UNIVERSITY OF NIGERIA, NSUKKA
FACULTY OF AGRICULTURE
DEPARTMENT OF SOIL SCIENCE

TOPIC
A QUASI PROJECT ON COMPARATIVE ANALYSIS OF CLIMATE CHANGE ON CROP AND SOIL WRITTEN IN PARTIAL

FULFILMENT OF THE REQUIREMENT FOR THE COURSE FARM WORK PROJECT AND REPORT WRITING (AG 402).

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REG. NO: 2002/107706

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SEPTEMBER, 2007
COMPARATIVE ANALYSIS OF CLIMATE CHANGE ON CROPS AND SOILS
DEDICATION

To all Christians especially, Christ Ambassador students outreach (Casor) UNN.
ABSTRACT

The primary objective of this study is to examine the effects of climatic changes on crops and soil and compare these effects on different climates with a view to determine the best management to assure the safety of the crop and still ensure optimum production.

There are many factors that affect climate around the world. They are:

- Distance from the sea,
- Ocean current currents,
- Direction of prevailing wind
- Relief
- Proximity to the equator
- El Nino phenomenon and
- Recently human activity.

Changes in any of these can bring about changes in climate. And changes in climate is manifested chiefly in the amount of solar radiation received on the surface of the earth, the temperature of the place and the precipitation amount received or can be received in the region.

These differences in temperature, insolation and precipitation will then influence the nature of vegetation and soil type in that particular region.

In this study two localities with different climate characterized by differences in relief, differences in insolation and temperature and probably
precipitation is chosen. The resultant effect is that there are differences in crop performances and differences in soil type as they occur in different attitudes.

In this study, in evaluating the performance of crops, twelve cassava (improved and local) genotypes were grown at two locations in NIGERIA (Ibadan and Jos). Leaf area development and dry matter partitioning were studied from 1994 to 1996. Destructive samplings for growth analysis were done at 3, 6, 9 and 12 months after planting. Genotype, environment and Genotype x environment effects were significant for leaf area index (LAI), total dry matter and total dry matter tuberous root weight.

The results indicate that dry matter partitioning of cassava to the root and leaves are dependent upon solar radiation and temperature in higher attitudes. The data may be useful for validation of models of cassava growth being designed for higher attitudes (ie hence changes in solar radiation and temperature).

For soil, the climatic condition that has been existing over the time resulted to changes in soil texture, pH, organic matter (g/kg), Exchange Ca (cmol/1kg), Exchange Mg (cmol/1kg), Exchange K (cmol/1kg) and NPK levels.
<table>
<thead>
<tr>
<th>TABLE OF CONTENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title page - - - - - - - i</td>
</tr>
<tr>
<td>Dedication - - - - - - - ii</td>
</tr>
<tr>
<td>Acknowledgement - - - - - - iii</td>
</tr>
<tr>
<td>Abstract - - - - - - - iv</td>
</tr>
<tr>
<td>Table of contents - - - - -</td>
</tr>
<tr>
<td>CHAPTER ONE: INTRODUCTION</td>
</tr>
<tr>
<td>1.1 Background of information on climate changes - - - - 1</td>
</tr>
<tr>
<td>1.2 Objectives of study - - - - - 2</td>
</tr>
<tr>
<td>1.3 Factors affecting climate in the world - - - 3</td>
</tr>
<tr>
<td>1.3.1 Distance from the sea (continentality) - - 3</td>
</tr>
<tr>
<td>1.3.2 Ocean current - - - - - 4</td>
</tr>
<tr>
<td>1.3.3 Direction of prevailing wind - - - - - 4</td>
</tr>
<tr>
<td>1.3.4 Relief - - - - - 4</td>
</tr>
<tr>
<td>1.3.5 Proximity to the equator - - - 4</td>
</tr>
<tr>
<td>1.3.6 El Nino - - - - - 5</td>
</tr>
<tr>
<td>1.3.7 Human influence (Human activity) - - - - 5</td>
</tr>
<tr>
<td>1.4 The possible effect of climate change - - - - 6</td>
</tr>
<tr>
<td>1.4.1 A rise in global sea level - - - - 6</td>
</tr>
<tr>
<td>1.4.2 A change in vegetation zone - - - - - 7</td>
</tr>
<tr>
<td>1.4.3 An increase in disease level - - - - - 8</td>
</tr>
<tr>
<td>1.4.4 A change in ecosystem - - - - - 8</td>
</tr>
<tr>
<td>1.4.5 A change in soil properties - - - - - 8</td>
</tr>
<tr>
<td>1.5 Climate factors in their effect in crop production - - - 8</td>
</tr>
<tr>
<td>1.5.1 Temperature - - - - - - 9</td>
</tr>
<tr>
<td>1.5.2 Solar radiation - - - - - - 12</td>
</tr>
<tr>
<td>1.5.3 Precipitation - - - - - - 15</td>
</tr>
</tbody>
</table>
# CHAPTER TWO

2.1 Review on crop to difference in climate  --  --  --  --  19
2.2 Review on variation in soil with respect in changes in climate  --  22

# CHAPTER THREE

3.1 Material and methods  --  --  --  --  --  --  24
3.2 Plant materials and experimental design  --  --  --  25
3.3 Data collection and analysis  --  --  --  26
3.4 Result  --  --  --  --  --  --  27
3.5 Presentation and analysis of data  --  --  --  --  29

# CHAPTER FOUR

Discussion in relation to the study

4.1 In crops  --  --  --  --  --  --  35
4.2 In soil  --  --  --  --  --  38
4.3 Global discussion on climate change  --  --  --  39

# CHAPTER FIVE

5.1 Conclusion  --  --  --  --  --  41
5.2 recommendation  --  --  --  --  --  44
CHAPTER ONE:
INTRODUCTION

1.1 BACKGROUND INFORMATION ON CLIMATIC CHANGES

Climatic is the average weather condition of a place over a long period of time of about 30 to 35 years.

It is the nature of a place as a result of the interaction among many factors such as the soil, vegetation, solar radiation, precipitation, relief, temperature, relative humidity etc.

Thus we can have different types of climates according to the Köppen classification of climates.

There are also subdivisions or climatic zones which were done on the basis of the inclination of the sun at different latitudes. The main climatic types of the world are: Tropical climates, Dry and Semiarid climates, mesothermal climate, micro thermal climates and Highland climates (cold climate due to elevation). They are designated by the alphabets: A, B, C, D, E, and H respectively (Köppen climate classification system).

However, a change in any of the factors that affect the global climate can result in a change from one climate to another.
Different climates have different features of the earth crust, like vegetation, soils, air temperature, precipitation and its distribution etc.

For instance there are specific crops and plants that are peculiar to different climates such plants would have features that will make them to survive in such climates. A change in climate will result to succession of the ecosystem until a new and stable ecosystem is established.

For soil different climates will have different soils also. Differences in soil can be noticed in their texture, structure, consistency, pH, colour, soil organic matter and other physical, chemical and biological characteristics.

1.2 OBJECTIVE OF STUDY

The objective of this study is not really to study The performances of cassava in two different localities, but to show that climates or that places of different climates or that climatic changes can affect The behavior of soil, hence affect The performances of crop.

In this study, cassava is just used as a case study representing what may likely happen to any crop especially tuberous crops.

SPECIFIC OBJECTIVES

To study:

1. The factors can affect The stability of climates and climatic factors.

2. Effects of climate changes on crops and soils.
3. Ways of making the soil resistive to climate changes.

4. To empower the people and you to join to save our world.

1.3 FACTORS AFFECTING CLIMATES IN THE WORLD.

There are many different factors that affect climate around the world. The most important of them are:

- Distance from the sea
- Ocean currents
- Direction of prevailing wind
- Relief
- Proximity to the Equator
- The El Nino phenomenon and Human Activities

1.3.1 DISTANCE FROM THE SEA (CONTINENTALLY)

The sea affects climatic of a place. Coastal areas are cooler and wetter than inland areas. Clouds form when air from inland are as meet cool air from the sea.

The centre of continent are subjected to a large range of temperatures. In the summer, temperatures can be very hot and dry as moisture from the sea evaporates before it reaches the centre of the continent.
1.3.2 OCEAN CURRENT

Ocean currents can increase or reduce temperatures. For instance, the main ocean current that affects the UK is the Gulf Stream. This Gulf Stream keeps the west coast of Europe free from ice in the winter and, in the summer, warmer than other places of a similar latitude.

1.3.3 DIRECTION OF PREVAILING WINDS

Winds that blow from the Sea often bring rain to the coast and dry weather to inland areas. Winds that blow to Britain from warm inland areas such as Africa will be warm and dry. Winds that blow to Britain from inland such as The Netherlands will be cool and dry in winter. Britain's prevailing winds come from a southwesterly direction over the Atlantic. The winds are cool in the summer and mild in the winter.

1.3.4 RELIEF

Climate can be affected by mountains. Mountains recover more rainfall than low-lying areas because the temperature on top of mountains is lower than the temperature at sea level. The higher the place is above sea level the colder it will be. This happens because as altitude increases, air becomes thinner and is less able to absorb and retain heat.

1.3.5 PROXIMITY TO THE EQUATOR

The proximity to the equator affects the climate of a place. The equator receives the most sunlight than anywhere else on earth. This is...
due to its position in relation to the sun. The equator is hotter of all parts
of the earth because the sun has less area to heat. It is cooler at the
north and south poles as the sun has more area to heat up. It is cooler a
the heat is spread over a wider area.

1.3.6 El Nino

El Nino which affect wind and rainfall pattern, has been known for
drought and floods in countries around the pacific Run. El Nino refers to
the irregular warming of surface water in the pacific. The warmer water
pumps energy and moisture into the atmosphere, altering global wind and
rainfall pattern. The phenomenon has cause tornades in Florida, Snog in
Indonesia, and forest fires in Brazil.

1.3.7. Human influence (Human activity)

The influence of humans on the climate cannot be neglected. We
have been affecting the climate since we appeared on this earth millions of
year ago. In those times, the effect on the climate was small. Trees were
cut down to provide wood for fires. The take in carbon dioxide and produce
oxygen. A reduction in trees will therefore have increases amount of
carbon dioxide in the atmosphere.

The industrial revolution, starting at the end of 19th century, has
had a huge effect on climate. The invention of the motor engine and the
increased burning of fossil fuels have increased the amount of
carbon dioxide in the atmosphere. The number of trees being cut down has also increased meaning that the extra carbon dioxide produced cannot be changed into oxygen.

1.4. The Possible effects of climate change

Globally, there are some uncertainties as to what effects a change in climate might have on the earth. To predict what might happen, we first need to start by understanding how the increase in gasses such as carbon dioxide and methane effect our climate. The carbon dioxide and methane form barrier for sunlight. The sun rays hit the earth, but when they are reflected back out into the space, they are trapped in the atmospheres. The sun rays cannot escape from the earth's atmosphere, and the earth heats up. This is "green house effect".

This green house effect may likely cause:

A rise in global sea levels
A change in vegetation zones
An increase in disease levels
A change in ecosystem

1.4.1 A rise in global sea levels

2.5°C increase in temperature will have a detrimental effect on the earth. One impact of climate change would be a rise global seal levels. If the
heat from the sun cannot escape through the earth's atmospheres then
the ice at the north and south poles could melt. This could have a huge
effect on the low lying areas of the world.

In 1998, 46 million people live in area at risk of flooding (BBC News,
1997). This amount could increase if sea levels rose. Scientists estimate
that a sea rise of only 50 centimeters would increase the number of people
at risk to 92 million. The sea level rise of 1 meter would put 118 million
people at risk. Scientists believe that there will be a sea level rise of 50
centimeters over the next 40 to 100 yrs (BBC News, 1997).

1.4.2 A change in vegetative zone

A change in climate would have an effect on the world's vegetation
zones. We would see a change in the boundaries between grassland,
forest and shrub land. This change in vegetation zone could cause famine
in arid areas such as Africa that depends on certain type of crop. The
change in vegetation would cause mass movement of people away from
arid regions.
1.4.3 An increase in disease levels

The range of pests could also change if the vegetation changes. This could bring about an increase in disease levels. Climate changes disturb the relationship between the host environment and the pathogens.

1.4.4 A change in ecosystems

Ecosystems could be affected by a change in temperature. It has been predicted that an increase in temperature would affect species composition. Scientists also believe that up to two thirds of the world’s forests would undergo major changes. Scientists believe that deserts would become hotter, and desertification would extend and become harder to reverse.

1.4.5 A change in soil properties

The properties of the soil could also change if the vegetation changes. This could affect the organic matter content of the soil, hence soil organic carbon, pH, texture, structure microorganism.

1.5 Climate factors and their effect on crop production
1.5.1 Temperature

Plants can grow only within certain limits of temperature. For each species and variety there are not only optimal temperature limits, but also optimum temperatures or different growth stages and functions, as well as lower and upper lethal limits.

There are certain biochemical processes preceding and following the reduction of carbohydrate, which are affected mainly by temperature (Gastra, 1963). As long as light limiting, temperature has little affected on the rate of photosynthesis. However, when light is not limiting, as is generally the case in agro regions, the biochemical processes associated with photosynthesis become the limiting factor, so that the effect of favourable temperature on the rate of photosynthesis is increased.

In general, high temperatures accelerated growth processes. Rarely are highly temperatures per se the direct cause of death of plants, provided the water supply is adequate.

However, beyond a certain limit, which depends on the crop, the stage of development, and the physiological process involved, high temperatures may have detrimental effect on crop production.

The photosynthesis process appears to become heat-inactivated at excessively high temperatures which, however, do not inhibit respiration,
so that apparent photosynthesis decline rapidly under these conditions (Moss et al., 1961).

Retardation of growth and difficulties in fertilization, even in heat loving crops such as maize and sorghum, occur at temperatures that are often well below the lethal limit. The harmful effects of excessive temperature are usually aggravated by lack of available moisture. Hot, dry winds will further increase the damage.

Change in climate with regards to temperature had occurred at temperatures had occurred with global temperature risen by 0.6°C in the last 130 yrs. This rise in global temperature lead to huge impacts on a wide range of climate related factors.

Levels of carbon dioxide, methane and nitrous oxide gases are rising, mainly as a result of human activities carbon dioxide is being dumped in the atmospheres at an alarming rate. Since the industrial revolution, humans, have been pumping out huge quantities of carbon dioxide, raising carbondioxide concentration by 30%. The burning of fossil fuels is partly responsible for this huge increase, these are the chief culprit of global warming as a result of global increase in temperature. For soil, changes in temperature will result to a lot of changes in it.

Changes in temperature will determine the rate of decomposition of organic matter in it.
For instant increase in temperature will result to increase in the decomposition of organic matter and increase in soil organic carbon. Increase in temperature also favours nitrification and ammonification. In other words increase in temperature increase in temperature increases the activities of microorganisms in the soil the optimum temperature fixation is 25°C to 30°C and the process cases entirely at a temperature of 40°C.

Again in horizon differentiation, different types soil profiles will develop under the same precipitation. In cold zone, where permanently frozen zones exist in the soil, very little percolation and leaching is observed, even in a subarctic climates, where severe winter persist, conditions are in favourable for rapid percolation of water through the profile organic matter accumulate on the surface and does entirely decay. The result is spongy layer which protect the under lying mineral and slows down weathering. On the northerly section of the hundred temperate zone, the soils are highly leached and the lower portion of the A horizon in sometimes ash grey and is generally higher in colour than the upper portion.

As one moves to a more arid climate zone, the tree give way to grass and the A horizon is dark and highly in humans to considerable depth. In semi arid and arid area where the temperature often soars in summer, evaporation is rapids, and soil formation is slow. These soils are not
leached of soluble salts. The B-horizon is light in colour and contains veins and concretions of carbonates of calcium of calcium and magnesium. In humid regions, the B-horizon contains no carbonate of lime, and the colour is usually brown or reddish brown. The compactness of the B-horizon increase until a certain is reached and then begins to decrease.

So the natural phenomenon on earth will also be altered both in crops and in soils.

1.5.2 Solar Radiation

Solar energy provides two essential need of plants.

(a) Light required for photosynthesis and for many other functions of the plant including seed germination, leaf expansion, growth of stem and shoot, flowering, fruiting and even dormancy (Stoughton, 1955) and

(b) Thermal conditions required for the normal physiological functions of the plant. There are characteristic of light which affect plant growth and development, they are duration, intensity and quality (wave length).

1.) The duration of light is of major importance to the growth and development of plants. The effect of photoperiodism which is the relative length of daily light and dark periods on the vegetation and
reproductive stages of development is well known-plants have been
classified on the basis of their photoperiodic requirements for floral
initiation into long-day (usually more than 14hrs), short-day ten then
10hrs), day neutral, and intermediate (requiring 12-1hrs of light daily to
initiate flowering) actually, the duration of the night or of complete
darkness is often more importance than the length of daylight.

Length of day largely a function of latitude. As the time it the
equinoxes the length of day is practically the same at all latitudes. At
the beginning of summer, day-length between attitudes 10 and 30° is
13-14hrs; between 30 and 50°, in the middle latitude, it is 14-16 ½ ;
at 60° it is approximately 19 hours.

ii) Light intensity and crop yield

Light is the most important factor influencing the photosynthesis activity of
a crop, as it is the energy source for the whole process. Light utilization by
the crop has two limitations: the maximum quantum yield at low
intensities, and light saturation at high intensities (Loomis et al., 1967)

(a) Minimum light requirements

It has generally been found that at low light intensities, for the
individual leaf, there is a linear relations between light intensities and rate
of photosynthesis. Theoretically, photosynthesis is possible at any light
intensity, however low; practically, respiration dominates when light
intensity is too low. Net assimilation will be zero at a light intensity of 500 candles, and a minimum of 500 to 1000 food candles is required for effective rate of photosynthesis, at which the photosynthetic gas exchange is greater than the respiratory gas exchange (Blackman and Black, 1959).

(b) Light saturation

with increased light intensity, photosynthesis of the single obeys the law of diminishing returns. Extremely high light intensities have an inhibitory effect on photosynthesis. This phenomenon is called solarization (Wang, 1963). In most crop plant, light saturation for single leaves is reached at a light intensity of 0.2 cal/cm² min, which is a typical of the light intensity on an overcast day with the sun at its zenith.

Solar radiation can therefore affect plant productivity in two different ways simultaneously: directly by its intensity, and indirectly by its effect on leaf temperature.

(iii) Light quality

Many factors, such as the amount and kinds of cloud cover fog, air pollution, and the colour of the foliage interrupting light, influence the quality of the incidence light.

Radiation up to 0.25 micron (ultraviolet spectrum is harmful to most plants) from 0.30 to 0.55 micron it has a photoperiodic effect, from
0.040 to 0.69 micron it is most effective in photosynthesis above 0.74 micron (the infra-red spectrum),

However light has practically no effect photosynthesis, its main effect is thermal, and respiration is encouraged.

In the soil, there are lot of reaction that is facilitated or inhibited by light. The later been in the formation of nitrates which is hundred by light.

On the other hand light exerts a thermal effect on the soil and therefore promoted respiration. This favours the decomposition of organic matter and the aerobes in the soils consequently crumbs formation is favoured and good structure and aggregate stability in obtained.

There changes in the amount of solar radiation received on the earth's surface as a result of changes in climates may through green house effect can affect both crops and vegetable.

1.5.3 Precipitation

Precipitation is one of the most important climate factor that can cause changes in climate and bring differences both in plants and soils.

There are many forms of precipitation each affecting both the crops and soil in their own way. They include rain, snow, dew,

Precipitation occurs mostly as rain worldwide through it depends on the season. Precipitation affect crop in a number of ways.
As a matter of fact the classes of vegetation ranges from forest trees, grasses, and desert shrubs. Trees occupy the humid areas, short shrubs are in the arid lands and native grass occupies the intermediate zone. The variation in vegetation are simply as a result of variation and different distributions of precipitations.

The yield and quality produce of crops are also determined by precipitation. Different development stages of crops have different water requirements which if not met may result to crop failure.

So changes in climate if exemplified by precipitation will in no way be “friendly” to the crops.

For soil, flooding, desertification and drought are sings of changes in climate by precipitation. When this changes occur the soil will be drastically affected.

In flooding, the pores of the soils are all foiled up, this will deny the soil aerobes of the oxygen necessary for their survival. The soil will also be highly leached and eroded, reduction reaction will take place owing to the absence of the soil.

Precipitation when it is in reasonable amount (not up to the amount of flooding) will percolate downward. This takes with it soluble materials from upper to lower zones. Solids material, mostly colloidal is also moved
downward and deposited below the surface to form 13 horizons. Thus the horizons of the profile become differentiated.

Also, evaporation and transpiration from the surface and capillary movement of soil moisture may be very influential in affecting the profile formed. Runoff and the resulting removal of surface soil by erosion affect the abnormal soil characteristics.

In analyzing precipitating as a factor of soil formation one must other forms of water like snow, frost, hail, etc.

For desertification in relation to precipitating, it occurs as a result of the extension of desert condition into formerly more productive areas or degradation of dryland environments to less productive stages. It occurs with a condensation of dryness showing the deficiency of rain in the area.

Drought is itself means simply rainfall deficit, leading to a protracted departures from normal water availability. In contest of this study, it expedient to at least define agricultural drought, which is a condition when the water supplies used directly for agriculture are scarce, and there is consistently high. High soil moisture deficit over the growing season.

There show that changes in precipitation as result if climatic changes will affect soil and crops in one way or the other.
Other climate factors change as the climate does and influence both crops and soils in their own way.
2.1 REVIEW ON CROP RESPONSES TO DIFFERENCE IN CLIMATE

LITERATURE REVIEW: IN CLIMATE:

Like I said in the objective, the purpose of this work or study is not to test the yield or performance of cassava in different location, but to examine the performance of crops which is exemplified by cassava and to also examine the differences in soil they are affect by changes in climate though the experiment was no done by me but I try to mark he determination that occur in crops & soils.

In this study production of dry matter or dry matter practically and leaf area index are examined.

The difference were based on differences in the amount of solar radiation receives, and differences in the favourable environmental condition which include normal and optimum amount of precipitation, temperature and any other environmental factor that may affect crop performance.

A proportion of the organic substances produced by photosynthesis will be needed for the vital processes of plant, and consumed by respiration, by the plant itself the total yield of dry matter will therefore be the total amount of dry matter produced less the photosynthesis used.
for respiration. In this study both the production of dry matter and the proportion used in respiration is a function of solar radiation and other environmental condition. Finally the manner in which the net dry matter produced is distributed among the different parts of will determine the magnitude of economic yield. On the other hand, the leaves of a plant are normally their main organ of photosynthesis, and total area of leaves of land surface called leaf area index (LAI) has therefore been proposed by Wattson (1947) as the best measure of the capacity of a crop for producing dry matter, this he calls its productive capital.

Differences in optimum LAI depend on the light intensity (being higher under high light intensity) and on the manner in which light is been intercepted by the crop canopy. The light received by a crop with a large optimal LAI is spread over more leaf surface than is the case with a crop having a low value for optimal LAI; this result in a lower intensity of illumination for most leaves, at which photosynthetic efficiency is higher than with more intense illumination (Wattson 1967).

Now specifically in cassava, it is grown in the area between latitude 30°N and 30°S (Cock 1985; Nweke 1994).

It tolerates cooler climates, but a critical point exist between a daily average temperature of 16°C and 20°C below which the cassava plants do not grow normally and the root yields are less (Irukura, Cock and
Kawano, 1979; Cock 1985). Reviews on cassava physiology (Hunt, wholly and Cock, 1977; Cock 1985; Ekanayake, Osiru and Porto 1997) highlighted information available on effects of environment, mainly climate variables, on cassava growth and development. Most work on cassava responses to environment has been conducted at lower altitudes of the tropic (Aunt et al, 1993). There is a considerable interest in the expansion of the crops into the higher altitudes but information to such environments. Leaf area development of cassava is influenced by several environmental factors such as day length, temperature, rainfall, relative humidity, and solar radiation (Hunt et al. 1977; Keating, Evenson and Fukai 1982a, b; Cock 1985; Manrique, 1990). The effects of each of these factors on cassava growth and yield have been studied extensively at lower altitudes (800) both in the tropics and subtropics (Keating et al., 1982a, b; Fukai and Hammer 1987).

However, little information is available on the effects of low temperature and low solar radiation on leaf area development, dry matter production and dry matter partitioning of various cassava clones. Other reviewed to buttress changes in the behaviour of plants in response to changes of the climates.

With a daily climate data for each of seven wheat growing regions centred around Goondiwindi, Miles, Roma, St George, Emerald, Biloela and
Dalby. Subsequently the effects of frost, and the influence of soil nutrient status and fertilizer application on grain yield and protein content were incorporated in the model. It was tested by 200 farmers before its commercial release. Time of planting can have a large effect on wheat yields in the eastern Darling Downs. The highest crop yields were obtained with the earliest date of sowing but this was also associated with a very high risk of first at anthesis. Sowing wheat earthy in June is recommended for the eastern Darling Downs because the first risk during anthesis is acceptable. The reduction in yield for late planting is due to the increase temperature an pan-evaporation around anthesis compared with early sowing.

Similar analysis of the interaction between planting time, first risk and variety selection have been popular farmers using the wheatman model. Survey result have indicated that after running the model 30% of farmers changes their view on planning time selecting of varieties.

2.2 Review on variations in soil with respect to changes in climate

There is a close relationship between vegetation, soil and climate such that changes in climate result to changes in soil properties. Soil can be from one soil type o another depending on what has happened to the soil.
Major variation in soil over a large geographic areas can usually be attributed to changes in climate. Climates affect the formation of soil both directly and indirectly.

MacDonald and Low (1994) argued that the yield obtained and quality of crops depend largely on the type of soil and the amount of nutrients available in the soil. But the type of soil and nutrient amounts and availability in turn depend on the climate.

So climate changes can transform a production soil into an unproductive soil and unproductive one. The basic danger facing agriculture and food security in many developing countries today is a steady loss of plant biomass, organic matter, humus, microbial activities, food and other crop yields (FAO; 1990) these problems can also be caused by climatic changes.
CHAPTER THREE

3.1 MATERIAL AND METHOD

Field experiment were conducted at Jos Plateau Nigeria (mid-altitude zone) and Ibadan (forest-Savanna transition zone). Also in Nigeria, Two experiments were conducted during 1994/95 and 1995/96 crop season at International Institute of tropical agriculture (IITA), Ibadan, and at the National Root Crop Research Institute Field Stations (Vorn and Heipang) on the Jos Plateau.

In 1994/1995 crop season, cassava stem cutting were planted on May 5, 1995 and May 13, 1994 at Ibadan and Jos Plateau, respectively, while in 1995/1996 crop season, cassava stem cuttings were planted on May 10, 1995 and May 20 1995 respectively, at Ibadan and Jos Plateau.

The Jos Plateau an Ibadan represent contrasting agro ecological zones: Ibadan at 210 metres above sea level (mase) (4% 46°N, 2° 34°E) in the low land humid forest most-savanna transition zone has mean annual minimum and mean temperatures of 22°C and 27°C, respectively, and mean annual solar radiation of 16MJ·m^-2·day^-1) and Jos plateau the mid-altitude wood land savanna zone. On the Jos plateau, vom at 1280 masl (9°55' N, 9° 53°E) has mean annual minimum and mean temperatures of
16°c and 20°c, respectively, and mean annual solar radiation of 15 mg-1 m² – day-1, while Ihepar at 1290 masl (9° 38' N, 8° 9' E) has mean annual minimum and mean annual temperatures of 15.6°c and 20°c respectively, and mean annual solar radiation of 7.4 mJ-1 m² day-1. Characteristics of different sites are presented in Table 1. The soil at Ibadan is classified as Oxic palustalf, Alagba soil services (Green land, 1981) while in Jos plateau the soil is ferruginous tropical soils (Kowal and Knahe, 1972).

3.2 Plant material and experimental design

Twelve cassava genotypes including six improved 11TA genotypes (Tms 30001, Tms 91934, Tms 4 (2) 1425, Tms 30572, Tms 50395, Tms 30555; four landraces commonly grown in southwestern Nigeria (Tme 1, Tme.2, Isunikiyan and oko-iyato), and two landraces grown in mid-altitudes (daudawa and Danwaru) were used. Cassava stem cuttings of 0.20m length were obtained from 12-month old mother plants, at the middle part of the stem, and were immersed in 0.05% of Benlate fungicide (ai= methyl 1- (butyl carbamate) solution. The experiments were set up in each location in a completely randomized block design with three replications. Each plot had 6 rows, 10m long and spacing of stakes planted singly was 1m between rows and 0.0m within row., each plot contained 72 plants.
Plants were grown rainfed under native soil fertility conditions. The fields were kept free of need by regular hand-weeding.

3.3 Data collection and analysis

Harvesting was done sequentially at 3, 6, 9 and 12 months after planting (MAP). At each sampling, four plants were carefully removed from the center rows in each plot. The plants were separated into fibrous roots (FR), tuberous roots (TR), stems (ST), leaves including the dead ones (LV), petioles (PT) and rootstock (mother stake) (RS).

The fresh weight of the samples were taken and the sample were then oven dried for 48 hours at 80°C prior to dry weight determinations. Leaf area was measured on a sub sample of green leaves using a leaf area meter (LI- 3100, LI- cor Lincoln, Nebraska, USA). Dry matter portioning ratios were calculated as LV/ TOTDWT, (ST+FR+TR+ST+LV+PT+RS) / TOTDWT, TR/TOTDWT(ST+LV+PT+RS) /TOTDWT where TOTDWT = Total dry weight. Data for leaf area, dry weight, and portioning ratios at each sampling were analyzed as a separate experiment for each location. Analysis of variance was done using statistical analytical system (SAS, 1996) programme and while mean differences were detected using the least significant difference test procedure. Seasonal effects on dry matter partitioning were quantified using average values of mean monthly air temperature and mean monthly solar radiation, respectively.
Variation in dry matter partitioning at a given time of the growing season was assumed to be controlled by both the plant age and by the environment prevailing at that time. The procedure STEWISE Regression using statistical analytical system (SAS, 1996) programme was used for model analysis to relates dry matter partitioning ratios with plant ages, temperature and solar radiation.

3.4 Results

Results of weather data monitored during the crop growth periods revealed that both air temperature and solar radiation differed between two locations (Table 1). Genotype, environment and Genotype x Environment effects were significant for leaf area index (LAI) total dry matter and total dry tuberous root weight (Table 2). In all the samplings, there were no significant differences (p<0.05) between the 1994/1995 and 1995/1996 planting seasons for LAI (Fig1). Although, LAI produced in 1994/1995 season was larger when compared to 1995/1996 planting season at both locations and years. There were significant differences among the four environments tested (Ibadan, 1994, and 1995, Jos 1994 and 1995) for LAI. Ibadan 1994/1995 season had the highest overall value of 3.6 for LAI at 6 months after planting whereas in Jos plateau, the highest value of 2.0 LAI was recorded during the 1995/96 planting season at the pattern of LAI showed that maximum LAI was obtained at 6 MAP in
the high-temperature size (Ibadan) thereafter a decline was observed
upto 9 MAP and later increased upto 12MAP. At the lower temperature
regime of Jos plateau, LAI continuously increased with plant age until 12
MAP (Fig1). Genotype differences were observed for both within and
across locations for leaf area index (Tables2).

Analysis of the data revealed significant differences (p<0.05) in total
dry matter production among the four environments through the sampling
periods (Fig 1). Dry biomass accumulation at Jos plateau was reduced
when compared to Ibadan at all ages (3,6,9and 12 MAP). The dry biomass
production followed a similar trend in the four environments (Ibadan
1994and 1995, Jos 1994 and 1995). There were continuous increase in dry
biomass with plant age as expected in all the environments tested (Fig1)
there were significant differences in dry tuberous root weight per hectare
among the four environments throughout the plant growth period (Fig1).
At 3MAP, Ibadan, 1994 had the highest overall tuberous root dry weight of
0.7 mg ha⁻¹. These were continuous increase in the total dry tuberous root
weight with plant age in all the environments tested (Fig1). Genotypic
difference were observed for both within and across locations for leaf area
index, total dry tuberous root weight and total dry matter (Tables3). Tms
30572, TME 1 and TMs 91934 performed better than the other genotypes
across the tested locations.
3.5 Presentation and Analysis of Data

Table 1. characteristics of the different sites and season used location Ibadan Jos

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Max-temp (°C)</td>
<td>31.8</td>
<td>31.5</td>
<td>22.9</td>
<td>23.9</td>
</tr>
<tr>
<td>Min temp (°C)</td>
<td>21.2</td>
<td>22.3</td>
<td>16.2</td>
<td>16.6</td>
</tr>
<tr>
<td>Mean temp (°C)</td>
<td>26.5</td>
<td>26.9</td>
<td>19.6</td>
<td>20.2</td>
</tr>
<tr>
<td>Mean rainfall</td>
<td>127.2</td>
<td>115.7</td>
<td>102.1</td>
<td>102.9</td>
</tr>
<tr>
<td>Mean solar radiation (\text{Mg m}^{-2}\ \text{day}^{-1})</td>
<td>15.5</td>
<td>15.0</td>
<td>15.1</td>
<td>7.4</td>
</tr>
<tr>
<td>Latitude</td>
<td>47°46'N</td>
<td>47°46'N</td>
<td>9°55'N</td>
<td>9°36'N</td>
</tr>
<tr>
<td>Longitude</td>
<td>22°34'E</td>
<td>22°34'E</td>
<td>9°53'E</td>
<td>8°51'E</td>
</tr>
<tr>
<td>Soil texture</td>
<td>Sandy loam</td>
<td>Loam sand</td>
<td>Clay loam</td>
<td>Sandy clay loam</td>
</tr>
<tr>
<td>Soil PH</td>
<td>6.0</td>
<td>5.6</td>
<td>5.1</td>
<td>5.0</td>
</tr>
<tr>
<td>N (g/kg)</td>
<td>0.17</td>
<td>0.13</td>
<td>0.14</td>
<td>0.17</td>
</tr>
<tr>
<td>P (g/kg)</td>
<td>0.6</td>
<td>0.5</td>
<td>0.3</td>
<td>0.5</td>
</tr>
<tr>
<td>Property</td>
<td>Value 1</td>
<td>Value 2</td>
<td>Value 3</td>
<td>Value 4</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>Organic matter</td>
<td>2.0</td>
<td>1.1</td>
<td>2.0</td>
<td>1.99</td>
</tr>
<tr>
<td>(g/kg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exchange</td>
<td>7.8</td>
<td>2.5</td>
<td>5.9</td>
<td>6.5</td>
</tr>
<tr>
<td>(ca, cmol/lkg)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Exchange Mg</td>
<td>0.6</td>
<td>0.5</td>
<td>1.8</td>
<td>13.5</td>
</tr>
<tr>
<td>(Cmol/kg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exchange K</td>
<td>0.6</td>
<td>0.3</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>(Cmol/kg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silt (%)</td>
<td>73</td>
<td>82</td>
<td>35</td>
<td>56</td>
</tr>
<tr>
<td>Clay (%)</td>
<td>17</td>
<td>9</td>
<td>40</td>
<td>30</td>
</tr>
</tbody>
</table>

A = Weather data from IITA meteorological unit
B = Weather data from Nigeria meteorological unit
At federal secretariat, Jos
Table 2: Mean squares for total dry tuberous root weight, total dry biomass, leaf area index and harvest index of 12 cassava clones grown at two locations. From 1994 to 1996.

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>d.f</th>
<th>Dry tuberous root weight (mg ha⁻¹)</th>
<th>Total dry matter (mg ha⁻¹)</th>
<th>Leaf area index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year (yr)</td>
<td>1</td>
<td>718**</td>
<td>2824**</td>
<td>26**</td>
</tr>
<tr>
<td>Location (col)</td>
<td>1</td>
<td>2748**</td>
<td>10814**</td>
<td>78**</td>
</tr>
<tr>
<td>Loc x yr</td>
<td>1</td>
<td>0.7 ns</td>
<td>39 ns</td>
<td>51 ns</td>
</tr>
<tr>
<td>Rep (loc x yer)</td>
<td>12</td>
<td>18 ns</td>
<td>61 **</td>
<td>2 ns</td>
</tr>
<tr>
<td>Clone</td>
<td>11</td>
<td>137**</td>
<td>388**</td>
<td>2525**</td>
</tr>
<tr>
<td>Clone x loc</td>
<td>11</td>
<td>47**</td>
<td>131**</td>
<td>5**</td>
</tr>
<tr>
<td>Clone x loc x yr</td>
<td>11</td>
<td>81**</td>
<td>250**</td>
<td>13**</td>
</tr>
<tr>
<td>Environment (Env)</td>
<td>3</td>
<td>1154**</td>
<td>4559**</td>
<td>52**</td>
</tr>
<tr>
<td>Rep (Env)</td>
<td>12</td>
<td>17**</td>
<td>61 **</td>
<td>2 ns</td>
</tr>
<tr>
<td>Clone x Env</td>
<td>33</td>
<td>54**</td>
<td>162**</td>
<td>9**</td>
</tr>
<tr>
<td>Error</td>
<td>516</td>
<td>8</td>
<td>22</td>
<td>9</td>
</tr>
<tr>
<td>C.V(%)</td>
<td>36</td>
<td>36</td>
<td>45</td>
<td>35</td>
</tr>
</tbody>
</table>

* = Significantly different at p< 0.05,  
** = Significantly different at p< 0.01  
N.s = Not significantly different at p< 0.05.
Table 3:

Stepwise regression equations expressing the effects of plant age and environment on dry matter partitioning to leaves (CV/ TOTDWE) and tuberous roots TR/TOTDWE).

\[
\text{LV/TOTDWT} = 0.218 - 0.008 \text{MAP}^{**} \quad R^2(\%) = 57 \%
\]

\[
\text{TR/TOTDWT} = -0.129 + 0.034 \text{MAP}^{**} + 0.014 \text{SAR} \quad R^2(\%) = 74 \%
\]

Jos Plateau (N=8)

\[
\text{LV/TOTDWT} Y = 0.140 - 0.009 \text{MAP}^{**} + 0.017 \text{MAT}^{*}
\]

\((57\%) \quad (29\%) \quad R^2(\%) = 86\)

\[
\text{TR/TOTDW} = -0.129 + 0.35 \text{MAP}^{**} + 0.0145 \text{SAR} \quad R^2(\%) = 74 \%
\]

Ibadan (N=8)

\[
\text{LV/TOTDWT} = 0.236 - 0.015 \text{MAP}^{*} \quad R^2(\%) = 59 \%
\]

In the analysis, it was found and shown on the graph (graph not shown in this work because of the difficulty inherent to have it placed in this work) that:

The proportion of total dry matter found in leaves decreased and later increased whereas the proportion in tuberous root increased
continuously with plant age. This pattern of dry matter partitioning was observed in both locations irrespective of differences in altitude. Significant differences (p < 0.05) were also observed between Jos plateau and Ibadan for the partitioning ratio to tuberous roots and shoots. The cassava grown at Ibadan were more efficient in allocating dry matter to roots when compared to Jos plateau.

Regression models of dry matter partitioning to leaves, shoots and tuberous roots were carried out in an attempt to quantify the effects of solar radiation and temperature and plant age on assimilate distribution (Table3). Only those model components that significantly (p < 0.05) improved the description of distribution ratio were considered here. When the data were pooled over locations, relatively poor relationships were obtained among dry matter partitioning ratios and environmental factors suggesting environment specific patterns of allocation. A large amount of the observed variation in tuberous roots and leaves could be accounted (57% to 63%) for by plant age while only 12% was due to solar radiation.

The data within locations give a better description of the effects of environment on dry matter distribution. At Ibadan, plant age accounted for 59% of the variation in dry matter distribution. At Ibadan, Plant age accounted for 59% of the variation in dry matter distribution to leaves. At Jos plateau, dry matter distribution to leaves was modeled as a function of
plant age and temperature whereas for partitioning to tuberous roots, 62% of the variation was accounted for by plant age and 12% was by solar radiation (Table 3).
CHAPTER FOUR

DISCUSSION IN RELATION TO THE STUDY

4.1 IN CROPS

There were significant genotype, environment and genotype X environment for leaf dry tuberous root weight. Thus, selection among the genotypes for leaf area index, total dry matter and total dry tuberous root weight should be conducted over more than one season in order to ensure some stability to seasonal influences. The result also implies that genotype performance will be enhanced by planting in certain locations in certain seasons.

The leaf area index (LAS) was significantly reduced at Jos plateau than Ibadan. The maximum LAI of 3.6 was obtained at 6 months after planting at high temperature requires while a maximum of 2.0 was recorded at 12 months after planting at low temperature regime. Previous work has also shown that cassava has an optimum LAI of 3.0 to 3.5 under a temperature regime of 24. C (Cook, Frankhn, Sandovol and Iuri, 1979).

Studies conducted in Australia (Sub-tropics.) have also shown that cassava achieve maximum LAI greater than 7 (Fukal, Alcay, Liamelo and Patterson, 1979). Although differences in LAI among cassava genotypes
may be due to differences in branching patterns, the lower LAI in tropical environments are probably due in part to very short life and small leaf size (Cook et al., 1979). Results obtained in this study may be due to high temperatures experience at Ibadan which promoted rapid initial leaf area development and by 6 months after planting, it reached its peak and thereafter declined. The reduction at 9 MAP may be due to dry experienced at Ibadan. The reduced LAI in Jos Plateau can be attributed to the lower temperatures which resulted in slower a pace of leaf area development.

Patterns of dry matter partitioning to leaves, shoot and tuberous roots in both locations were similar. Partitioning to leaves and shoots decreased while tuberous roots increased with plant age, indicating a shift in sine capacities which is affected by both the plant age and environment (However and cadavid, 1983). The cassava grown at Ibadan (Lowland) were more efficient in allocating dry matter to roots than those planted at Jos Plateau (Mid-attitude). This finding was consistent with other studies which have shown that cassava growth was reduced when grown under low high or temperature and therefore tuberous root formation also affected (Keating et al, 1982a, b; Cock 1985; Manrique, 1990).
The large amount of variation in dry matter partitioning to leaves and tuberous roots were accounted for by plant age and solar radiation. This result indicates that plant age was the main factor controlling dry matter partitioning in cassava. Similar results have been reported by Monique (1990). The results from within locations enabled a reasonable description of the effects of solar radiation and temperature on dry matter positioning of cassava. At Jos Plateau, Plant age accounted for variation in dry matter partitioning to leaves and tuberous roots while temperature and solar radiation accounted for variation in leaves and tuberous roots respectively. From these study, it is interesting to note that solar radiation instead of temperature controlled significantly the dry matter partitioning to tuberous roots while temperature affected the partitioning to the leaves. These results appear to support the view that leaf growth was more sensitive to temperature than any other shoot component in cassava (Inkura et al 1979). These findings were also consistent with studies which have shown a decline in dry matter part partitioning to roots with a reduction in solar radiation (Fukai et al; 1984) other studies indicate that low solar radiation delays root enlargement and reduces root cell size and number (Vincele, Halin, Oputa and Vine, 1984).

Having seen from this study, the influence of solar radiation and temperature on dry matter partitioning both in roots and leaves and the
effect of solar radiation on root enlargement it is evident that change in climate which can bring about change in precipitation amount and distribution (NIB since Jos has a lower temperature comparing to Ibadan by reason of elevation it has a very high tendency to have a lower rainfall amount), change in temperature, change in solar radiation and even changes in vegetation in no doubt result to changes in crop performances and quality and sizes of yield.

It is worthy of note that this study compared performances of crops in two localities with marked contrasting climate, and that the same result could be gotten if the crops were grown in one of the localities but witnessed a changed in climate such that the new climate simulates the climate of Jos Plateau, the crops in Ibadan will begin to respond to the new climate and will perform as though they were grown in Jos.

4.2 IN SOIL

On the analytical table the differences in soil components in the two localities. We saw variation in soil texture; in 1994/1995, the texture was sandy loam in Ibadan and clay loam in Jos, in 1995/1996, it was loamy sand in Ibadan and sandy clay loam in Jos.

pH was 6.0 in 1994/95 at Ibadan and 5.1 at Jos and 5.6 in 1995/96 at Ibadan and 5.0 at Jos.
There were differences in the quantity of the fertilizer elements WPK, differences exchangeable Ca, Mg K and variation in soil component; sand, silt and clay in the two localities. These are simply because of differences in climatic.

It is also evident from this that change in climate will bring changes in the properties of soil.

4.3 GLOBAL DISCUSSION ON CLIMATIC CHANGE

Some time it was reported that the ozone layer was badly damaged or "broken", another time it was also reported that global warming was on the increase. Recently some part of the earth has witnessed one type of natural disasters or the other. Tsunami tension "died" down, Typhoon came up and was forgotten then tornadoes has occurred too. The earth is getting hotter daily, desertification is occurring (encroachment of sahara towards northern Niger).

But man is burning soil fuels, chlorofluoro carbons emission has not stopped, generally industrialization is increasing consequently the stability of the climate is deteriorating and the climates are struggling to change. Ice caps are melting trees being felled and alof by other changes on the surface of earth. The amounts of some trace gasses in the atmosphere, notably carbon dioxide, Nitrous oxide, methane, chlorofluoro carbons and tropospheric ozone have been alarming increasing. All these gasses are
transparent to incoming short-wave radiation, but they absorb and emit long-wave radiation and are thus able to influence the Earth's climate. The accumulations of these gasses in the atmosphere is known as green house effect.

Generally it has been agreed that regional patterns of climatic change cannot yet be predicted. Thus, the ways in which higher CO$\text{_2}$ concentration and given changes in climate would affect ecosystems and human activities cannot be predicated either. This is presumably one of the main reasons why there has been substantial disagreement among previous studies regarding recommendations for future action.

In agriculture, the direct effects of enhanced CO$\text{_2}$ concentration on crop yields are beneficial. It is estimated from laboratory experiments on individual plants that, in the absence of climatic change, a doubling of the CO$\text{_2}$ concentration would cause a 0-10% increase in growth and yield of $C_4$ crops (e.g. maize, sorghum, sugarcane) and a 10-50% increase for $C_3$ (e.g. wheat, Soybean, rice), depending on the specific crop and growing conditions.
CHAPTER FIVE

5.1 CONCLUSION

At present, conclusions cannot be reached regarding the direct effects of elevated CO₂ concentrations on the productivity, species completion or size and a real extent of the world's agriculture. This is because of the paucity of experimental evidence for relevant tree species (in forestry) and other crops that have one or more growing cycles, and large uncertainties involved in scaling up from the short-term responses of individual leaves or plants to complex agricultural systems.

In analyzing the sensitivity of crop yields to possible changes in climate without including the direct effects due to higher CO₂ concentrations, most research has focused on average yields of cereal grains in core crop regions of the temperate latitudes. Less attention has been paid to the tropics and subtropics, to the climate. Sensitive margins of production and to possible changes in year to year climatic extremes.

Crop impact analyses show consistently that warmer average temperatures are detrimental to both wheat and maize yields in the mid-latitude core-crops regions of North America and Western Europe. Given current technology and crop varieties, a warming of 2°C with no change in
precipitation might reduce average yields by $10 \pm 7$. Increase in precipitation could partially offset these effects, while drier conditions could exacerbate (worsen) them. Changes in the length of the growing season or in the frequencies of extreme climatic events could also have important effects:

At the margins of crop areas, spatial shifts in cropping patterns might occur as a result of changes in climate. A limited number of marginal spatial analyses suggest that, in the mid-to-high-latitude, cereal growing regions, horizontal shifts of several hundred kilometers per $^\circ$C change are possible, assuming unchanged technology and economic constraints. In North America, these are comparable in magnitude with shifts in crop patterns that have taken place over this century. At the cool, high-altitude limits of production, altitudinal shifts of more than 100 metres per $^\circ$C may be possible.

Models of agricultural production and trade suggest that numerous feedback mechanisms exist in many regions through which agriculture can adjust and adapt to environmental change. Over the long term, food production in such areas appears more sensitive to technology, price and policy changes than to climatic changes, and these factors are largely controllable, whereas climate is not.
However, for some regions, particularly the kinds marginally for food production in the developing world, agriculture may be acutely sensitive to climatic changes, as evidenced by the tolls taken by year to year variations in climate. If these regions can adopt measures to reduce further the ill-effects of current, short-term climatic variability it is likely that they will be better prepared to adapt to some adverse effects of future changes in climate, should they occur.

For it is evident that it is "the giver of life to crops" so whatever impact that the crops feel as a result of climatic changes starts from the soil. If the climate is too hot and the soil is capable of supplying enough water, the impact will not be there on the crops.

If the crops receive optimum solar radiation and temperature and the soils do not, corresponding optimum nutrient will not be provided by the plants. So climatic changes affects soils also drastically and in a number of ways.

Nutrient availability in the soil can be attributed to the climate of the place. Favourable climate will enable soil microbes to perform their duties in the soil to ensure the release of the required nutrients in optimum amount.

Precipitation wherein in excess can reach away soils and erode them, this will result to "starvation" of crops of the sustaining nutrients.
Elutriation and Illumination of soil nutrient away of the root zone are problems of soil nutrients capable of having as a result of climatic changes.

In arid zones, salt from within move to the top and cause salinization if there is a long spell of time without rain the condition will becomes worse. Formation of laterites, cracking of soil, sophocation of soil living organisms are different problems associated with one problem of the soil and the other as a result of climatic changes.

5.2 RECOMMENDATION

Climate change is too serious to be left in politicians hands alone. The way current negotiations are being deliberated, proposed and decided upon, there is a danger that the real issues will be buried under proposals that obfuscate, rather than clarify, the need for drastic solutions. There are the issues of unsustainable patterns of development and consumption if industrialized countries, of the use of carbon emitting fossil fuels, of making sure that these industrialized countries who continue to pollute the air take responsibility for cleaning the atmosphere.

Consequently a challenge is thrown to the indigenous people who cannot but be involved in fight against climate change. They are already feeling the effects of global warming was ming through disruption of agricultural cycles, destruction of resources and loss of biodiversity, and increasing health risk.
Indigenous people have already made significant inroads in terms of active participation with the UNFCCC processes. They have instantiated lobby work and made interventions. While it is true that indigenous people have not yet achieved official participation, the call for an indigenous working group on climate change within the UNFCCC has already been put forward. They have registered and campaigned for the indigenous people's stand on issues such as the flexible mechanisms and carbon "Sinks" among others.

The possible problem of a change in climate due to the emission of greenhouse gases should be considered as one of today's most important long-term environmental problems. It should be considered in the context of other ongoing changes of our environment also caused by human activities, such as air pollution, acid rain and deforestation. Only in this way can we achieve a realistic integrated view of the interplay between the environment as a whole and the global society that is required for thoughtful considerations of options and policies for avoiding long-term adverse consequences.

For organic agriculture should be encouraged. This is because in organic agriculture, the organic matter level of the soil is very high. And organic matter acts, as butter in the soil with high level of organic matter will not easily respond to climatic changes.
Biotecnology should highly encourage especially breeding crops that can resist constraints of crop production. That is breeding to resist drought, flood, temperature extremes, acidity and other climatic constraints.
REFERENCES


