CLIMATE AND GROUNDNUT PRODUCTION IN THE KANO REGION

BY

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BEING

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DEPARTMENT OF GEOGRAPHY SCHOOL OF SCIENCE AND SCIENCE EDUCATION FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA NIGERIA.

MARCH 2002

CERTIFICATION

This is to certify that this thesis is an original effort of **Suleiman M. Shado** in the Department of Geography, Federal University of Technology Minna for the award of masters degree of Technology (M. Tech) in Metrology.

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I declare that this work 'CLIMMATE AND GROUNDNUT PRODUCTION IN THE KANO REGION" is my own work and has not been submitted at any institution before for whatsoever reason.

Information derived from published and unpublished works of others have been duly acknowledged.

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DEDICATION

This thesis is dedicated to the oneness of Almighty Allah.

ACKNOWLEDGEMENTS

In the name of Allah the most gracious the most merciful Thanks to Almighty Allah, to whom all praises is merited, for his divine guidance since my inception on the earth.

I am very much grateful to my parents and family who are always struggling to see me to the post of success in life. My unflinching acknowledgement goes to my ebullient and erudite supervisor Professor J. M Baba who has never loose interest in correcting my work repeatedly, raise constructive suggestion and contributions at any time and any place despite his tight schedule in order to see the work well done. Thanks Prof. And to all the lecturers in the department for their useful advice and contributions towards the success of my work especially Dr. P.S Akinyeye who made available to me some useful materials for my study and Dr. Halilu for having time going through my work.

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ABSTRACT

Most of the developing nations are economically weak and they cannot afford the importation of food on a large scale. They therefore, have to depend on food production within their land for the survival of their respective large population. Several factors tend to affect agricultural production in an area. These are climatic and non-climatic factors. The purpose of this research is to assess the climatic impact on the variations in the yield of groundnut in Kano. Agro climatological parameters such as the annual rainfall, the onset and cessation of he rains, the length of rainy season are closely related to groundnut yields. These relationships are quantitatively expressed in terms of climatic indices and egression equations, which are used to examine the causes of variety in roundnut production in Kano. The research findings came out with the ollowing conclusions: That the onset, cessation of rains and length of raining eason (LRS) are paramount features for understanding precipitation ffectiveness in the region. For the purpose of agricultural planning, rainfall uantity cannot be enough to determine crop development and yield, but some ssential climatic parameters must be put into consideration, they include ydrological growing season (HGS) the hydrological ratio and specific water onsumption (W/F) requirements. It was also discovered that other non-climatic actors affect groundnut production. This however, to an extent direct indirectly lepends on climatic event.

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CHAPTER ONE

1.1 INTRODUCTION

Above 90% of the food requirement of Nigeria are produced by small-scale farmer. They are also the major producers of export crops, which used to be the main source of revenue in 1950's and 1960's. The advent of the oil boom in the early seventies suppressed agricultural to the detriment of the rural population. The income accruing to the farmers fell drastically. The farmers were therefore trapped in a complex web of various circle of poverty. Further aggravating the already deteriorating condition is also the stress caused by rapid population growth and declining soil productivity.

Several factors tend to affect agricultural production in an area. Agronomic practices are not the only factor responsible for the variations in crops yield. Crop yield is also influence by both climatic and topographical factors.

Some of these agricultural problems have been suppressed through the impressive advancement in agricultural technology, such as crop breeding and pest control, application of chemical fertilizers on the crops. Meteorological factors have little or no benefit from the influence of the agricultural technology advancement. World meteorological organization

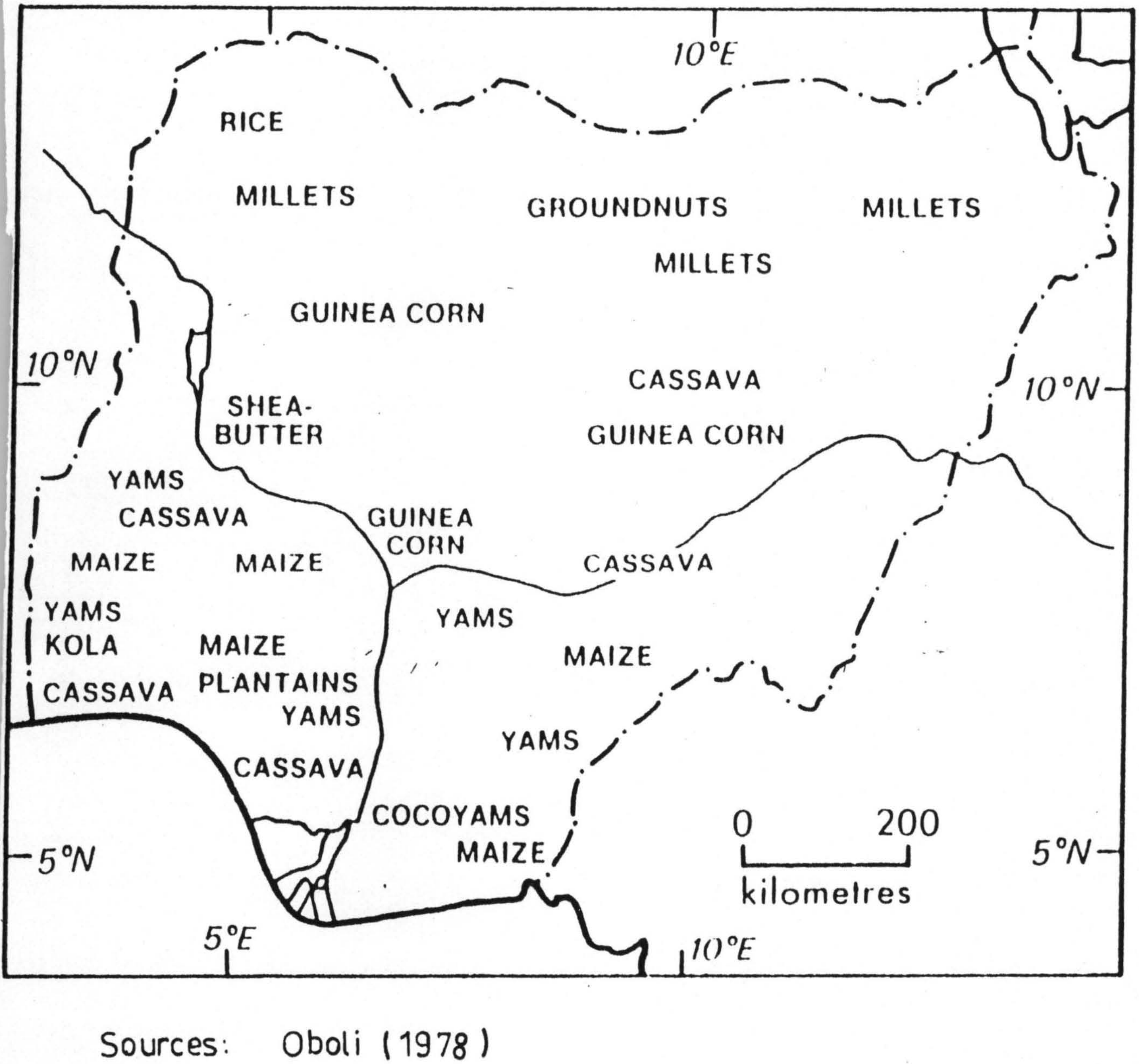
(WNO) 1981 noted that, “Agricultural production is still development on weather and climate in spite of the impressive advance in agricultural technology”.

Notable metrology variables that play significant roles in agricultural production are: -

Solar radiation, temperature and moisture content of the soil. All these climatic elements stated above directly or indirectly affect the crop development and production. The past and present government embarked on some agricultural development programmes. They include, state farms, farm settlements, cooperative marketing and commodity boards, National Accelerated Food Productions Programme (NAFPP), Operation Feed the Nation (OFN), Green Revolution, Directorate of Food, Road and Rural Infrastructure (DERRI), Better life for Rural Women, Agricultural Development project. This was established to boost agricultural productivity through practical tutoring of farmers and introducing new improved seeds, Nigeria agricultural and cooperative bank, which takes care of agricultural credits and of course River Basin Development Authority amongst others,

In Nigeria like any other African countries, due to the low level of technology and capital, we have not been able to ameliorate the most

FOOD CROPS IN NIGERIA



Sources: Oboli (1978)

Fig 1.1

devastating influence of weather on agriculture. As a result of this, most farmers are still living at the expense of weather condition. This is a reason why agricultural production has been erratic and unpredictable.

Recently, there were series of attempts to moderate agricultural productions through research work. Agro - climatologists have not been left out of the endeavour. By way of marrying agriculture and the metrological factors, so as to achieving the desired goals. Conscious efforts has been making by the government in the quest for an increase in food production and if possible eliminate the influence on climatic factors through the understanding of the relationship. In connection of this, many agricultural research stations have been established in order to ensure acceleration of agricultural productions, improve varieties and the multiplication of seeds. Some of the stations include: - The International Institute for Tropical Agriculture [IITA] Ibadan, Institute of Agricultural Research Samaru, National Cereals Research Institute [NCRI] Badagi, Institute of Root Crop Agriculture, Umudike, just to mention a few. The inclusion of agro – meteorological units in all the established institutes, has been facilitating the relevant collection of climatological data, which will boost the understanding of the relationship between climate and agriculture.

As a result of seasonal variation in rainfall temperature, solar radiation, humidity, evaporation and evapotranspiration, which influence the crop yields, vary from year to year. From the knowledge of environmental resources and expected conditions from below the soil surface through the soil air interface to the lower atmosphere over the past decades provides guidance for strategic decisions in long range planning of agricultural system [W.M.O] 1981. The knowledge and understanding of micro climatic effect and crop relationship facilitates the inter – relation required in areas of crop management and crop productions. This is with a view to explaining the variations in the field and possibly formulating a productive model for forecasting the future yield of the crop given certain environmental parameters.

The cereals that are well grown in the region of semi and zone are millet, sorghum, maize, and wheat. Thus, according to Nwafor [1982] who identifies the Northern part of Nigeria to be a belt of cereal dominant area in which the water balance of plant soil system is a critical factor: The low annual rainfall, short wet period between two to three (2 – 3) months and high evaporation rate restrict the principal food crops to grains this? As a result of some tolerance for moisture stress.

In spite of its place as the pillar of any agrarian venture, climate, particularly, precipitation, has not been accorded the deserved priority in agricultural planning in Nigeria. The general neglect of this natural resource might be based on the impression that the tropical climate is equitable. However, experiences have shown that several attempts to boost food production in Nigeria are being foiled by persistent drought spells [Adefolalu, 1991].

Thus this study will direct its focus on to the appraisal of agro climatic as a natural resource.

1.2 PREVIEW OF GROUNDNUT

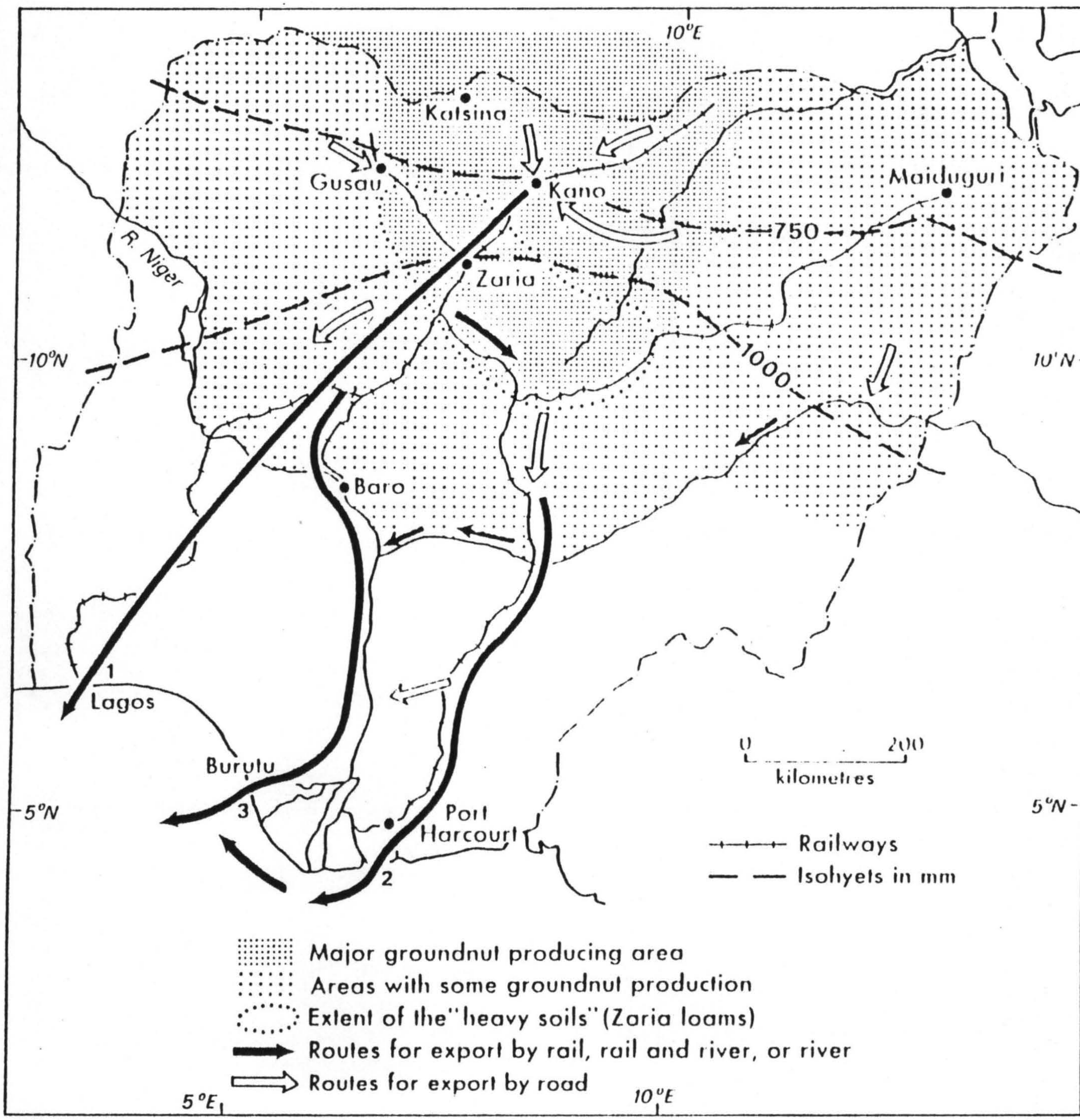
The war of 1939 – 45 saw the decline if Indian as a large groundnut exporter, and the emergence of West Africa to prominence. Nigeria is one of the greatest exporters and much or most of the export is now in the form of oil. Oboli [1978] explain that "the groundnut, peanut or monkey nut, is a member of the pea family, its fruits forms in the sandy soil, two in each pod. This is the so – called "nut", the flowers are yellow, and the leaves medium green". The development of groundnut cultivation in Nigeria has been very rapid within the last sixty years. This rapid development is largely explained by:

1. Increase demand for margarine, salad oil and soap.
2. The development of means of utilizing palm and groundnut oils in either manufacture – e.g. by the hydrogenation process, which makes the oils odorless.
3. The development of bulk transport in and from West Africa. The Darkar – St Louis railway, the first in West Africa, was opened in 1885, and soon stimulated groundnut cultivation along its track. The Kano –Lagos line did likewise for Northern Nigeria after 1912.

Groundnuts are grown in many parts of Nigeria. But the great center for the crop is Kano State and Kastina. Groundnut is a seasonal crop, which requires only 90 to 120 days to mature. So it is very well suited to the Sudan savanna area.

The physical requirements, - Groundnuts are grown between about latitude 8^0 and 14^0 to 16^0 N, where are 500 – 1250mm of annual rainfall. The ideal rainfall condition is with 625 – 875 mm, concentrated in the wet half of the year. The crop is grown partly for export between the whole northerly area is more favourable for export because the lower relative humidity keeps the groundnuts is not really a nut but a legume or pea, which after flowering and fertilization

NIGERIA GROUNDNUT AREAS



Sources Church (1978)

Fig 1·2

forms a pod in the soil. So the soil should be a loose sandy loamy, rich in lime nitrogen and phosphorus.

These can be added in fertilizer the greatest producing areas are around Kano and Kastina in the Northern Nigeria. In the grown areas, groundnuts are grown for food the farmers family, sometimes more than what they sale. In any case, they are grown intercrop with, or else rotated with, guinea corn or millet, as well as with other crops such as cotton chilies or okro in relation to the crop production inclusively other forms of agronomic factors. A proper understanding of the impact of climate on soils, plants and agricultural production will be a giant step to the use of meaningful agricultural productivity of any place.

1.3 STATEMENT OF PROBLEM

Agriculture has been the main – stay of the Nigerian economy over the years. In some decades back, the main staple foodstuffs in Nigeria have been cassava, millet, sorghum, yam and rice. Of all the factors influencing the crop production in Nigeria among which are, soil conditions, management practices of the farmers, pest and discusses, the reduction of labour on the farms and movements of the people from rural to urban amongst other, the most challenging factors that limits the production of crops is climate and precisely, precipitation. Thompson (1964) noted that a period of favourable weather interacts with – technological method in agriculture, produce higher yield at a given place. That is to say, technology alone cannot increase crop production but rather with favourable climate condition

Similarly Adefolalu (1983) also observed that cereal crops would wilt before reaching maturity, because of irregular or inadequate rainfall. He equally indicates that "water, being one of the most essential variables in the food production chain should receive primary attentions especially in the whole northern state of Nigeria rather than rely on the provision of others, such as planters, harvesters and sprayers and imported high yielding grain hybrids".

Obviously, increase in demand for foodstuff in recent years has been accompanied with corresponding increase in production Church and Oboli (1978) observed that the variation in the food production is as a result of interaction between the climate and meteorological factors. Thus, the agro climate factors that influences groundnut production in savanna belt shall be analysed and qualified in this study, particularly, in Kano region. Apart from agro – climate variables, there are other local factors that influence the yield of crops, which will be also analyzed, so as to highlight the contributions and problems that facing the farming system in the study area, most importantly, those factors associated with ineffective precipitation (drought).

The phenomena that influence the variation in the production of groundnut in Kano region could be identified and quantified through the appraisal and analysis made on the weather elements from this study and consequently enhances adequate crop production.

1.4 AIM AND OBJECTIVES OF THE STUDY

The general aim of this research is to examine the role of climate on Agricultural production especially variation in the yield of groundnut in Kano Region. So the specific objectives of the study are as follows: -

(i) To quatify and analyze the agro – climate factors influencing groundnut production in Kano which include the computation of indices of precipitation effectiveness e.g. onset, cessation (c) and length of rainy season [LRS] such as rainfall seasonality, hydrological ratio, specific water consumption, dry spell and rainfall intensity.

(ii) To identify features that need further investigations.

1.4 JUSTIFICATION OF THE STUDY

Agro – climate factors are well known throughout the African continent, but a study on the area of crop production and weather elements relationship at this stage of development would help to update the knowledge and understanding of the influence of whether variables on agricultural productivity as a tool for economic development in Nigeria. Findings from such studies may be useful in planning and execution of other similar programmes in future, even in improvement of existing ones. The research will also serve as a useful feed back to agricultural research institutions and other rural development agency.

There is generally too little information on the climatic factors affecting production in the savanna region of Nigeria. In Kano particularly, despite increasing attention being given to agriculture nation wide, groundnut is one other basic food for about ½ of the population (farmers) study of this kind is therefore necessary to fill the gap existing between the agro – climatology of groundnut and its potential production in the Kano Region.

1.5 SCOPE AND LIMITATIONS

This research is scoped to cover the Kano city and the close – settled zone around it, but not cover the whole of the state because of cost, time and constrains of distance, with the view to examine the role agro – climatic variability play in crop yield.

Limitation:- In a research of this nature, it is expected that comprehensive study of data based on many years of survey will be better yardstick for impact assessment, but this is not very possible because of lack of important information which are correct and reliable . So the research is based on the existing situation in the study areas, and might not properly reflect what is going to take place in the future in the areas.

Also the study is limited to a relatively short length of the data. The data were eight years of record. The limitation arose from the fact that crop yield record did not extend beyond period of between 8 – 10 years.

In addition therefore to the limitation is a term of the area covered. The study would have gathered more variables, if data were to be collected over a wider area. Nevertheless, insight would be obtained from the study for both economic and agricultural planning.

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CHAPTER TWO

STUDY AREA

2.1 LOCATION

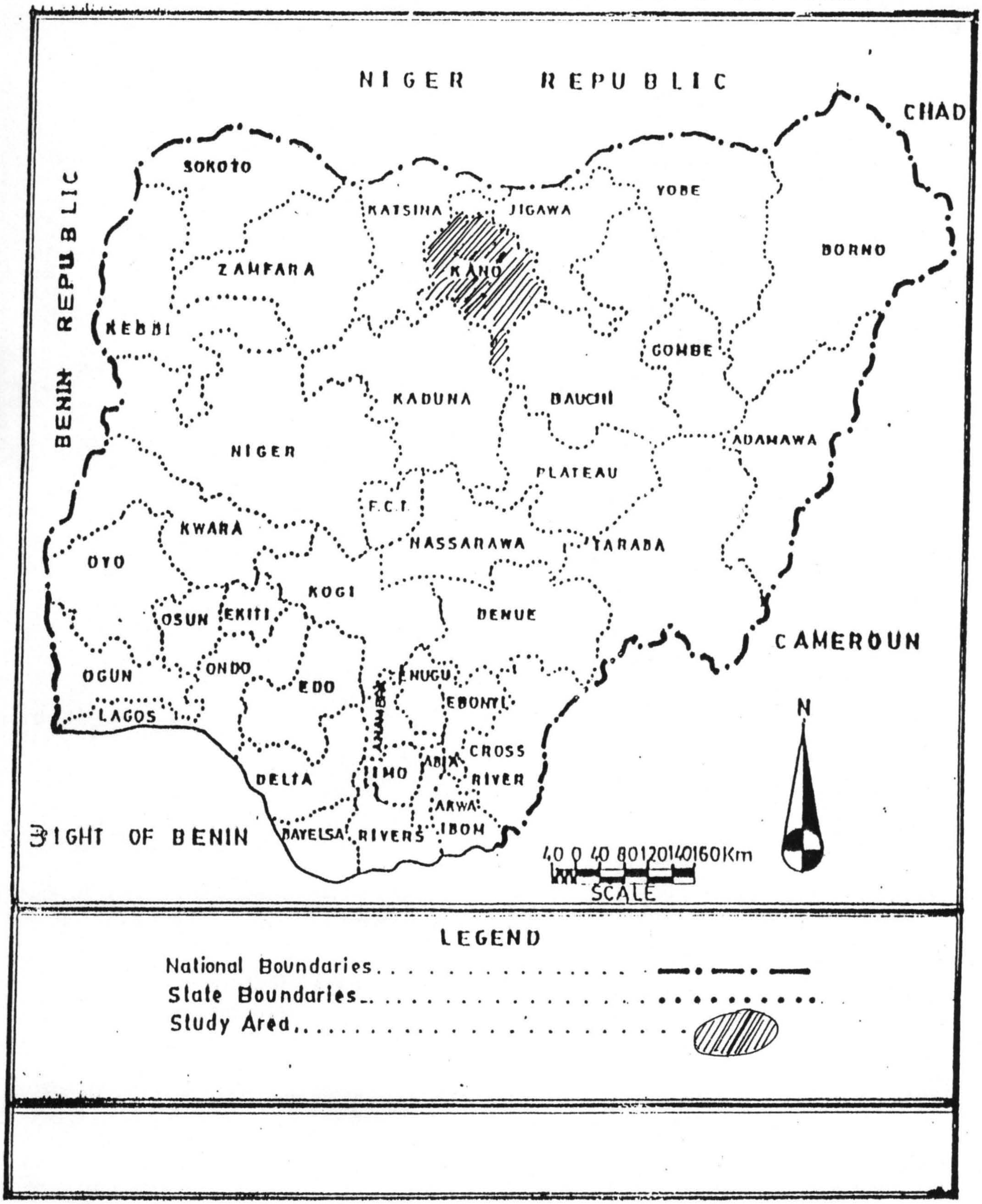
The Kano close settled zone is located on the latitude 13^0 North longitudes 7^0 East and generally above 450.8 m above mean sea level. Bounded by Jigawa to the North East and Katsina to the North West, Bounded to Kaduna and Bauchi to the South West and South East respectively.

2.2 HISTORICAL AND SOCIO ECONOMIC

Kano, was one of the most powerful centers in the Hausa land, Moltimore (1972) noted that Kano, for more than a century is one of the most economically viable in the Northern state. He also noted that the majority of the population grows in a shadow of stable and highly organized emirate, which was basically due to the organized production of widely, traded craft goods. Kano therefore, became one of the greatest commercial centers in the interior of West Africa. As a result of the commercial activities the population of Kano grows tremendously up to date.

The emergence of modern buildings, which replace the old mud types, sprang up in old city. New residential and commercial areas were also

MAP OF NIGERIA SHOWING THE STUDY AREA



Source: Catography Sec. F.U.T MX

Fig 2.1

developed outside the old city in the neighborhood of the railway station and Nassarawa. As usual in most northern towns, a "Sabon Gari" (new settlement) was developed to accommodate people from other parts of Nigeria and beyond.

About 75% of Kano area is under cultivation every year of which 5 % is under irrigation, growing sorghum, millet and maize as food crop while cotton and groundnut are for export, some have own cattle, which are looked after by the village herdsmen in the day time or are in the care of the Fulani's. (Akinyeye) 1989.

2.3 CLIMATE

It is very useful to understand the weather conditions for the purpose of agricultural planning. The present climate of Kano is the tropical wet and dry type, coded as A. W by W. Koppen, although climatic changes are believed to have occurred in the past .The characteristics of the major elements of the present climate are described below. The climate of northern Nigeria is divided into the following:

(a) A warm rainy season from June to September

(b) A cool dry season from October to February

(c) A hot dry season from March to May

The warm rainy season is traditionally the farming period. There is a high amount of precipitation in July and August. Rainfall exceeds the potential evapotranspiration in most of [July, August, and September]. During the rainy season the cloud has a moderating impact on daily temperature.

In the cool dry season the weather condition are suitable for crops to be able to be harvested. North – Eastern winds prevail. They are cool and sometimes carry fine dust from the Sahara, which intercept a great deal of sunshine. This season id favourable for the cultivation of many crops from temperate region. Wheat and various vegetables are provided by irrigation water.

The hot dry season is characterized by rise in temperatures, while the relative humidity dwindles progressively. The high temperature affects the growth of crops from temperate regions, which are susceptible to catch diseases and to mature precociously.

Crop on tropical region have tolerance of high temperature and do better if sufficient water is available. There is an increase in relative humidity in many heralds the approach of rainy season.

2.3.1 RAINFALL

The average length of the rainy season is between 90 – 100 days [June – September]. In a normal year, the rainfall values range from 600mm in the North of Kano to about 1,000mm in the south [Olofin 1987].

Table 1 shows the average annual rainfall over a long period (more than 50 years) for Kano Airport to be 884mm. However, calculation based on the period 1965 – 1974 result in an average of 729mm, while the next five years [1975 – 1979] recorded an average of 748 mm. Variations of up to 0% on either side of the mean value are considered normal. Wider variation occurs under drought conditions. Thus, during the 1972/73 droughts, the Kano Airport received only about 48% of its long-term mean annual rainfall.

The variations in the amount and other aspects of rainfall result in three rainfall regimes.

(a) There is wet regime when the amount of rainfall received is longer than the long term mean, the duration of the wet season is longer than the normal, and the pattern of rains is steady.

(b) There is a moderate regime when both the amount and the duration of rainfall are approximately normal, and the pattern of rains is steady.

(c) There is a dry regime when either any of the amounts and duration of rainfall is less than normal with erratic rain pattern, or both of the amounts and duration of rainfall are less than normal with, or without, erratic pattern of rains. The regime occurs at random. The occurrence of the dry regime for two consecutive years means a major drought.

TABLE 2.1 AVERAGE CLIMATIC CONDITIONS IN KANO AREA

Month	Mean Temp (^{0}C)	Range (^{0}C)	Rainfall (mm)	Et (mm)	S'shine (h/d)	RH/* (%)
January	21.2	17.8	0.0	133.3	9.0	28
February	23.7	20.9	0.3	141.1	9.0	25
March	27.7	18.5	1.8	182.5	8.6	23
April	30.5	16.4	8.9	195.5	8.4	36
May	30.4	13.6	70.2	187.9	8.8	51
June	28.1	13.0	132.7	156.3	8.7	65
July	25.7	10.7	210.9	126.4	7.5	78
August	24.9	9.0	314.0	112.7	6.0	83
September	25.9	10.9	132.8	126.5	7.9	79
October	26.8	16.5	12.8	144.0	9.5	58
November	24.6	19.7	0.0	139.9	9.8	37
December	21.7	18.7	0.0	127.4	9.2	32
Year	**25.9**	**15.5**	**884.4**	**1771.8**	**8.5**	**49.6(50)**

Sources: Olofin (1987)

2.3.2 TEMPERATURE

The temperature regime is warm to hot through the year, even though there is a slight cool period between November and February. The mean annual temperature is about 26 degrees centigrade [^{0}C], but mean monthly value range between 21^0 C in the coolest months [December / January] and 31^0 C in the hottest month [April / May]. The long – term mean conditions at the Kano Airport are shown in table 2.1.

2.4 GEOLOGY

The Kano region is characterized by two major geologic structures, with minor intrusion of a third. The larger area of the region to the south and North –West is under lain rocks of basement complex with intrusions of Younger granites in the extreme southern parts. To the northeast are the unconsolidated sediments of the Chad formation. The two structures are separated by a transitional zone, which constitutes the well – defined hydro – geological divide of the area.

The rock of basement complex has been subjected to weathering to produce fairly deep regolith, which has been subjected to lateritization. Thus the occurrence of exposed and hardened laterites and unexposed hard pans constitute part of structural character of Kano state. Another addition to structure is the occurrence of a layer of wind drift material on the surface, particularly on the plains developed over the basement complex rocks.

2.5 RELIEF

The Kano region occupies the southern west rim of the Chad depression and share physiographic divides with the Niger and Benue river systems to the south and with the Niger systems to the southwest and West as the Chad – Sokoto divide.

The elevation of Kano above mean sea level ranges from about 400 meters to 1200 meters of north and south tip. The Kano region is part of the popular high plains of Hausa land except for the section east of the Hydro – Geological divide. The rock structure, the relief, and the landforms of the region are closely linked.

The relief of this region can be described under three types occupying three distinct zones, as high lands, the high plains, and the low Chad plains. The first two types are parts of the high plains of Hausa land, and the third is a part the Chad plains. The relief is greatly influenced by the geology; the highest elevations are associated with igneous structures, and the lowest with the Chad formation.

2.6.0 VEGETATION

The "natural " vegetation of Kano region is savanna type. Most of the area is contained within the Sudan savanna variety. The exceptions include the southernmost area which is characterized by northern Guinea savanna occupies area south of Tundun Wada, particularly the Lilly areas of Dadi plains and Rishi Hills. This is a woodland type of vegetation composed of numerous medium trees and grass undergrowth most of the vegetation here is a secondary re-growth in forest reserves.

The Sudan savanna can be said to be the typical vegetation of the Kano region. It composed of variety of trees scattered over an expense of grassland. The trees are usually characterized by broad canopies and they are hardly taller and larger than others, which is common all over the landscape. Most of the trees species are adapted to drought conditions through long taproots, leathery leaves and tiny leaves. These retained their greenness throughout the year other shed their leaves during the dry season. Grasses hardly grow taller than 1.5m at maturity except in favourable spots.

The Sahel thorn shrub, the vegetation is characterized by thorny shrub and tufts of grass, complete ground covered is never achieved, other plants include those that store a lot of water in their stems and leaves. These "sappy" plants include shrubs and creepers.

2.6.1 CULTURAL VEGETATION

It is pertinent to state here that the consideration of natural vegetation, as contained above is an academic exercise in Kano. Over almost all the region natural vegetation has been removed and replaced by varieties of cultural vegetation known together as "farmed parkland ". Three major types of cultural vegetation can be identified. They are; cropped land where food or cash crops are grown usually on permanent basis; afforestated land, where exotic plants are grown. Some portions of the forest reserves are afforested land, and annual bush fire and illegal grazing, are fast turning the other part of the forest reserves into cultural vegetation types

2.7 DRAINAGE

The drainage of the Kano region is part of the inland drainage system of the Chad basin and consists of the head streams of the river system. Both the drainage and hydrology of the region are influenced by the climate, rock structure and human activities. "Natural drainage". The region of Kano is essentially drains northwest wards of the lake Chad, Kano river rises from the foot slope of the Jos plateau to the south and flows generally north and northwest until about 30km from its confluence with the Chalava river where it swing more than 90^0 to flow northeast. The swing is caused by a topographic divide believed to be created by a slight up lift after the Kano valley was formed, diverting the flow of the Kano from its original probable destination towards the northwest.

Two types of surface drainage can be identified. The principal type is the through – flow which consist of the Hadejia and Jama'are River systems. The second type of surface drainage consist of the "disappearing flow", this type made up of individual streams such as the Gari, the Tomas and the Jakara which drained the northwest and north of the region eastward. Modified drainage and hydrology, the construction of dams, which started about 1969 marked the beginning of the modification of drainage and hydrology in the region. The reservoirs of the completed dams and intricate networks of main, distribution and field canals in numerous irrigated sites have created a different type of surface drainage. The modification is great on basement complex section and minor significant in drainage and hydrology in the parts of Chad formation

2.8 LAND USE

The use of the land is clear to see in the field in the Kano region the is used for agricultural, forestation and urban purposes. Of these, emphasis shall be on agricultural use.

Agricultural use: - three major agricultural land use can be identify in the region;

(i) Rainfed Agriculture, up to 70% of the land of Kano is put to agricultural use, and about 90% of this cultivated land is under rainfall for both subsistence and commercial (cash)

(ii) Fadama cultivation, fadama cultivation, a dry season market gardening is associated with valley bottom, that is, the flood plains and the floodable parts of the low Terrance. Shaduf pits or low terrace depressions retain water, which is used to irrigate the farms. Fadama cultivation is a traditional form of irrigation complete with its own system of canals (main, distributing and field).

(iii) Large – scale irrigations modern irrigation layout with elaborate Canal systems are now a common sight. The Kadawa pilot scheme was the first modern irrigation project to be started in the region. This scheme is now part of the Kano river project.

In irrigation an area, agricultural is practiced, so two crops per year are produced: the irrigated crop and rainfall crop with supplemental irrigation. The nature of soils and other economic factors led to the choice of specific crops and cropping patterns. The water for irrigation comes from dams, the water is convey to the project areas through the main canal where it will later bisects into two branch canals, other to the distribution canals and ends to the field channels where it is available for supply to the crops.

CHAPTER THREE

3.1 LITERATURE SURVEY

The plant growth, development and yield in the tropics as elsewhere, is influenced by a wide range of physical factors including various climatic elements such as temperature, radiation, wind, and humidity. In many cases water availability to plant or crop is a major control only in the humid tropics does water shortage not have an impact, but even here the characteristics of tropical rainfall and the fact that many crops require dry periods at certain growth stages have a marked influence on agriculture.

Adefolọlu, (1983) rightly points out that plants do not only depend on the amount of rainfall received for growth, development and yield but on how much water is available to them (plants) as soil moisture. When this amount becomes available within the lengths of the days and months to which the soil is able to retain enough moisture required it would enhance good yield.

Groundnut or peanut, belongs to the family leguminosae. Asiedu (1992) further explained that it is grown as an annual crop on about 19 million hectares in tropical and sub tropical regions and the warmer areas of temperate regions of the world, principally for its edible oil and protein-rich kernels or seeds, borne in pods, which develop and mature below the soil surface.

Climatic variability constitutes a major determining factor in crop production at a given location. Oboli et al (1981) observed that groundnuts are grown between about latitude 8°N and 14°N to 16°N, where there are 500 – 1250mm of annual rainfall. The ideal rainfall condition is within 625 to 875mm concentrated in the wet half of the year, the crop is grown partly for export between about 11°N and 16°N in West Africa. He further explained that this difference is because in the latter region the rains usually penetrate less far inland and the whole northerly area is more favourable for export because the lower relative humidity keeps the groundnuts from becoming mouldy after harvest.

Despite all climatic factors that influence the agricultural production, the major control of plant growth, development and yield in the tropics in many cases are the water availability to plants and crops. Only in the humid tropics the inadequate water not have an impact, but even here the characteristics of tropical rainfall and the fact that many crops require dry periods at certain growing stages have a marked influence on agriculture. Of all climatic factors precipitation has been the pillar of any agrarian development but then it has not been accorded the deserved priority in the field of agricultural planning in Nigeria. According to Adefolalu (1991) in his studies who said that the general neglect of this natural resource may be based on the impression that. However, experiences have shown that several attempts to boost food production are being foiled by persistent drought spells. Much work has been published on the effect of meteorological factors on both annual and perennial tropical crops in which precipitation seems to be the most important factor. Olaniran, (1987) used empirical statistical technique, based on regression analysis to examine the influence of meteorological elements on the yield of maize and sorghum at Kabba Nigeria. He discovered that with such variable, climate, maize and sorghum yield correlations were higher for at least one phonological phase of athe growing season. He also found that fluctuations wigh sowing period and air temperature conditions during the grain-tilling yield.

Duncham, (1986) used climatological data to predict the yield of corn. He adopted a method to predict corn yield during the growing season using a plant process model, current weather data ând climatology data. The procedure is to place the current year daily weather (temperature and precipitation) into the model up to the time yield prediction is to be made and sequence of historical data (one sequence per year) after time until the end of the growing season to produce yield estimates.

The work represented the first step towards the ultimate goal of developing a method for obtaining reliable estimate of corn production during the growing season, production being yield period area harvested. He concluded with a caution on the use of the model as it depends on two components, these are: the accuracy of the corn process model and accuracy of the weather forecast from the time of the yield prediction to the end of growing season. That led him to the create a confidence limit within which yield can only fluctuate from the predicted.

Ability to predict climatic variations skillfully probably represents the most important element for planning future activities in modern societies in an intelligent manner. This will be most expedient in the 21st century when the effect of climate change is expected to create the most difficult challenges to man. Similar studies in Sahel may focus on water-tele-connections in an indirect manner. The obvious threat of drought to food security in Nigeria as well as its exacerbating influence on the southward "march" of the Sahara desert makes it expedient to at least carry out vulnerability analysis of impacts of the effects of drought in 19 drought-prone states of Nigeria. Duncham, (1974) define region of 19 drought-prone states as the north of the latitude where the hydrologic ratio (λ) of degree of dryness or wetness is less than 1.0. In simple terms, it refers to areas where precipitation falls below potential evaporation. But, when precipitation is greater than potential evaporation (PE) then flood may occur. This unique relationship is the reason why present and future studies should emphasize the significance of flood and drought studies with a view to having a lasting prediction model.

This point has been previously stressed by Adefolalu (1988) who identified the actual latitude where Duckhan's regional results hold in Nigeria. The latitude where $P < PE$ with low Hydrologic growing season (HGS) is 6.7°N. Thus Duckham's Hydroneutral zone is in the Guinea Sudan/Rain forest belt.

In the tropical environment, temperature and rainfall are the most important determinants of vegetation, as temperatures are high all the year round, they are not limiting to plant growth but determine what plants will grow Anthony et al (1999). Those authors also observed that, the type of agricultural activity carried on in any environment usually resembles the nature and rhythm of the natural vegetation. In a dense, equatorial rain forest region, for instance, perennial tree crops such as rubber, cocoa and banana are grown, whereas in a Savannah region, seasonal crops such as sorghum, millet, groundnut and cotton are common. Akinyeye, (1987) who revealed from his studies that, groundnut is drastically declined as a result of adverse climatic factors, especially the persistence drought effect in the growing area.

He concluded, from regression analysis result, that over 60% of total annual groundnut productions in Kano were from rainfed agricultural production.

Some of the studies on the crop and agroclimatic factor relationship in Nigeria are concerned with cotton from the study of Oguntoyinbo (1967), while Kowal, (1968) observed on Groundnut/cottgon/sorghum/millet,

Not all rainfall is effective but only the portion that contributes to evapotranspiration could be considered as effective rainfall.

3.2 REVIEW OF TEMPERATURE

For each plant species, there exists an optimum temperature range at which growth and development proceed with minimum intensity and speed. Duncham (1986) observed that, temperature affects the rate of growth, the time required for plant to shade the ground and blooming dates, for most growth processes, the optimum temperature is 10°C higher temperature over

38°C Stephen (1997) noted that temperatures are of course closely correlated with insulation and therefore not always possible to separate the effects of these two factors on plant life. However, it is certain that most physical and chemical processes in plants are strongly effected by the temperature conditions according to Cocheme and Franquin, (1967) who observed that temperature affect the rate of development notably that of flower production, even within the fairly uniform regime of the area. This would allow short-cycle varieties grown in the north to produce a sufficient number of flowers in a short time.

3.3 WATER REQUIREMENT

Although the early varieties of grown in the north show good resistance to drought, especially during the vegetative period, groundnut has been found to need water at most stages of its growth and development but more particularly during the period of useful flowering Cocheme and Franquin, (1967). They noticed further that, ripe nuts left in humid well tend to germinate while nuts maturing long after the rains when the ground has hardened might not be possible to harvest. Taking into account loss by evaporation, water requirement range between 450mm to 700mm.

3.4 LIGHT REQUIREMENT

The continuous process that takes place in the parts of plants, plants are generally and highly sensitive to photo-periodic stimuli during the process of photosynthesis. Solon radiation is utilized by chlorophyll to produce by matter from water and carbondioxide, i.e. production of dry matter depends on incoming solar radiation, which, the type of energy plants uses to exploit or manufacture food Stephen, (1997). Although groundnut is generally held to be photoperiodically neutral, Cocheme, (1967) noticed that variation in the cycle length of some late varieties when sown at different dates suggests short-day reactions. When light is sufficiently unavailable, the rate of photosynthesis is said to be proportional to the intensity of insulation called saturation light intensity.

Oguntoyinbo, (1978) also noted that, the geographical location, size, and shape allow West Africa to experience most of the types of weather and climate in the region. That is to say, the proximity of the West African Region to the equator in the tropical belt, increases evaporation rate and usually very high to some extent. This is the changing of phase of water from liquid to vapour, this is an area where the rate of evaporation is usually very high, this may point to water needs as it is very essential for the growth and development of crops.

3.5 FORECASTING CROPS YIELD

Agro meteorological forecasting is the assessment of the current and expected performance from crops. According to WMO, (1983) where it is observed that, the assessment of current and expected crop performance, includes the stages of crops development and yield as well as other factors affecting production pattern, such as density of sowing and location of areas of planting. A forecast in the yield of any agricultural production before the harvest period is of prime importance to any nation with a well-organized programme in the food and agricultural field. As a result of the above points, Edem, (1997) observed that in forecasting, the yield of agricultural crops, two lines of approach can be identified. These are the direct report from field workers about the conditions. The other method involves the use of current and immediate past weather data. The disadvantages of the former ones observations are subjective depending on local and recent weather conditions; there is the tendency to over-emphasize the values of impending flood and drought damages; there may be communication problem which may delay information flow; crop condition reports are usually given in subjective terms which makes it difficult to apply numerical terms on the data. The use of past-weather data also involves some problems such as: the possibility of imperfect and incomplete mathematical relationships leading to large errors in season with anomalous weather, there is also the inability to account for the significance of insects and epidemics of disease and the inadequate of weather station density.

Probably, the best technique is a combination of the crop-condition reporting system and weather based estimating system to avoid induced error. Edem, (1988) who observed the study of Robertson, (1977) developed an equation to predict rice yield in Maharashitra State, India.

$$X_1 = 430 + 33.7x_2 - 49.7x_3 + 9.65x_4$$

Where x_1 = expected yield

X_2 = number of rainy days in July

X_3 = number of occasions of drought in August

X_4 = number of rainy days during the last half of September.

One of the important features of these forecasting models is that they are only valid in a particular region and hence the need to develop for many regions. With the reason that agrometeorological variables are spatially homogeneous only over limited areas with the same soil type, topography, climate and cultivation practices among others.

At this juncture, it will be proper to say that not all forecasting models are valid due to other environmental factors, but a very close correlation/correspondence to observe values have been noticed in many ways.

3.6 PROBLEMS AND PROSPECTS

In summary, apart from the socio-economic problems facing Nigerian farmers, climatic variability constitutes a major setback in crop productions. This is because the bulk of food produced in Nigeria is grown under rainfed conditions.

The factors that affect crop production generally are the climatic effect, the nature of the soil, incidence of pest and diseases, topography and economic consideration.

CHAPTER FOUR

RESEARCH METHODOLOGY

A reconnaissance survey was undertaken to familiarize the researcher with some locations in the research areas. Informal discussions with the farmers and rural people and some project officials were carried out. This afforded an opportunity to intimate some of the villagers and farmers on the purpose of the research.

METHODOLOGY AND DATA COLLECTION

4.1 DATA REQUIREMENT AND COLLECTION

Apart from the reconnaissance study taken, primary and secondary sources of data were employed to elicit information required on the research.

Primary data required for this work were collected through the use of oral interview and personal observations on the activities of the farmers on their farm area. The questions were directed to mostly farmers to the study area. Observations is another primary method of collecting data used by the researcher. This method was of great importance to the research as it enabled the researcher to find out things for himself rather than depending solely on information from the secondary data. The researcher share his personal experience with the farmers during the period of observations as a uniform check list.

4.2 ORAL INTERVIEWS

In addition, oral interviews were conducted with a representative sample of the respondents in order to crosscheck the information; collected in the various ministries and KNARDA, as well as finding out more fact about the written responses from secondary data.

4.3 SECONDARY DATA

The secondary data for the study were also obtained from the various sources. In order to understand crop and climate relationship, relevant data have to be collected and appropriate statistical techniques must be applied. Relevant climatic data, which include rainfall data, both maximum and minimum temperature data, Relative humidity data, were collected from Aminu Kano International Airport Kano. For the period of ten years between 1991 – 2000. The groundnut yield data were obtained from various departments of the ministries of Agriculture at both the federal and state levels. The agricultural yields were obtained from office of statistics in Kano as well as Kano State Agricultural and Rural Development Authority

(KNARDA). The data cover a period of ten years between (1991 – 2000). The topographical maps were obtained from Federal Surveys Department in Kano.

4.4 DATA ANALYSIS

Statistical analysis are employed in carrying out the data analysis, these are combined with the graphical methods which are also used in the analysis. The primary data obtained were computed in percentages, from which description and inferences were made, frequency distribution, tables, means were also used for illustrations.

The mean rainfall (daily, monthly and annually) was computed by using the following techniques.

4.5 AGRO-CLIMATOLOGICAL ANALYSIS

The daily rainfall will be used in calculating the mean monthly, seasonal and annual rainfall for the region from the following derived precipitation effectiveness indices will be computed as follows.

The onset, cessation and length of rainy season is a method adopted by Olaniran (1988) to compute the indices. However, it has been noted that Ogive method using rainfall data is more accurate noted by Adefolalu, (1993). This method will be used in the research, where daily rainfall data are available, where daily rainfall are not available, Olaniran (1998) modified version of Walter's (1967) method could be used.

For the start of the rainy season days of the month, this method could be applied.

51 Accumulated Rainfall total of previous month

Total Rainfall for the Month

However, where the month under reference is that during which accumulated total of rainfall is in excess of 51mm, and if the month following is less than 51mm of rainfall, the previous month is disregarded and the next month with more rainy season start. For the end of the growing season the formulae is also applied in the reverse order from December.

4.6 HYDROLOGIC RATIO (λ)

Adefolalu (1988) observed that, hydrologic ratio could be defined as the ratio of mean annual rainfall to the potential evaporation (PE). This symbolizes soil moisture deficiency or surplus. Also Ducham (1994) noted that, this index helps with decision making in Agriculture, because it provides a guide on the best choice of the area/plot where particular types of will not only thrive but will equally have highly yield or reach optimum growth level.

4.7 SPECIFIC WATER CONSUMPTION

This is the water equivalent to avert drought in the areas of rainfall deficiency. Amount of water required for the effective plant growth, development and yield, is the hydrologic rates and its calculated (water consumption) as follows:

W/F	=	Length of wet period + D day (Q dry – P dry)
Where W/F	=	specific water consumption
D.Wet	=	length of wet period in days
Q.Wet	=	water demand equivalent to PE during Wet period in mm/day
P.Wet	=	Average daily precipitation during wet period in days
Q.dry	=	maximum water demand equivalent of PE during dry period (mm/day)
P.dry	=	average daily precipitation total during dry period (mm/day)

PE = potential evapotranspiration.

Between the latitude $10^{o} - 20^{o}$ in the semi arid region where water demand is very high used the following values. Q.wet and Q.dry.

In analysis of agroclimatic factors and groundnut yield. Agroclimatic variables would be analyzed using correlation and regression analysis. So as to identify the factors that are critical in groundnut production in considering other factors outside the climatic factors such as Agrochemicals (fertilizer), market.

The regression analysis that are used in presenting the study is expressed in the form

$$r = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{\left[n\sum x^2 - (\sum x)^2\right]\left[n\sum y^2 - (\sum y)^2\right]}}$$

Where:

y = Groundnut yield of a particular year

n = number of cases or year

x =annual rainfall total of a particular year

4.8 MEAN

The mean rainfall (daily, monthly or annually) was computed by using the following equation.

$$= \frac{\Sigma\, x1}{N} = \frac{\Sigma\, x}{n}$$

where

x = the annual (daily, monthly or hourly) rainfall for a given period of time.

n = the number of the cases (years)

Σ = sum of the values of variable

4.9 STANDARD DEVIATION (ó)

This is another statistical method that is adopted to carry out the data analysis. It is expressed as follows

$$\sigma = \sqrt{\frac{\Sigma (x1 - \overline{x})^2}{n}}$$

where x1 = the annual (monthly, daily) rainfall of a given period

$\overline{x}$ = the average annual (monthly, daily or hourly) rainfall

4.10 CLIMATIC INDEX (C.I.)

This is a method used to analyze the variation of rainfall. It (index) represents the extent of variation of a parameter from an established normal. It can be expressed as follows:

$$C.I. = \frac{x1 - x}{\sigma}$$

Where x_1 = Rainfall of a particular year

$\overline{x}$ = Mean annual rainfall for the study area

σ = denote standard deviation.

The climatic index ranges are as follows:

0 and –0.5 = it indicates mild drought. When C.I. is within –0.6 and –1.0, it denotes severe drought. Climatic index (C.I.) greater than –1.0, it indicates extreme drought.

Wetness in the climatic index also ranges from 0 and +0.5 denotes mild wetness.

+0.6 and +1.0 indicates severe wetness and climatic index of +1.0 and above indicate extreme wetness.

4.11 REGRESSION ANALYSIS

Regression analysis is used in determining the degree of relationship between agroclimatic variables and crop production i.e. linear relationship with the following equation:

$$r = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{\left[n\sum x^2 - (\sum x)^2\right]\left[n\sum y^2 - (\sum y)^2\right]}}$$

x = annual rainfall total of a particular year

y = groundnut yield of a particular year

n = number of cases or year

CHAPTER FIVE

5.1 ANNUAL RAINFALL AND DEPARTURES FROM MEAN

Kano area of Northern Nigeria was suited to grow the groundnut on an enormous scale. Light, sandy soils are of a great advantage since harvesting involves lifting the entire plant out of the earth by hand. Such soils are present in much of Kano province. The groundnut also needs at least 22 to 24 inches of rain during growing season and this too is almost always achieved in the region of Kano, (Icher and Liedholm 1970) narrated this:

The characteristics of some aspects of rainfall variations particularly in Kano State and generally in Nigeria have been a topic of studies. At this segment of the study, the distributions of rainfall are examined in Kano region, coupled with detailed analysis of some variations in rainfall in some years back. As well, the dry and wet years are also discussed in this chapter. Seasonal rainfall variations, trends in climatic indices and departures from the mean will be looked into.

Looking at the figure 5.1, it can be noticed that the annual rainfall pattern within Kano State varies from place to place. This pattern tends to

RAINFALL DISTRIBUTION OF KANO STATE

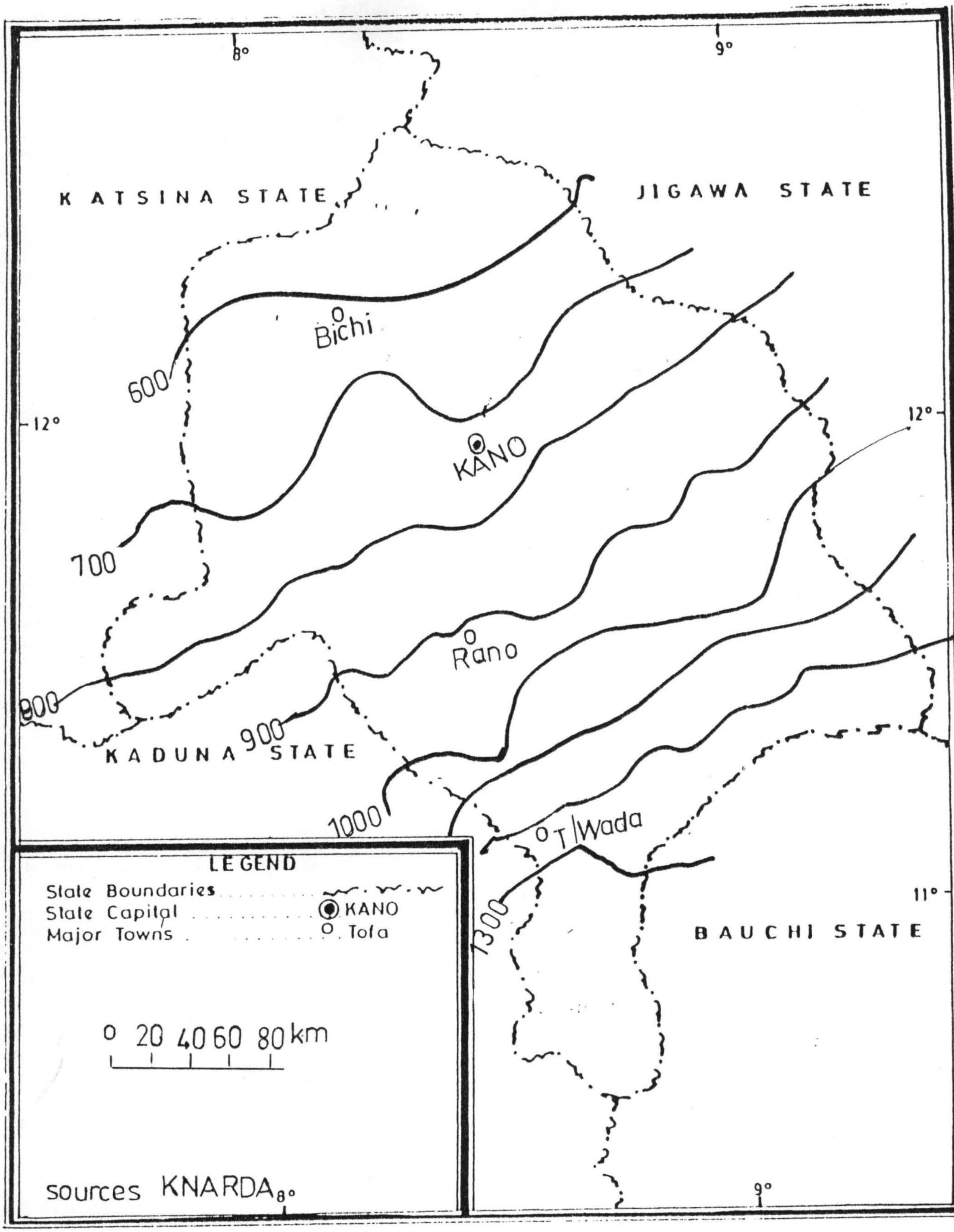


Fig 5.1

show increase in rainfall from northwest to the southwest direction. For instance, Bichi in the northwest area of Kano region recorded about 700mm of rainfall while Tudun Wada in the Southwest recorded about 1300mm of rainfall. Kano metropolis has approximately rainfall of about 800mm and Rano recorded between 900 and 1000mm rainfall annually.

It can be noted that, the geographical location, size and shape allow West Africa to experience most of the types of weather and climate in the region.

5.2 CLIMATIC ELEMENTS AND GROUNDNUT YIELD

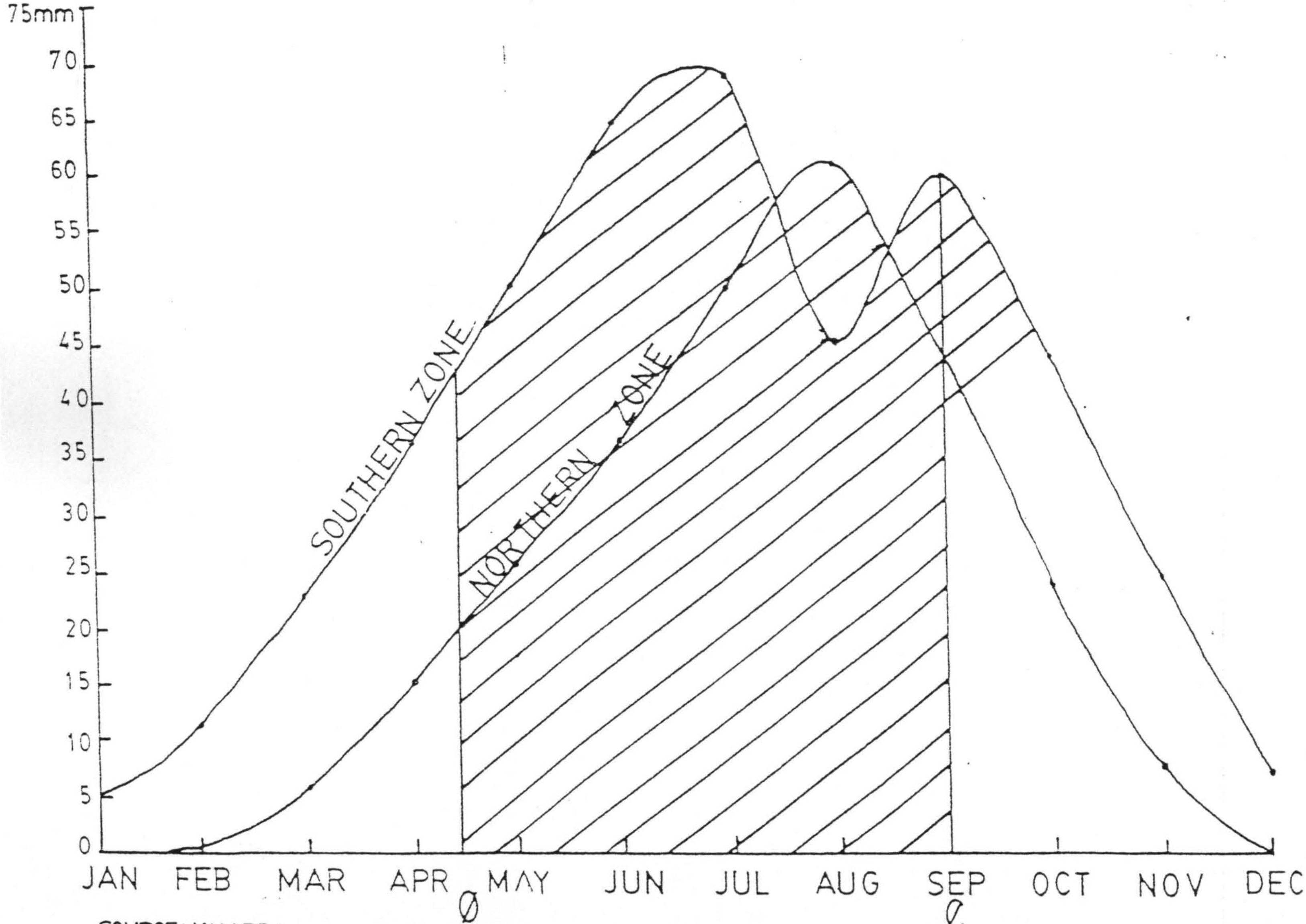
Climatic factor affecting groundnut yield, principally is precipitation. Indices for instance, the on set (ϕ) date of rains, cessation (⊄) dates and length of rainy period (LRS).

The onset of rain is the determinant period for planting and yield of groundnut also depends on the onset of rain period because early sowing date facilitates the proper development, maturity and yield. Onset of rains helps the farmer in planning for the sowing date so as to beat the effect of pest, which normally, attacked the crop at its maturing stage.

The cessation dates determined the crop maturity while the length of rainy season dictates the crop productivity and yield.

In Kano, rainfall decreases from the southern part of the region northward. The onset of rain usually occur around April and May in the southern part of the region, while other places received their rains in a progressive transition toward northern part. Usually between May 10^{th} and May 30^{th} is the onset of rainy season in the southern part. The anomalies of the onset date are within May and sometimes overlapped to June.

The cessation dates in Kano region as well as onset of rainfall varies between north and southern part at a different latitude. Southern zone of the region is located at latitude $10^{o}30'$N and 11^{o}N while the Northern zone located at latitude $11^{o}20'$N and 13^{o}N.



SOURCE: KNARDA

Fig 5·2

Mean Rainfall For The Southern (Southern to Latitude 10° 55′N) and the Northern (Latitude 11°N to Latitude 13°N) Areas Over

5.3 VARIABILITY IN PRECIPITATION

There are two main seasons in Kano region, thus, dry and wet period. The dry season is usually when northeast trades blow between October and March. This encroachment is synonymous with dryness where spells of dust haze are associated with the prevailing Harmattan, which is defined as the continental dry northeast trades. This period, rainfall is totally absent and relative humidity is low.

The wet season is between the month of April/May and September. The length of the wet season varies in both time and space. The northern part of Kano recorded rainfall less than 600mm total annually while the southern part of the region received over 1200mm as total annual rainfall.

TABLE 5.1 AVERAGE RAINFALL IN KANO REGION

Zone	Average Rainfall (mm)	Number of Rain Days	Period of Normal Rainy Season
SOUTHERN ZONE	800	56	Early Aprl – Late October
MIDDLE ZONE	750	52	Mid April – Early October
NORTHERN ZONE	600	43	Early May – Late September

Source: KNARDA (2001)

The present climate of Kano is the tropical wet and dry type.

Rainfall is a very critical element in the region because of its deficiency during the dry season in a normal year, the mean initial rainfall in the southern part of the region is about 900 – 800mm, decreasing to about 750 around metropolitan Kano and about 600mm in the north and northwest. Great temporal variations occur in the amount of rainfall received anywhere in the region. No two consecutive years record the same amount, and average calculated for any two periods are never the same.

The variations in the amount and other aspects of rainfall result in three rainfall regimes Olofin (1987) noted that:

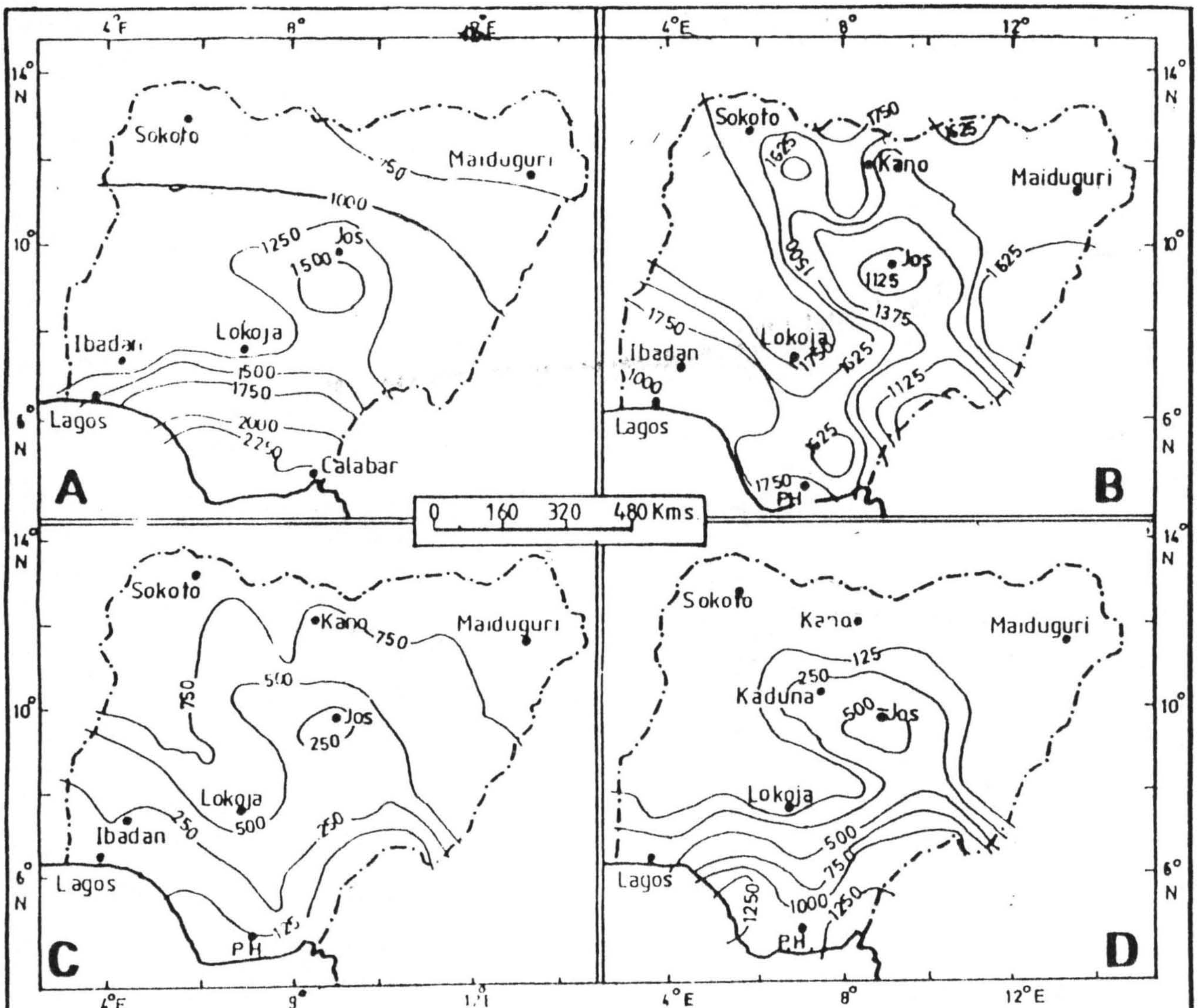
(a) There is a wet regime where the amount of rainfall received is larger than the long-term mean, the duration of the wet season is longer than normal, and the pattern of rains is steady.

(b) There is a moderate regime when both the amount and the duration of rainfall are approximate by normal, and the pattern of rains is steady.

(c) There is a dry regime when either any of the amounts and the duration of rainfall is less than the normal with erratic rain pattern, or both of amount and duration of rainfall are less than normal with, or without, erratic pattern of rains. He also said that, the regimes occur at random. The occurrence of the dry regime for the consecutive years means a major drought.`

(d) The dry and warm season, which starts at the end of the rains, and ends about early November in Kano metropolitan ± 10 days north and south of the region with the onset of the Hammattan. It is the second hottest period of the year when relative humidity is still sufficiently high to make sensible temperature almost unbearable.

DISTRIBUTION OF SOME WATER BALANCE COMPOTENTS IN NIGERIA IN(mm)



A mean annual rainfall
B mean annual potential evapotranspiration
C mean annual water deficit
D mean annual water surplus

After Ayoade and Oyebande, 1983

Fig 5-3

Normal or seasonal variation, this is temporal variation, which occurs at different scales in the amount and duration of rainfall in the region. The normal or seasonal variation occur annually and it believed to be in order ± 30% about the mean value Jackson (1977) in this tropical wet and dry climate.

The seasonal variations result in three types of rainfall regime for a normal year, which reflected in the crop productions. Any of the regimes may occur during any year, but it is not known for certain which regime will occur in a particular year or which regime will follow a particular one.

Apart from the normal seasonal variations, there are periodic variations, which are greater than ± 30% stated above. There are short-term periodic cycles (5 to 10 years) and there are longer cycles. A pattern that emerges is that the longer the cycle the more is the number of consecutive years that are involved in the extreme variation. A second pattern is that the variations are more is the negative than in positive. For instance in the records from 1991 to 2000. There are more consecutive years that are involved in extreme variations from 1993, 1994 and 1995, which recorded low total annual rainfall, which is slightly drier than the normal while three more consecutive years are also wetter than normal 1997, 1998 and 1999. These variations also reflected in all the zones within the region North and south of Kano region when the variations associated with cycles 10 or more years long a climatological/meteorological drought condition is said to exist. In this region, major droughts have occurred in the last century in 1913-15, 1940/41, 1948/49 and 72/73 with minor ones in 1963. 1967/68 and in 1977. Olofin (1987) Another minor one but (major for other parts of Nigeria) occurred in 1983/84. During the most recent major drought i.e. 1972/73 in this Kano region received only 414mm of rainfall per year which is about 48% of the mean value for the metropolitan. The table below illustrates the 1972/73 conditions in three other stations in approximately similar environment to the Kano region.197273 R/Fall Characteristics

TABLE 5.2 SOME CHARACTERISTICS OF RAINFALL IN SAVANNA ZONE DURING 1972/73 DROUGHT

Station	Normal (mm)	Mean (mm)	% of Normal	Number of Months < 25mm	> 75mm
Sokoto	693.4	388.1	56.0	8(7)	2(3)
Nguru	541.0	247.7	45.8	9(7)	1(3)
Kano	864.1	414.4	48.0	8(7)	2(4)
Maiduguri	650.8	353.8	54.4	8(7)	2(3)

- Figures in brackets represent normal conditions.

Source: Olofin (1985).

The droughts of West Africa in general and Nigeria in particular are caused by departure from "normal" climate. The droughts were throughout much of Sahel and Sudan regions and have indeed become relatively persistent for the past two decades. Rainfall failure has become a characteristics of the affected areas and land has continuously been under water stress. During the drought year of 1969/73, it was established that the 300mm Isohyet is seen to be depressed between 100 – 125 km southwards of the normal position from the work of (Ojo 1986).

5.6 AGRICULTURAL PRODUCTIVITY

In Kano region, mixed cropping cultivation has become the traditional system of agricultural activities. Groundnut is one of the crops sowing within the first stage of onset of rainfall. If there is any delayment in onset of rains, the early planting season is affected and early season crops also affected and if subsequent rains are no too favourable, the late crop would not be planted in the season. Even though planting takes place, germination may be poor or nil as a result of prolonged stress period immediately after planting. While replanting may not be possible. The common farmers' wisdom from the past experience, that, mixed cropping is an insurance against risks from erratic rains, is still in existence or practiced among the farmers. Consequently, the early planting (thereby meaning early rains) leads to higher yield of crops. Other things remain equal. Both false onset of rains and sudden breaks (dry spells) during the course of a particular rainy period within the study area are very important, because, it has been observed that occurrence of false onset and sudden breaks of the rainy season are injurious to plant life while the late rains cause potential losses to the agricultural produce.

It was therefore, reported by the farmers that, such characteristics of summer rains (late onset) caused more drastic drop in the yields of the agricultural produce for instance 1994 and 1999 reduction was as a result of such breaks and false onset in the rains.

The false onset rainfall deceives farmers to plant groundnuts early while later they become disappointed as the rains turned erratic, consequently crops become wilts after germination. In other way round years of steady and normal rains the farmers anticipate bumper harvest, but the incidence of the effect of pest cause damages and general draw-back in the production of groundnut in particular and to the other crops as a whole. For instance farmers said in 1998 when the rain was stable and high, the effect of pest was said to have affected the production.

It has been long that researchers have been trying to find out the precise relations between agricultural output (crop yield or production) and simple readily available weather data such as temperature and rainfall. In any case are the only method and possible measure to determine the relationship. Since more refined procedures of climatic environments are not yet available. Recently, it has been possible to begin to relate agricultural output to such factors like soil temperature or soil moisture content to radiation or derived climatic indices through improved instrumentation that reflect how well the vegetation is utilizing the energy and water potential for the growth, development, and production. The achievement of significant correlation between the climatic factor and yield brought about by the active climatic elements.

Other climatic indices that need consideration are the Hydrologic Relation (λ) and water equivalent to avert drought which are discussed as parameters for effective precipitation.

5.7 PRECIPITATION EFFECTIVENESS PARAMETERS

The characteristics of rainfall, constitute an important data set for the understanding the rainfall feature of Kano Region. However, planning in relations to crop production cannot be by using rainfall amount alone in determining crops optimum yield. Therefore it is important to compute applied parameters based on the rainfall for effective planning. Examples of these parameters are the hydrologic rate and specific water consumption as postulated by Adefolalu (1988) and Ducham (1994) parameters and the implications of these parameters to the agricultural planning in Kano Region are very important and used to be discussed.

5.8 HYDROLOGIC RATIO (λ)

The ratio of mean annual rainfall to the potential evapotranspiration, is the soil moisture deficit or surplus with the value equal to unity is defined as hydroneutral condition.

Index saves as a guide in decisions making in agricultural practices, it guide on the best choice on area or plot where a particular crop type can produce higher and optimum yield.

From the above figure, all the places under the hydrologic ratio of 0.40 and 0.60 that are within the latitude 11°N and 13°N required supplementary irrigation during the drought spells, so as to ensure maximum potential yield level of the planted crops.

Pure rainfed crops that survive under short period are possible between the latitude 10°N and 13°N. This is the zone of hydrologic ratio values ranges between 0.50 and 0.60. At latitude 11°N where the hydrologic ratio is above 0.60, all the agricultural rainfed crops can be practiced successfully.

5.9 SPECIFIC WATER CONSUMPTION (W/F)

At this region the dry period is much longer than the rainy season based on observations so far. The dry season commences as early as September and terminates at May/June. While the rainy season pick up from June and September with low probability values. The highest rainfall probability occurs in the night to early hours of morning. This is an indication of line squalls, in which sometime contributes to the local rainfall than it does in storms, even when late evening maximum probability is observed in September.

The consequence of rainfall variability in the tropics is the dry spells and other hazard posed to agricultural practices, this required additional water in form of irrigation in order to ensure adequate soil moisture for plants during the growing season.

The appropriate technique for quantifying the amount of water required ~~by a grain~~ to irrigate a soil over a given location is the specific water consumption (w/f). According to Flohn et al (1974) defined the specific water consumption as the water equivalent to avert drought, it is the exact amount of water that is needed to irrigate a field for effective plant growth and development.

Generally, Kano Region there is a south-north increase in the w/f values. This is a zone of positive and negative wf. Thus (negative wf) zone of deficit soil moisture and positive wf surplus soil moisture. The southern part of the region e.g. Tudun Wada falls with the zone of surplus while any place above 11°30'N of latitude in the region is within the zone of deficit which occupies about 2/3 of the total area of the region. In the northern part of the region, sometimes delayment in the onset of rains used to occur as a result of climatic variability and caused agricultural drought, while a slight departure from the mean may be a critical factor in crop failure. The solution to this hazardous occurrence and sustainable agricultural development during the dry season is irrigation scheme.

Distribution Of Rainfall Indices Value Of Kano Region (1993-2000)

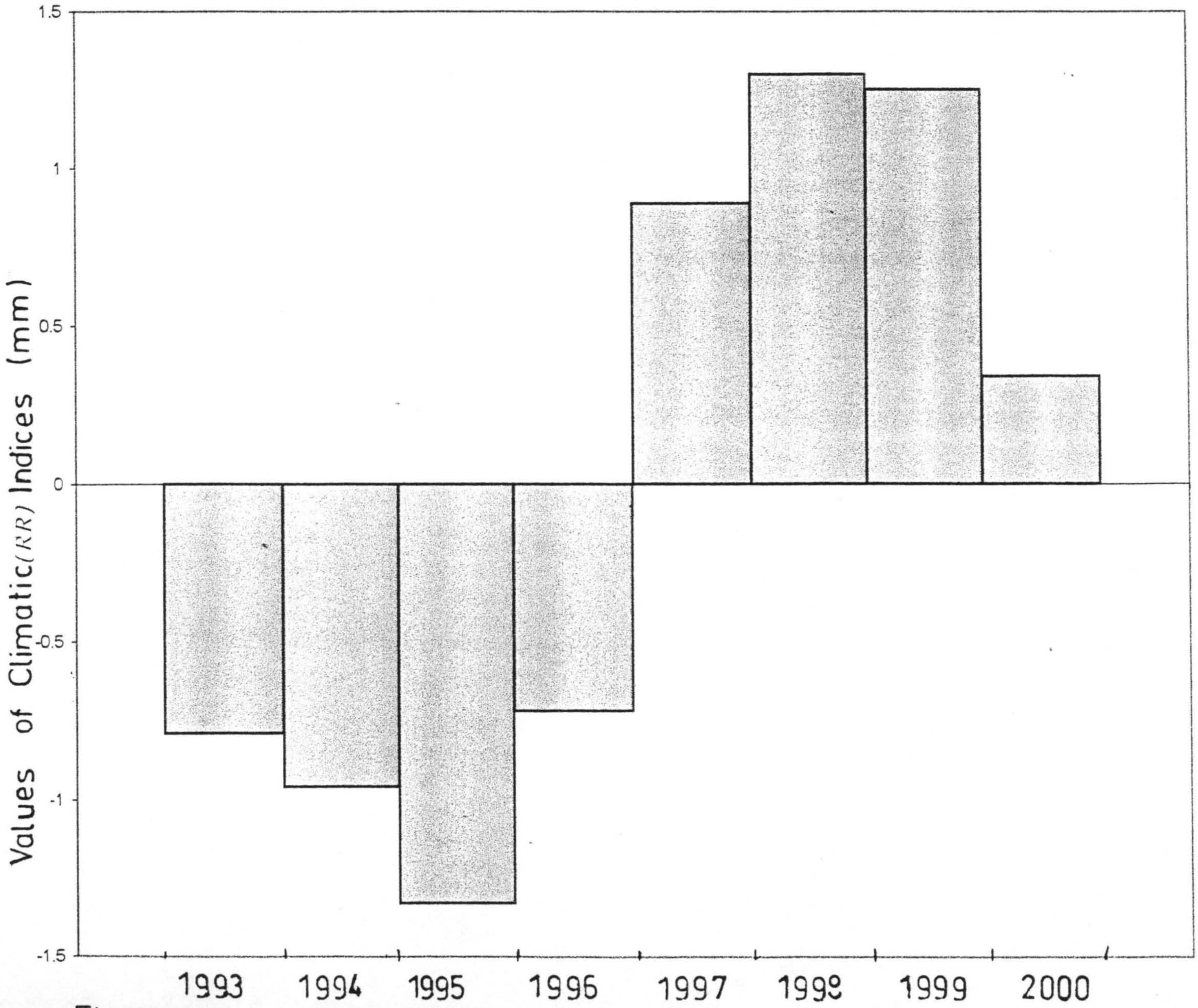


Fig 5·5

5.10 CLIMATIC INDEX

Using the climatic index values as a basis for measurement, it can be noted that Kano region is characterized by both drought and flood periods. Although it has been observed that, in some decades back Kano region that drought periods occurred more frequently than the flood periods. But from the figure above within the period under study (1993-00) it was only 1995 show the indication of extreme drought. With climatic index value of –1.33 ó and this is the year recorded lowest rainfall, with the total annual rainfall of 688.8mm.

In 1993 and 1994 the fig. 5.5 show climatic indices that below the mean with –0.97 ó and –0.96 ó respectively and this indicate severe drought in the area while 1996 also show –0.72 ó with indication of mild drought.

However, in 1997 there was a great recovery from the effect of drought that have been persisting from 1993 – 1996. In this year 1997 rainfall total have increased to 1289.3mm with climatic index value of +0.89 ó. From 1997 – 2000, the climatic indices were positive with increase in total annual rainfall for the periods. Only 1998 that recorded the greatest amount of total rainfall with highest value of climatic index of +1.30 ó when the total annual rainfall was 1398.5mm, this indicates extreme flood for the year in the study area. This was closely followed by 1999 with climatic index value of +1.25. The year 2000 was the only year that showed indication of mild flood within the periods of study, with total annual rainfall of 1139mm and climatic index value of +0.34 ó. Appendix I revealed the yearly climatic index value of the periods under study.

It must be noted that throughout the year under study, the years with total rainfall lower than the mean were equal to those years with total rainfall higher than the mean.

5.11 THE ANNUAL TREND IN GROUNDNUT YIELD IN RELATION TO RAINFALL

Groundnut is a typical crop of Northern part of Nigeria. The main groundnut producing areas are similar to those of cotton. Unhappily for the proponents of cotton, the Kano area of Northern Nigeria was suited to grow the groundnut on an enormous scale. Light, sandy soils are a great advantage since harvesting involves lifting the entire plant out of earth by hand such soils are present in much of Kano province. The groundnut also needs at least 22 – 24 inches of rain during the growing season, and this too is almost always achieved in the region of Kano.

Other areas of groundnut production apart from Kano environment include Kaura Namoda, Gusau, Katsina, Funtua, Zaria and so on. Where in the past, pyramids of governments are found. Groundnut are less sensitive to reduced rainfall and could be consumed in lieu of export should the output of other food crops be deficit.

Recently, decline in groundnut production, is partly due to the outbreak of diseases such as aphids and frequent drought in semi arid region of Nigeria. The production in groundnut is highly influenced by the increasing demand especially for domestic consumption and export trade. The urban rural interaction in groundnut trading activities as well as profit motive influenced the farmers in the rural areas, which was suitable for groundnut cultivation on an enormous scale.

Numerous factors could be responsible for the groundnut production level in which sometimes affect the total yield of groundnut in any given year, some of these factors may include rainfall, temperature, length of rainy season and other non-climatic factors.

Annual yields of groundnut collected for about eight years, between 1993 and 2000 (available yield record) show that groundnut yields has been fluctuating in Kano along with the effect of rainfall variations.

TABLE 5.3 GROUNDNUT MAIN VARIETY YIELD AND TOTAL ANNUAL R/FALL (1993 – 2000)

YEAR	RAINFALL (MM)	YIELD (TONES/HA)
1993	834.4	750.00
1994	789.5	652.00
1995	688.8	750.00
1996	853.0	740.00
1997	1289.3	800.00
1998	1398.5	760.31
1999	1385.7	688.26
2000	1139.0	703.00

Source: Field work (KNARDA)

Table 5.3 shows the annual variations in groundnut yields in Kano region within the study period (1993 – 00). It can be observed that there is a fluctuation in the trend of groundnut yield from year to year. The variability may be due to some of the factors mentioned earlier.

5.12 THE ANALYSIS OF AVERAGE GROUNDNUT YIELDS WITH TOTAL ANNUAL RAINFALL INDICES

The results indicate that 1998 has the highest annual rainfall amount of 1398.5 mm, despite the higher rainfall total amount at the year 1998 groundnut yield was not the highest yield within the period of study. This implies that the amount of rainfall does not alone determine the yield but length of rainy season and other factors. Despite the fact that 1998 has the highest annual rainfall total within the years of study, the length of the rainy season was only 88 days which is not the highest rain days among other years between 1993 – 2000. While 1997 had the highest yield of groundnut of 800 tones/Ha, but it was not the year of highest annual rainfall total but it is the year of highest of average length of rainy season (LRS) of 102 raindays. Which means that the rains were properly spread during the rainy period of the year. The lowest total annual rainfall was 1995 and had second highest yield within the years sof study with total annual rainfall of 688.8mm with the length of rainy season of 50 days. Going by this one could therefore conclude that the longer the length of rainy days (LRS) the higher the yield, therefore the belief in rainfall deficit over the year for poor crop yield must be erased as crop production does not depend solely on the amount of rainfall received either for growth or yield but it is based on how much or quantity of water that is available in the soil within the length of rain days in which soil is able to retain enough water required for the proper plant growth, development and yield.

5.13 CORRELATION OF CROP YIELD WITH LENGTH OF RAINY SEASON (LRS)

Length of growing season is correlated with the data collected on mean annual groundnut yield within 1993 and 2000 as sample within the period of study, below are the results of correlated mean length of rainy season with the annual average of groundnut yield (tones/hectares) using correlation coefficient analysis.

$$a = \overline{y} - \overline{b}x$$

$$b = \frac{\Sigma x1y1}{\sqrt{\Sigma (x)^2}} = \frac{\Sigma (x1 - \overline{x1})(y1 - \overline{y1})}{\Sigma (x - x)^2}$$

where Σ = summation

y = groundnut yield of a particular year

x = mean length of rainy season (rain days)

The result of the correlated analysis of the length of rainy season (raindays) and mean annual groundnut yield for the eight years between (1993 and 2000) see Appendix 4 shows that the (LRS) raindays has a very strong and positive relationship with the groundnut yield within the study area over the length of years of study. Using statistical relationship between raindays and groundnut yield, a coefficient of 0.67 indicates that about 68% of the variance in the yield of groundnut is accounted for by the variable x (LRS). The remaining 32% are due to other factors.

5.14 CORRELATION OF MEAN TOTAL ANNUAL RAINFALL AND MEAN AVERAGE GROUNDNUT yield (Tones/hectares) with the following formulae, thus:

The regression analysis for groundnut yield and total annual rainfall for the period of study between 1993 – 2000 shows positively non-significant relationship of groundnut yield and total amount of rainfall. See Appendix 3. The correlation coefficient reveals 0.19 for the relationship between groundnut yield and total annual rainfall amount and a determinant of 0.19300. This indicates that about 19% of the total rainfall contributes to yield of groundnut which is very low to determine the yield. Then there are other factors rather than the total amount of rainfall value that determine the groundnut yield.

TABLE 5.4

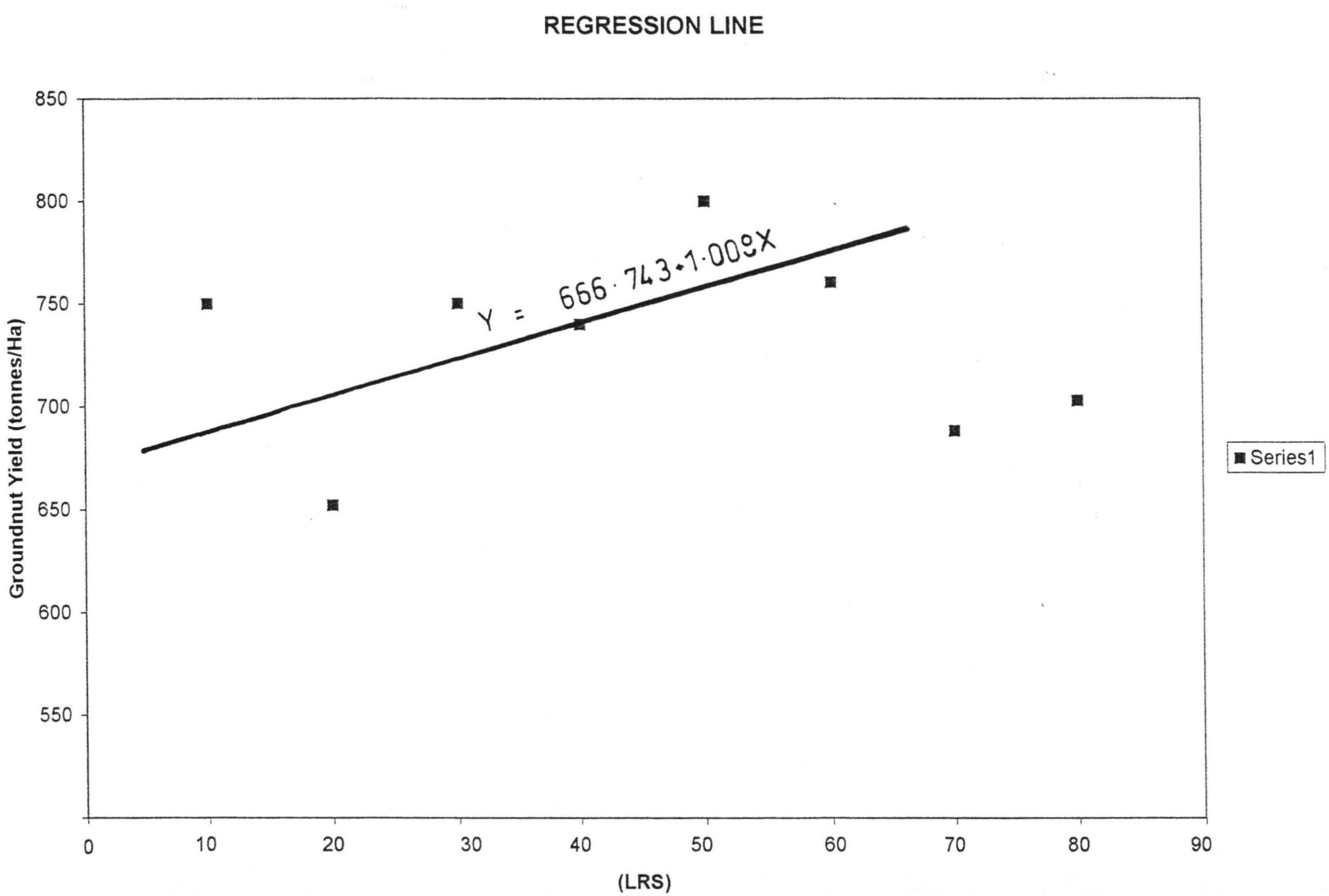
Year	1993	1994	1995	1996	1997	1998	1999	2000
G/nut yield (Tones/Ha)	750.00	652.00	750.00	740.00	800.00	761.00	689.00	703.00
(LRS) Average R/days	44	57	55	42	102	88	61	63
Total annual RR(mm)	834.4	789.5	688.8	853.0	1289.3	1398.5	1385.7	1139.0

5.15 DISCUSSION ON CROP YIELD AND LENGTH OF RAINY SEASON (RAINDAYS)

The research revealed that there was more groundnut yield in the period of high length of Rainy season, than the period of the higher Rainfall amount. See Table 5.4. For instance in 1998, when the total annual rainfall was 1398.5 mm which was the year that recorded highest rainfall amount within the study years, one would have been expected highest groundnut yield to be recorded at the same year. But it was not, because of low raindays compared to 1997 where the highest raindays was recorded with 102 raindays. This is the period of highest groundnut yield within the study period.

Meanwhile, the length of Rainy season (LRS) was correlated with the groundnut, yield the result confirmed positive relationship with high correlation. At the same time the total annual rainfall was also correlated with the groundnut yield but the relationship between the groundnut yield and rainfall amount revealed low positive relationship.

At this juncture the researcher concluded that length of rainy season determine the crop yield (groundnut). The longer the rainy days the higher the yield. Therefore poor crop yield should not be associated with the rainfall deficit amount because plant does not depend on total rainfall for good growth and better yield. But depends on amount of water retained in the soil for the plant growth.



REGRESSION LINE
850
800
750
700
650
600
550
Groundnut Yield (tonnes/Ha)
Y = 666·743+1·008X
0
10
20
30
40
50
60
70
80
90
(LRS)
Series1

Fig 5·6

CHAPTER SIX

SUMMARY, RECOMMENDATIONS AND CONCLUSION

6.1 SUMMARY

So far, it's being observed and also tested, that rainfall amount is by far not the only determinant factor of plant growth, development and yield but rather length of rainy season (LRS) plays a significant role in crop production, especially under the rainfed agriculture in the semi arid zone of Nigeria. Where Kano again is located.

6.2 RECOMMENDATION

With the above findings, it is necessary to establish the need for a lot of planning in agriculture in the face of climatic events. For better groundnut yields in Kano, it is essentially important to improve on the following:

(i) The nutrient contents of the soil and protect the crop from attack from diseases, as well as improve on irrigation schemes.

(ii) As regard to climatic condition, it is usually profitable to introduce variety short growing season crops and substituted for the local variety types. So as to enhance greater crop yields.

(iii) Meteorological stations in the various localities are also useful for the prediction of length of rainy season which always affects the cultivation of groundnut.

(iv) Credit and incentive facilities should be provided in the region, in order to help the farmers with capital for more investment on the farm.

(v) (a) Extension of basic infrastructural amenities should be made available in the farming area.

(b) Proper education of the farmers on the effect of climate to agricultural and environment through extension services should be more encouraged.

(vi) Any planning programme towards the agricultural development should involve the farmers themselves. It must also take into consideration the socio-economic and cultural background of the people to be planned for.

If these recommendations are properly implemented, the abundant groundnut yields will be a proper instrument for agricultural development in Kano Region.

6.3 SUGGESTION FOR FURTHER RESEARCH

Although, many studies have been carried out on the performance evaluation of climatic variables on agricultural development programme in the country, some of them were however, not very exhaustive, thereby leaving room for future researchers.

As regard to this study, it is discovered that farmers use stimulant to make them work very hard for a longer period on the farms. A research into the cause, degree, speed, types of stimulant and finally, the consequences to the agricultural and socio-economic advancement may be a source of useful information.

It is envisaged that further research on this aspect could continue as more relevant and reliable data is available.

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APPENDIX 1

Year	Total R/F	($\bar{x}$) Mean	Std. Deviation	$\frac{x - \bar{x}}{\sigma(C.I.)}$	Deviation from the mean
93	834.4	69.5	269.9	-0.79	-212.9
94	789.5	65.8		-0.96	-257.8
95	688.8	57.4	269.9	-1.33	-358.5
96	853.0	71.1		-0.72	-194.3
97	1289.3	107.4		0.89	+242
98	1398.5	116.5	269.9	1.30	+351.2
99	138.7	115.5		1.25	338.4
2000	1139.0	94.9		0.34	91.7
	8378.2				

Mean = 1047.3

APPENDIX 2

Year	Area/Ha	Prod.(Tons)	Yield(Kg/Ha)	Ann.RR(mm)	Rainday
1993	198.302	148,727	750.00	834.4	44
1994	208,675	136,056	652.00	789.5	57
1995	190,675	143,006	750.00	688.8	50
1996	225,760	167,062	740.00	853.0	42
1997	240,013	192,811	800.00	1289.3	102
1998	242,439	184,329	760.31	1398.5	88
1999	135,234	93,076	688.26	1385.7	61
2000	236,651	166,381	703.00	1139.0	63

APPENDIX 3

REGRESSION BETWEEN RAINFALL AND GROUNDNUT YIELD

Year	Y Yield	$(y-y)^2$	X Rainfall	$(x-x)^2$	(x-x)	(y-y)	(x-x) (y-y)
93	750	375.391	834.4	45315.766	-212.875	19.375	-4124.453
94	652	6181.891	789.5	66447.951	-257.775	-78.625	20267.559
95	750	375.391	688.8	128504.326	-358.475	19.375	-6945.453
96	740	87.891	853.0	37742.776	-194.275	9.375	-1821.328
97	800	4812.891	1289.3	58576.101	242.025	69.375	16790.484
98	761	922641	1398.5	123359.001	351.225	30.375	10668.459
99	689	1732.641	1385.7	114531.481	338.425	-41.625	-14086.941
00	703	763.141	1139.0	8413.476	91.725	-27.625	-2533903
	5845	15251.878	8378.200	582890.878			18214.424

$\overline{Y} = 730.625. \quad \overline{X} = 1047.275$

$a = \overline{y} - b\overline{x}$

$a = 730.625 - 0.031(1047.275)$

$= 730.625 - 32.466$

$= 698.159$

$y = a + bx$

$= 698.159 + 0.031x$

$$R^2 = \frac{\Sigma(x-x)(y-y)}{\sqrt{\Sigma(x-x)^2\,\Sigma(y-y)^2}}$$

$$= \frac{18214.424}{\sqrt{(15251.878)(582890.878)}} = \frac{18214.424}{94287.754} = 0.193 = 19.3\%$$

APPENDIX 4

Year	Y Yield	X Rainday	Y – Ȳ	$(Y-Y)^2$	X – X̄	$(X-\bar{X})^2$	(X-X̄) (Y-Ȳ)
93	750	44	19.375	375.341	-19.375	375.391	-375.391
94	652	57	-78625	6181.891	-6.375	40.641	501.234
95	750	56	19.375	375.391	-13.375	179.891	-259.141
96	740	42	9.375	87.891	-21.375	456.891	-200391
97	800	102	69.375	4812.891	38.625	1491.891	2679.609
98	761	88	30.375	922.641	24.625	606.391	747.984
99	689	61	-41.625	1732.641	-2.375	5.641	98.859
00	703	63	-27.625	763.141	0.375	0.141	-10.359
	5845	507		15251.878		3155.878	3182.404

Ȳ = 730.625. X = 63.375

c — —

a = 730.625 – 1.008(63.375)

= 666.743

= a + bx

= 666.743 + 1.008x

$$R^2 = \frac{\Sigma(x-x)(y-y)}{\sqrt{\Sigma(x-x)^2\,\Sigma(y-y)^2}}$$

$$= \frac{3182.404}{\sqrt{(3155.878)(15251.878)}} = \frac{3182.404}{6937.800} = 0.459 = \sqrt{0.459} = 0.6773 = 67.73\%$$