-rocketing in prices of foodstuff all the respondents were of the opinion that they reduced their eating habit and tried other types of staple food. For instance, the principal staple foods before drought used to be guinea –corn, maize and rice. However, since most of this crops are insufficient to consumption demands, most of the respondents therefore substituted these food stuifs with millet, cassava and garri with any other edible food available for the staples.

4:11 WAYS TO MAKE MONEY IN ORDER TO BUY FOOD.

From the responses gathered about 28% of the respondents were contemplating migrating into the urban center for an alternative job. To them farming was discouraging and with the variable rainfall regimes and precarious methods of production, the benefits accruing to them was insignificant compared with other sectors of the economy.

Table 8: WAYS TO MAKE MONEY FOR FOOD

Individual Opinions	1983 %	1993 %
Contemplating migration	28	20
Stop selling food stuff for farm labour	16	22
Abandon farming for petty trading	32	38
Engaging in herding (hire basis)	14	8
Undecided and expects government assistance	10	12
Total	100	100

Source: - Questionnaire survey, 1999

Other respondents took to fire woodcutting for sale. This was intensified by the women since it fetched money easily. The youths also took to other source of getting money through truck driving and selling of goat herds and petty trading while some were casual labourers ready to take on any sort of paid job. Unfortunately a few others that are jobless farmers took to stealing, pick-pocketing and arm robbery in their search for money to buy food and worldly materials. This development reached an alarming rate, particularly the theft of foodstuff and herds that made the farming communities set up vigilant groups to guard their farm steads and herds.

DEPENDENCE ON OTHERS

Those farmers whose crops could not last for long time had no alternative than to turn to their relatives and friends for aid. Some farmers shared their children among relatives that have some reserves of food stuff, although such categories of people were few, furthermore, some farmers were compelled to give out their children to Fulani herds men for cattle rearing for payment of calves or sheep herd in one year. This development also led to migration of the production population to the south where new pasture for the cattle was discovered.

4.12 RESPONSE BY THE GOVERNMENT

The response by the state government according to most farmers consisted of mere promises. About 70% of the respondents did not receive any aid from government during the 1973 drought and 1986 floods in the area. While 30% claimed to have received such aid in the 1973 and just fertilizer subsidy in the 1986 flood. For the 1983 drought year 16% of the respondents claimed to have received aid. About 44% received such aid in the form of fertilizer, while the remaining 56% received such aid in the form of food subsidies and other essential commodities in early 1984. But the most amazing thing was the general response of dissatisfaction of the farming communities from government in the 1992/93 growing seasons for the late distribution of the much publicized subsidized fertilizer and tractor hiring. Most of the farmers complained bitterly about the method of distribution and the quantity given which was more politically inclined.

CHAPTER FIVE

SUMMARY, CONCLUSION AND SUGGESTIONS.

5.1 SUMMARY

The research has shown that basically variability could result in drought which is either insufficient moisture in soil at the time of maximum demand due to either late onset of the rain or earlier than normal rainfall or lower than normal rainfall amounts over a specific time, or declining under ground water and hence, lowering of the water table. It could be flood where there is excess soil moisture surplus or amount of water exceeding the banks of river, dams, water wells and canals.

The annual rainfall has been fluctuating since the droughts of 1973 and 1983. There has been decline of yields in crops as a result of uncertainty on the part of the farmers as what might happen to the crops if they plant earlier than normal time of planting or delayed planting when rain might have stopped before cessation dates.

Therefore variability in yields depends upon the kinds of crops, degree of plant wilting, the duration of drought or extent of floodwater and sizes of farmlands affected. Hence, drought and floods designates the period between rainfalls. As for drought the longer the interval the greater the severity and for flood the more intense is the downpour the more destructive would be the floodwaters. Consequently, such has been the case in Sudano- Sahelian zone even beyond when one move southward.

The research has shown that meteorological or human factors or a combination of both may cause rainfall variability. From the meteorological point of view, it has been established that increases in area and persistence of the sub-tropical high pressure cells in the late 1960's and early 1970's led to a south ward expansion of the A zone anticyclones, such phenomenon prevented the maritime air mass from

penetrating far enough in land to bring rain to the desert margins during successive years between 1969 and 1973.

But the effect of global warming and melting of the ice cover with a consequent sea-level rise has debunked the above view when the incidence of floods intensifies in this region from the mid – 1980's to date. However the processes of over-cultivation and over grazing have increased the exposure of land on desert margins to high surface reflectivity (albedo). The increase in the surface albedo, it has been opined may lead to a mechanism which suppressed convective rainfall derived from local Evapotranspiration. Thus, the processes of over-cultivation and over-grazing help to perpetuate desertification.

Drought and flood have a detrimental effect on agriculture and the state of the economy. It is a serious problem that is critical to cropping in the area (Kontagora farming community) since there is uncertainty about the onset and cessation dates of rainfall. The effects these two phenomena have on people range from mal-nutrition to semi starvation, insecurity and even death. However, in the study area, the effect has not been so severe to warrant death, except for the 1986 flood when three lives were lost in Kontagora town, but people suffered in subsequent floods and drought, either, from a lack of sufficient food or a lack of drinking water since most rivers either dried up or became contaminated with flood water.

Thus, the flood and drought that results from 1983 to 1997 has affected resources as a result of low and poor yields of crops. It has led to serious escalation of prices of foodstuff in the markets and placed majority of the farmers in a difficult position as regards repayment of agricultural loans because of crop failure.

It has been found that most of the farmers responded to the drought or flood by adopting new techniques of production including the cultivation of early maturing

crops (new high breed variety), dry season irrigation farming, change of staple foods and managing the available food more economically.

5.2 CONCLUSION

The conclusion one may draw from the research are presented as follows:

(i) Variability in rainfall is an inherent characteristics of Sudano- Sahelian zone of Nigeria including the Kontagora farming community in Niger state. The situation only intensified from 1980 when the variation of rainfall was ± 35% to ± 40% in 1992/93, which is greater than normal variation of ± 30% in the area.

(ii) The effects of variability in rainfall is not as severe and serious in this area as compared with other parts of the country especially where droughts were persistent, although some crops do fail to mature or yield much as desired.

(iii) A drought or flood year affects farming activities in the following year. Hence there was always some reluctance on the part of the farmers for fear of early planting and experience sudden break. However, the farmers as discovered from the research do keep fertilizer and pesticides ready in case the rainfall normalizes. Another way they employ to increase the output was increase in the hectare of the farmlands.

(iv) In general the variability of rain will continue to affect the region and northern part of Nigeria unless something remarkable is done by the government and the people themselves to adopt and check the situation.

5.3 SUGGESTIONS FOR THE AMELIORATION OF DROUGHTS AND FLOODS IN KONTAGORA FARMING COMMUNITY.

The unchecked ravages of floods and drought in this part of the state and the country in general over the years testify to the inability of the people affected to take concrete actions to be masters of their environment. Drought and flood scourges have

left to assume a permanent character and needed permanent solutions. It has already caused terrible human sufferings, displacement malnutrition and starvation.

To make losses arising from agriculture to be more bearable in the study area in particular and in the northern part of the country in general the government must plan for the amelioration of drought and reduction of the menace caused by flood.

In the olden days when the extended family system was strong, families do have a common way of safe –guarding the effects of drought and flood by way of assisting the most affected families, adoption of communal work by expanding farmlands and mixed cropping. However under over prevailing conditions such strategies will not be sufficient to guarantee adequate food supply and maintaining family tradition due to rapid population growth and costs of living.

The researcher is hereby putting forward some recommendations categorized into short-term and long -term measures.

The short –term recommendations are to cater for immediate needs of the farmers and the whole populace affected in order to survive. And the long-term recommendations are to eliminate the effect of the two phenomena (Flood and drought) by being combat ready for them.

5.4 SHORT-TERM RECOMMENDATIONS.

As short –term solutions, the following are recommended:

a) Food Aid:- There should be a nationally organized responses to floods and drought affected areas in the form of Food Aid Agency, the agency will distribute food among affected people anytime there is a major flood or drought disasters. The function of Food Aid Agency would include among others the supply of seeds to farmers for the following planting seasons. This is due to the fact that most of the farmers consume or sell most of their meager productions that will be very difficult for them to have

enough reserved for planting. However, food aid will only succeed in helping people to barely survive any drought or flood because food so supplied is easily exhausted.

b) Flood and Drought Relief Fund Committee should be reactivated at the national and state levels where philanthropic individuals and organizations can contribute to emergency relief funds. However, people of proven character and high integrity should be selected as members, and they should co-ordinate their efforts with the food aid agency.

c) The government should make provisions for agricultural loans/credits to the farmers to sustain them over the difficult period and aid them in production. This loan should be given in a good time i.e. before the beginning of the next rainy season, and should be interest- free.

d) The government should set out a separate fund in the yearly budget for resettlement schemes to reduce hardship for the people from flood-prone areas. This can be done especially where temporary shelter is expected before permanent settlements are created for the victims.

5.5 LONG-TERM RECOMMENDATIONS.

As a long-term solution to the effect of floods and drought arising from variability of rainfall, the following are recommended:

a) The state government or federal government should embark on massive sinking of bore-holes and canalization schemes for irrigation farming especially during dry seasons and drilling purposes in the areas prone to drought. Network of earth dams should be constructed in areas where possible.

b) There should be research into drought resistant and short- term varieties of crops. The development of early maturity species of crops such as cassava, beans, maize, sorghum, etc will alleviate the effects of drought.

c) Proper storage facilities should be introduced to various farming communities because most of the country's agricultural products are lost to the menace of insects, birds, rodents, etc both on the field and at the post-harvest stages. It is therefore imperative to adopt a strategy of reducing food losses as a means of increasing food availability in case of floods and drought.

d) There should be an early warning system by meteorologists to detect a meteorological drought and flood (moist air mass movements), and provide input to determine this phenomenon. This early warning of impending floods and drought would give individuals as well as governments and agricultural agencies in the country sometime to plan and take action designed to reduce the hunger and starvation associated with each drought or flood year.

e) A competent approach towards desertification is aggressive tree-planting campaign to stop desert encroachment. In addition to this there should be a regional policy to check over-grazing. This will be achieved by the introduction of more scientific ranching, the sedentary settlement of pastoralists and agriculturists particularly the move towards mixed farming.

f) It is possible to suggest that, as a permanent solution to the perennial flood problems in the regions that settlements of farmers in the flood prone lands to permanent housing shelters should be introduced in the uplands, and the river valleys be declared disaster areas by the government. Then the areas can be reappraise in relation to the available sources of water for dry season irrigation farming. This is where the application of space-based observation platforms becomes most pertinent.

g) Finally, government should embark upon desalination programme where the ocean will pump water through pipelines to the northern part of the country where

drought is a perennial problem. Although it is an expensive scheme the government could afford it by sacrificing some part of the ecological fund for that purpose. If this is done the adverse effect of drought will be drastically reduced.

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APPENDIX I

QUESTIONNAIRE

1. What is your major occupation?

   (a) Farming

   (b) Trading

   (c) Livestock Rearing

2. What is your age?

   (a) below 18

   (b) 18-25

   (c) 25-40

   (d) 40 and above

3. For how long have you been farming?

   (a) Less than 5 years

   (b) 6-10 years

   (c) 11-15 years

   (d) More than 15 years.

4. What type of crop do you cultivate?

   (a) Cereals (specify) .....

   (b) Legumes (specify).....

   (c) If both, in what proportion (cereals to legumes).

   (a) 20:80; (b) 40:60; (c) 50:50; (d) 60:40; (e) 80:20.

5. What time of year do you normally plant your crops?

   (a) March

   (b) April

   (c) May

(d) June

6. What crop do you plant at this time of on-set among the following crops (select as appropriate)

   (a) Millet

   (b) Rice

   (c) Maize

   (d) Groundnuts

   (e) Sorghum

7. Why do you plant others later than those you selected above? Give reasons

   .....

8. Would you specify the period (months) you plant your crops from the year 1973 to 1988?

YEAR	PLANTING PERIOD (MONTHS)
1973	
1974	
1975	
1976	
1977	
1978	
1979	
1980	
1981	
1982	
1983	
1984	

9. How would you compare the rains from 1973-1987 and 1988-1997?

   (a) Some are very much less than normal

   (b) Some are slightly less than normal

   (c) They are all steadily normal

   (d) Some are more than normal

10. What were the characteristics of the rainfall pattern of the years above? Pick as appropriate:

   (a) In some the rain started late/ early

   (b) In some the rain stop late /early

   (c) The rain fell steadily in all the years in rainy season.

   (d) The rains were erratic in some years during the rainy season.

   (e) There were enough rains in all the years for these crops.

   (f) There were enough rains in some of the years for these crops.

11. Would you classify the yield (rate of harvesting per hectare) for the years 1980 to 1985 and 1992 to 1997 (tick as appropriate).

'A' RATE OF HARVESTING AS IN .....

YEARS	LITTLE	MODERATE	VERY MUCH
1980	----------	----------	----------
1981	----------	----------	----------
1982	----------	----------	----------
1983	----------	----------	----------
1984	----------	----------	----------
1985	----------	----------	----------

'B' RATE OF HARVESTING AS IN ----------

YEARS	LITTLE	MODERATE	VERY MUCH
1992	----------	----------	----------
1993	----------	----------	----------

1994	----------	----------	----------
1995	----------	----------	----------
1996	----------	----------	----------
1997	----------	----------	----------

12. Do you harvest all your crops at the same time, considering the fact that they are not planted at the same period?

    If No, give reasons ----------

13. How do you improve the growth and production of your crops. Tick as many as appropriate.

    (a) Application of fertilizer

    (b) Application of insecticides / herbicides

    (c) Weeding only.

    (d) Increase in the farmland and improve seeds.

    (e) Weeding and application of animal dung/local manure;

    (f) Application of fertilizer and Weeding.

14. Where do you obtain fertilizer and pesticides?

    (a) Government Agricultural Agencies

    (b) Marketers

    (c) Private Company / Manufacturing Plants.

15. Which of the crops thrive most in all the years from 1980 – 1997?

    (a) Groundnuts

    (b) Rice

    (c) Maize

    (d) Millet

    (e) Sorghum

16. Could you identify the years you have high appreciable harvest attributable to rainfall? Please specify ----------

17. Which years would you remember you had very low yield due to rain deficiency from 1980 to 1997? (specify) ----------

18. What would you attribute to be the cause of low yield of some of these crops in all years. Pick as appropriate:

    (a) Pests and disease attack

    (b) Low-rainfall

    (c) Late on-set

    (d) Early cessation

    (e) Lack of Fertilizer and poor soil

    (f) Flooding

19. Out of the factors above which do you think has the greatest influence on crop production?

    (a) A and B

    (b) A and C

    (c) B, C, and D

    (d) C and F

    (e) B, D and E

20. What is your attitude towards farming?

    (a) Encouraging

    (b) Discouraging

21. Which of the farming practices offers you much yield for the five crops throughout the years 1980-1997) pick as appropriate.

    (a) Mono-cropping

(b) Mixed Farming

(c) Crop rotation

(d) Mixed cropping

(e) Shifting cultivation

22. How would you rate flooding and drought among the problems you encountered as a farmer?

(a) The most serious problem

(b) One of the serious problems

(c) One of the slight problems

23. Whenever there is flood or drought do you receive any aid from the government or any organization?

(a) Always

(b) Sometimes

(c) Never

24. In what form is such aid?

(a) Cash and house hold materials

(b) Food stuffs

(c) Fertilizer

(d) Improved seeds

(e) Others (specify).

25. How would you prepare for future floods and drought? Tick as appropriate

(a) Look for alternative jobs

(b) Stop selling my food stuffs

(c) Abandon farming as a whole

(d) Co-operate in the construction of drainage and canals, and planting trees

(e) Others (specify).

APPENDIX II

YIELD IN THOUSAND TONNES

YEAR	MEAN(mm) TOTAL	SURGHUM	MAIZE	RICE	G/NUTS	BEANS	TOTAL
1970	136.54	112.07	17.28	08.32	105.98	18.52	262.11
1971	128.5	98.01	12.11	05.10	88.75	21.16	225.13
1972	145.7	121.20	15.64	08.48	120.26	31.22	296.8
1973	124.66	67.02	02.93	0.27	23.55	0.45	094.22
1974	132.66	102.67	08.23	02.96	100.44	33.51	247.22
1975	177.3	148.20	20.22	10.16	108.24	35.58	322.4
1976	178.9	150.38	13.75	07.97	102.90	35.66	310.66
1977	135.7	89.11	12.80	08.14	109.19	39.23	258.47
1978	126.6	125.35	18.04	10.15	100.64	35.82	290.0
1979	172.1	190.08	20.45	10.28	115.23	36.97	373.06
1980	116.8	138.16	18.11	08.20	98.17	30.85	293.49
1981	154.9	172.54	20.13	08.17	92.56	32.05	325.45
1982	121	142.13	18.25	08.12	92.89	33.01	294.4
1983	77.9	108.02	05.81	0.89	20.77	13.71	143.2
1984	148.4	201.25	78.28	16.56	122.11	52.91	471.11
1985	137.78	199.68	80.05	15.88	120.02	48.72	464.35
1986	100.4	198.23	66.79	12.78	88.64	52.11	418.55
1987	141.3	120.08	48.52	12.23	79.92	33.80	294.55
1988	147.97	108.65	48.22	10.08	78.33	33.12	278.4

1989	141.5	112.69	48.98	11.21	80.25	35.05	288.18
1990	138.2	121.55	49.52	12.10	82.11	32.89	298.17
1991	133.98	102.35	47.78	11.56	80.77	33.67	276.13
1992	92.27	91.15	38.32	10.39	63.02	28.33	231.21
1993	89.67	82.64	31.68	09.21	55.13	23.76	202.42
1994	172.8	184.23	64.68	12.16	115.75	30.89	407.71
1995	144.56	200.92	79.22	12.87	109.89	48.11	451.01
1996	201.3	200.75	80.02	14.96	112.08	30.68	438.49
1997	111.78	180.32	80.13	12.74	118.14	45.72	437.05

Source:- Gidan Gona (ADP) Kontagora 1998.

APPENDIX III

X	y	(x-x)	$(x-x)^2$	(y-y)	$(y-y)^2$	(x-x)(y-y)
108.2	82.64	75.58	5712.34	42.16	1777.47	3186.45
05.81	31.68	-26.81	718.78	-8.80	77.44	235.93
0.89	9.21	-31.73	1006.79	-31.27	977.81	992.20
20.77	55.13	-11.85	140.42	14.65	214.62	-173.60
13.71	23.76	-18.91	357.59	-16.72	279.56	316.18
			7935.92		3326.90	4557.16

ξ=32.62 y = 40.48

$Sxy = \sqrt{\Sigma(x-\xi)(y-y)/n}$ $Sx = \sqrt{\Sigma(x-\xi)^2/n}$

$Sy = \sqrt{\Sigma(y-y)^2/n}$ $r = Sxy/Sx.Sy$

$Sxy = \sqrt{4557.16/5}$ = 30.19 then 30.19/(39.84)(25.79)

Sx=39.84 Sy = 25.79 = 0.029 appx. 0.03

Correlation (r) vary small.