ANALYSIS OF THE IMPACT OF CLIMATE CHANGE INDICATORS ON LIVESTOCK PRODUCTION IN TEN WEST AFRICAN COUNTRIES

BY

AGBO, STEPHEN UCHENNA

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SUPERVISOR: PROF. ONYUKWU E. ONYUKWU

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TITLE PAGE

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CERTIFICATION

This is to certify that AGBO, Stephen Uchenna, an M.Sc. student of the University of Nigeria Nsukka with registration number PG/M.Sc./09/51646 has successfully completed the research required for the Award of Masters of Science Degree in Economics in the University of Nigeria Nsukka.

Agbo, Stephen Uchenna
PG/M.Sc./09/51646

Date

Supervisor

Date

Prof. Onyukwu, E Onyukwu

APPROVAL

The research work titled: "Analysis of The Impact of Climate Change Indicators on Livestock Production in Ten West African Countries" has followed due process and has been approved to have met the minimum requirement for the award of the Master of Science degree in the Department of Economics - University of Nigeria, Nsukka.

Approved

____________________	____________________
Supervisor	Date
Prof. Onyukwu, E. Onyukwu	
____________________	____________________
Head of Department	Date
Prof. (Mrs.) S. I. Madueme	
____________________	____________________
Dean of Faculty	Date
Prof. I. A. Madu	
____________________	____________________
External Examiner	Date

DEDICATION

To my late parents-Mr. and Mrs. Ugwuagbowo and Deborah Agbo and all who diligently and honestly desire education at all legitimate costs.

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ABSTRACT

This study examines the impact of climate change indicators on livestock production in ten West African countries. Climate change is a contemporary challenging issue threatening the very existence of the earth and Less developed parts of the world suffer its impact most. Climate characteristics affect the environment, agricultural production, and health. Climate affects every nation and every economy. A combination of descriptive statistics and econometrics methodology were used in the analysis of data. The study used two objectives; to ascertain the level of climate change indicators in the countries under study and to determine whether climate change indicators are major determinants of livestock production in those countries. The indicators include carbon dioxide emission (Co_2E), Renewable Internal Fresh Water Resources in addition to other macroeconomic indicators like population and GDP growth rate.

The study used the production function approach to model the effects of climate change on livestock production. The result suggests that a positive relationship exists between carbon dioxide emissions and livestock production up to a threshold of 350ppm. Beyond the threshold, CO_2 emissions affect livestock production negatively. This implies that an increase in CO_2 emissions will increase livestock production in the countries studied but beyond the tipping point (threshold) an increase in CO_2 emissions will decrease livestock production. The study also suggests that the other climate change indicator which is renewable internal fresh water resources (RIFR) also has a positive relationship with livestock production. This implies that an increase in RIFR increases livestock production.

Keywords:Climate Change, Carbon dioxide emission, Livestock Production, West African Countries

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CHAPTER ONE
INTRODUCTION

1.1 Introduction

Strange climatic phenomena are now rampant in the world. Areas previously characterised by low rain fall, high temperature, drought and desertification now experience high level rain fall and flooding. Rain forest zones occasionally have excessive rain or low level rainfall.

In May 2011 the Mississippi river in the United States of America overflowed its banks and flooded about 4 states. This left an unprecedented destruction of the economy of those states in its trail. The last time the rivers overflowed its banks was in 1935.

In Nigeria, areas known for very low volume of rainfall in a year, now experience flood. For instance, states in the Sahelian climate in the Northern part of Nigeria, namely Sokoto, Kebbi, Jigawa, to name just a few, experienced heavy flooding in the past two years.

Coastal erosion affects most coastal lines all over the world as a consequence of sea level rise. Harmattan no longer starts around late October or early November but starts now around January lasting up to March. The usual severe cold is now absent (Nigerian Environmental Study/Action Team (NEST, 2011).

In 2012 severe and wide spread flooding occurred in Nigeria. It was reported that between July and October 2012, flooding in Nigeria pushed rivers over their banks and submerged hundreds of thousands of acres of farmland, (Satnews Daily October 16, 2012). The newspaper went further to say that Nigeria was not alone in coping with floods in 2012; floods had affected several other countries in west and central Africa by mid-September. By mid-October, floods had forced out 1.3 million people from their homes and claimed 431 lives, according to Nigeria's *National Emergency Management Agency*. Flash floods are common in Nigeria in the rainy season (May to September), but news reports characterized last year's floods as the worst in more than 40 years. The Nigerian Red Cross,(2012) reported that about 120,000 people had been left homeless.

These strange climatic phenomena have been classified by Environmental experts as Climate Change.

The Intergovernmental Panel on Climate Change (IPCC, 2007) defined Climate Change as a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activities.

It has also been defined as a variation in the atmospheric characteristics in a particular location over a long period, usually between 30years and millions of years.(NEST,2011).

These atmospheric characteristics include solar radiation, temperature, humidity, precipitation, atmospheric pressure, rainfall and wind.

It is this variation in climate characteristics that causes global warming. Global warming refers to an increase in the average surface temperature resulting from an increase in the amount of carbon dioxide (CO_2), Methane (CH_4), Nitrous oxides (N_2O), water vapour (H_2O) and industrial gases, Hydro fluorocarbon (HFCs), per fluorocarbons (PPCs) and Sulphur hexafluoride (SF_6) emitted naturally or by human activities into the atmosphere. These gases are called Greenhouse gases.

These gases are mainly emitted through burning of fossil fuel, car exhaust, industrial production, bush burning and wood fuel (fire wood). The accumulation of these gases in the atmosphere over time prevents the natural balancing of atmospheric characteristics such as temperature and precipitations. It is this balanced atmospheric characteristics that makes the earth habitable.

1. 2 Statement of Problem

Agriculture is one of the very important sectors of every economy and it is the desire of governments always to strive to develop the sector. Agriculture provides food for human and livestock consumption and raw materials for industries. It is also a source of employment for the economy.

However, variability in livestock production has become a general scenario being experienced by many developing countries especially sub-Saharan African countries.

Most studies of climate change impacts have focused on changes in mean climate conditions although global climate change is likely to bring changes in climate variability and extreme events as well. The IPCC(2007) states that climate effects and variability in Africa depend on the location. Rapid changes in this variability may severely disrupt production systems and livelihoods. Besides an increased variability, the IPCC (2007) detects a pattern of increased aridity throughout most of the continent. Mean rainfall decreased by 20-49% in the Sahel in most of the years between 1930 and 1997 and generally 5-10% across the rest of the continent, (IPCC, 2007 and United Nation Framework on Climate Change, 2007).

Research has shown that countries in tropical and sub-tropical regions are expected to be more vulnerable to global warming as a result of additional temperature increases (Mendelsohn et. al., 2000). These temperature increases will affect their marginal water balance and harm their agricultural sector. However, doubling of the atmospheric carbon dioxide (CO_2) concentration will lead to a small decrease in global crop production and the largest reductions are projected for the southern crop areas due to increased temperatures and reduced water availability (Rosenzweig & Parry, 2002). So, there are controversies over what could be the cause of the decline in agricultural production in these countries, whether it is climate change or other factors. Research has not yet concluded on this in west Africa. This is what the study intends to unravel,

Furthermore, some West African countries are naturally not endowed with favourable weather conditions and human resources for agricultural production. For instance, some are desert countries while some have small populations. These unfavourable situations may be accountable for their level of agricultural production rather than climate change and variability. Thus, there are controversies over what could be the causes of decline in agricultural production in these, whether it is climate change or the other factors mentioned above. Research have not yet concluded on this in West Africa, and this is what the study tends to unravel.

Livestock production has been found to be declining over the years in West Africa and this has been attributed to poor nutrition.

This study will attempt to determine whether climate change affects West African livestock production.

1.3 Research Questions

(1) Do changes in climate and its indicators significantly impact on livestock production in the selected West African countries?

(2) What impact do climatic indicators have on Livestock production in the selected West African countries?

1.4 Objectives of the Study

The general objective of the study is to analyze the effects of climate change on livestock production. More specifically, the study intends to;

(a) To show the trend of climate change variables (indicators) in the selected West African countries.

(b) To determine the impact of climate change on Livestock production of each of the selected West African countries.

1.5 Hypotheses:

H_o: There is no significant difference in Livestock production in the West Africa countries studied.

H_o: Climate change indicators do not impact significantly on Livestock production in the West Africa countries studied .

1.6 Policy Relevance of the Study

The vulnerability of the agricultural sector (Livestock production in particular) to climate change in West Africa is of particular interest to policy makers because agriculture is a key sector in these economies and accounts for between 60-70% of the labour force and contributing between 30-40% of the nations' GDP. The sector is also the source of raw materials used in several processing industries as well as a source of foreign exchange earnings for these countries. The food security challenges of the nations depend on the sector also. This study will therefore aid Administrators to ascertain to what extent climate change affects livestock production in the west African Countries under consideration. Also, this study should guide policy makers in designing climate change adaptation strategies as well as other related strategies based on the outcome of the findings. In addition, the work is a contribution to the already existing literature and therefore instigates the existing debate on the subject matter and might also suggest areas for further studies.

1.7 Scope of the Study

The work intends to use survey data from FAO, World Bank, FOS, CBN and other West African data Bases on environmental and livestock sectors of ten West African countries comprising of major four trading blocs of the region (Nigeria, Ghana, Senegal and Cote d' Ivoire) and the highly agrarian countries (Burkina Faso, Gambia, Benin, Togo, Mali and Niger) from 1990 to 2010. . The choice of these countries is based on major trading blocs of the region and the highly agrarian nature of the countries.

1.8 Limitations of the study

Climate change study is relatively new and its literature on LDCs a bit scanty. Data on a good number of indicators are not available. For instance, data on precipitation and its threshold, Methane and other climate variables are not available for West Africa at the various reliable statistical sites this researcher sought for them. Presentation of Radar data are at times very difficult to understand or inexplicit.

1.9 Organisation of the Study

This study is organized into six chapters. The first chapter elaborates the background of the study showing related works. It also deals with the statement of the problem then shows the research and economic problems of the study that translates into the research questions. The second chapter forcusses on the existing theoretical and empirical literature on climate change and Livestock production. While, chapter three shows the theoretical framework and model specification for the study. Presentation of results and evaluation of hypothesis are discussed in chapter four. Chapter five summarises the work, concludes the result of the findings, proffers solutions to the problem and then suggests areas for further research.

CHAPTER TWO

BACKGOUND OF THE STUDY

2.1 Seven Theories of climate change

The Intergovernmental Panel on Climate Change (IPCC) report projects Anthropogenic Global Warming (AGW) as the only theory of climate change. This means that climate change is only caused by greenhouse gases emissions like (CO_2, Methane, water vapour, etc) brought about by man-made burning of fossil fuel, bush burning, car exhaust, deforestation and other human activities.

In the words of (Bast, 2010), "at least seven theories of climate change enjoy some support in the scientific community". He went on to list them as follows:-

(i) Anthropogenic Global Warming: This theory states that human emissions of greenhouse gases, principally Carbon dioxide CO_2, Methane, Nitrous oxide etc., cause catastrophic rise in global temperatures. The proponents of this theory believe that the rise in global temperatures causes floods, droughts, severe weather, crop failures, species extinctions, diseases spread, ocean coral bleaching, famines and so many other catastrophes. They also believe that all these will continue to increase in magnitude and frequency as temperatures continue to rise and can only be mitigated by reduction in human emissions.

(ii) Bio-thermostat: this theory of climate change states that negative feedbacks from biological and chemical processes totally or all most totally offset any positive feedbacks caused by rising CO_2 thus keeping atmospheric temperature in equilibrium. There are about eight such feedbacks in scientific literature namely:- Carbon sequestration, Carbonyl Sulfide(COS), Diffuse light, Iodocompounds, Dimethyl Sulfide (DMS) and other Aerosols. This may mean that rising CO_2 would not cause catastrophic global warming.

(iii) Cloud Formation and Albedo: The proponents of this theory postulate that changes in cloud formation and Albedo create negative feedbacks which cancel out all or almost all CO_2 warming effects. Many researchers using observational data found that changes in cloud coverage in the tropics acted as natural thermostat to keep sea surface temperature between 28^oC and 30^oC.

(Bast 2010) thinks that if these discoveries are right, clouds act as negative feedback to the warming that would otherwise be caused by man-made CO_2 emissions, eliminating any net warming.

(iv) Human Forcings besides Greenhouse Gases: This fourth theory of climate change holds that mankind's greatest influence on climate is not its emissions, but its transformation of Earth's surface through clearing forests, irrigating deserts and building cities. These other activities of man other than greenhouse gases emissions are called "Human Forcings" and they include Urban Heat Islands, Aerosols and Ozone, deforestation, coastal development and Jet contrails.

(v) Ocean Currents: Ocean Current theory states that global temperature variation over the past century-and-a-half and particularly the past 30 years were due to the slowdown of the ocean's thermohaline circulation.

(vi) Planetary Motion: This theory states that natural gravitational and magnetic oscillations of the solar system induced by the planet's movement through space drive climate change.

(vii) Solar Variability: The theory states that changes in the brightness of the sun cause changes in cloud formation, ocean currents and wind which cause climate change.

2.2 Climate Threshold or Tipping Point

Climate threshold or tipping point has been defined by Wikipedia as a point when global climate changes from one stable state to another stable state, in a similar manner to a wine glass tipping over. After the tipping point has been passed, a transition to a new state occurs. The tipping event may be irreversible, comparable to wine spilling from the glass: standing up the glass will not put the wine back.

According to Wikipedia, Global warming changes the composition of gases in the Earth's atmosphere through the emission of greenhouse gases such as carbon dioxide and methane. Subsequent warming brings about changes to the natural environment which may result in other changes. For instance, warming may begin to melt the Greenland ice sheet and/or West Antarctic Ice Sheet. At some level of temperature rise, the melt of the entire ice sheet will become inevitable, even though complete melting may not occur for millions of years. So a tipping point may be passed without any immediately obvious consequences, nor any acceleration of the warming process. Carbon dioxide as of May 2012 made up 396.18 parts per million(ppm) of Earth's atmosphere and monitoring stations in the Arctic spring 2012 measuring more than 400 ppm of the heat-trapping gas in the atmosphere. James E. Hansen quoted by Wikipedia said that this tipping point had already been reached in April 2008 when the CO_2 level was 385 ppm. (Hansen states 350 ppm as the upper limit.) "Further global warming of 1°C defines a critical threshold. Beyond that we will likely see changes that make Earth a different planet than the one we know.

(Orostegui, 2010) defined it as the point at which there is an abrupt change in an ecosystem quality, property, or phenomenon, or where small changes in one or more external conditions produce large and persistent responses in an ecosystem.

Ecological thresholds occur when external factors, positive feedbacks, or nonlinear instabilities in a system cause changes to propagate in a domino-like fashion that is potentially irreversible. Once an ecological threshold is crossed, the ecosystem in question is not likely to return to its previous state. Over the past three decades, climate change has become a recognized driver of ecosystem change. Much ecosystems research focuses on enhancing understanding of climate change impacts on ecosystems and in developing the capability to predict the potential impacts of future climate change. The potential for sudden, unanticipated shifts in ecosystem dynamics make resource planning, preparation, and management intensely difficult. These sudden changes to ecosystems and the goods and services they provide are not well understood, but they are extremely important if natural resource managers are to succeed in developing adaptation strategies in a changing world (Orostegui, 2010).

2.3 Climate Change in Africa

The Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), (2001) established that Africa is one of the most vulnerable regions in the world to climate change. The report showed how human activities, through bush and fossil fuels burning, is modifying the global climate with projected rising temperature over the next century. The continent is also expected to experience varying degrees of vulnerability and impacts of climate change because of her level of poverty. These impacts including flooding, temperature rises and coastal erosions are projected to affect human welfare and the environment for next 100years. Climate change records for Africa shows that the continent experiences warming of approximately 0.7^{o}C in the 20th century. This warming trend, and changes in precipitation patterns, are expected to continue and be accompanied by a rise in sea level and increased frequency of extreme weather events (Desanker, 2005).

Climate change also affects humans and animals by stressing African biodiversity. Biodiversity provides food, fiber, fuel, shelter, medicine, wildlife trade and tourism sites. The gradual yet dramatic disappearance of glaciers on Mount Kilimanjaro is a result of global warming (IPCC, 2001).

However, climate change is not the only threat to African biodiversity. (Desanker, 2005) states that:

> Other threats include increasing land use conversion and subsequent destruction of habitat; pollution; and the introduction of exotic (nonnative) species. Land-use conversion from wild habitat to agricultural, grazing and logging uses, for example, leads to habitat loss, fragmentation, and introduction of exotic species—all of which adversely impact biodiversity. Given this multitude of stress factors on biodiversity, climate change may exacerbate the stress on environmental systems beyond recovery.

2.4 Climate Change in West Africa

West Africa situates approximately between 5° N and 20° N and occupies an area of approximately 5 million km^2. It is bounded on the West and South by the Atlantic Ocean and on the North by the Sahara desert. The eastern border lies on a line running from the Cameroon mountains to Lake Chad.

The inhabitants of West Africa depend solely on rain fed agriculture for sustenance. However rainfall variability – arising from the interaction of the region's climate with large-scale atmospheric circulation – is evident through changes in extreme precipitation events such as erosion and floods. These remain a major challenge for increased agricultural production, necessary for food security (Abayomi, 2011).

The climate of West Africa is characterized by wet and dry seasons and the region can be subdivided using mean annual rainfall into zones: Sahelo-Sahara, Sahel, Soudan, Soudano-Guinea and Guinea savannah.

West African countries have coastal boundaries and as such vulnerable to coastal erosion. According to (Conway, 2009)

> "Africa’s climate is naturally both highly diverse and highly variable. It encompasses the extreme aridity of the Saharan deserts at one end of the range and the extreme humidity of the Congo rainforest at the other. Interacting with these natural patterns are the combined effects of anthropogenic global warming and human interference more generally."

These atmospheric patterns are also likely to have severe consequences along the West African coast. Some of the likely consequences would, according to (Conway, 2009) be: Permanent connection of lagoons to sea, Penetration of salt water inland, Increased coastal erosion, Salinisation of freshwater lagoons and aquifers. Increased depth of water table in coastal areas, Destruction of wetlands and associated industries. Some coastal cities like Lagos and Guinea-Bissau are projected to be submerged by coastal erosions during the 21st century.

2.5 Agriculture in West Africa

A study of contributions of agriculture to a few West African countries' economy will further show the importance of this sector.

During the early days of her independence, agriculture was both the main stay of the Nigerian economy and the chief foreign exchange earner. Then agriculture accounted for well over 80 percent of her export earnings and employment; about 65 percent of the GDP (gross domestic product) and about 50 percent of government total revenue. All these have, however, declined over the years. In the 1970s, its contribution to GDP was about 50% and 34% in 2003. At present, agriculture accounts for only 41 percent of the real sector, while crude oil accounts for 13 percent (Wikipedia, 2011).

Although agriculture no longer serves as the leading contributor to Nigeria's gross national product and leading foreign exchange earner due to phenomenal growth in the petroleum sector of the economy, it is still the dominant economic activity in terms of employment and linkages with the rest of the economy. However, there is threat of hunger and about 70% of the population are poor, living below US$1 a day (Wikipedia, 2011).

In Burkina Faso agriculture dominates the economy. It employs 86% of the total population (estimated at 12.1 million in 2003). About 40% of GDP comes from agricultural activities (crops 25%, livestock 12% and forestry and fishing 3%), which are the main sources of the county's economic growth. Burkina Faso agriculture is a subsistence agriculture based on cereal growing (sorghum, millet, maize, fonio and rice) which take up 88% of the cultivated area per year and constitute the staple diet of the majority of the population. Cotton is the main export crop and provides on average 50% of export income.

Burkina Faso is one of the land-locked West African countries that have a dry tropical climate. Her climate can be grouped into dry season-characterized by the harsh harmattan winds from October to March; humid winds in April and rainy season from May/June to September (Wikipedia, 2011).

The duration and volume of the rainy season decreases progressively from the south-west to the north and very erratic. There are large seasonal variations in temperature and high ranges at night, particularly in the north of Burkina Faso, (Somé and Sivakumar, 1994).

Agriculture in Burkina Faso is dominated by the rain-fed system. About 24,000 hectares are irrigated out of an irrigable potential of 160,000ha including 130,000ha under partial water control and 30,000hectares under full water control. The irrigated crops are rice, sugar cane and vegetables (Ouedraogo, Somé and Dembele, 2006).

Agriculture in the form of crop production, livestock breeding, fishery and forestry is the primary sector of the economy, accounting for nearly 40% of Burkina Faso's GDP, and ensuring employment and income to about 90% of the active population and guaranteeing around 80% of total exports. From 1994 to 2004, this sector contributed up to 38.23% to the GDP, compared with 19.09% for the secondary sector and 42.68% for the tertiary sector. During this period, its contribution to the GDP rose by about 1.3%, after the boost from cotton farming, (Ouedraogo, Somé and Dembele, 2006).

Also Agricultural production in Ghana is heavily reliant on rain-fed system; there is a lack of good water management and soils are coarse with low water holding capacity and crop water stress during the growing season. Ghana experiences large, spatial and temporal variations in rainfall with the least rainfall from Coastal savannah while the highest is from the Rain forest zone. Rainfall is also the most important element of climate change in Ghana and a good source of water supply in the country, (Sagoe, 2006).

Agriculture production is Ghana's main source of employment with over 70% of the population earning its livelihood from this sector. It generates about 75% of the export earnings of the country and a major source of food and government savings on revenues. An overall economic progress will therefore depend to a large extent on the agriculture sector. Root and tuber crops occupy an important position in Ghana's agriculture, contributing 40% of the country's agricultural gross domestic product (AGDP); with cassava accounting for 22% of the AGDP.

The main root and tuber crops grown in Ghana are cassava, yam and cocoyam. They are mostly grown by smallholders for household food security. They may also be produced for sale. (Nankani, 2007).

Sustaining and accelerating Ghana's agricultural growth thus pose several challenges. Ghana's recent development process is characterized by balanced growth at the aggregate economic level and the continued importance of agriculture as the backbone of the economy. In recent years agricultural growth has been more rapid than growth in the non-agricultural sectors, expanding by an average annual rate of 5.5%, compared to 5.2% for the economy as a whole. In terms of subsectors, crop production between 1995 and 2006 has expanded steadily. With the exception of sorghum, millet and cassava, in the period 2000–2006, output of most crops has increased at a faster rate than population growth.

There is also a consensus that the severest impacts of climate change will affect the developing countries the most (Stern, 2006). Climate change will severely affect the bedrockof sustainable development which include growth, poverty reduction and environmental sustainability.

According to Cline (2007) climate change poses the greatest risks to World agriculture. He also predicted that developing countries will lose more than industrial countries and that climate change will gradually have a negative impact on agricultural productivity

Agricultural production has been found to be affected by climate change and since such changes cause response in many human and natural systems, understanding climate variability will improve agricultural decision making and eventually production. Climate change has the possibility of degrading soil and water resources and subsequently subsistence agriculture production which is largely practiced by root and tuber crop farmers. Although, impact of climate change on agriculture is estimated to result in small percentage change in global income, which is positive for developed regions but negative for developing countries such as West African countries, estimated economic impact indicates the lowering of income of vulnerable population and increase in number of people at the risk of hunger.

The location, size of, and characteristics relief in West Africa give rise to a variety of climates; ranging from tropical rain forest climate along the coasts to the Sahel climate in the northern parts of the sub-region, each being different by its annual precipitation, sunshine, and other climatic elements. For instance, in Nigeria, Adejuwon (2004) states that the diverse nature of the country's biological diversity results, mainly, in seven vegetation zones: the mangrove swamps, the salt water and fresh water swamps, tropical rain forests, guinea savannah, derived savannah, Sudan savannah, and Sahel savannah. He further explained that the country (Nigeria) experiences large, spatial and temporal variations in rainfall and less variation in evaporation and evapo-transpiration. Consequently, rainfall is by far the most important element of climate change in Nigeria and a good source of water supply in the country.

Opinions about the relationship between climate change and agriculture are issues that are very important; as the world's food production resources are already under pressure from rapidly increasing population. (Mathews and Stephens, 2002 as cited by Ramaraj, Jagannathan and Dheebakaran, 2010). They also maintained the views of European Parliament Science and Technology Options Assessment (STOA) panel, (1999) by asserting that agriculture is sensitive to short term changes in weather and to seasonal, annual and longer term variations in climate.

Rapid changes in this climate variability may severely disrupt production systems and livelihoods. The IPCC (2007) in addition to increased variability, also detected a pattern of increased aridity throughout most of the continent. Mean rainfall decreased by 20-49% in the Sahel in most of the years between 1930 and 1997 and generally 5-10% across the rest of the continent.

In the words of Mendelsohn and Dinar (1999) as cited by (Meijerink & Roza, 2007) climate change is not likely to dramatically reduce aggregate productivity in developing countries due to various mitigating factors and adaptations implemented by farmers. In addition, global warming is likely to increase productivity in industrial countries, temperate and polar regions.

Therefore, Mendelsohn and Dinar (199) as cited by Meijerink and Roza,(2007) concluded that on a global scale, food production is not at risk. But as these cooler regions become more productive, the increased supply is likely to depress world prices, making farmers in developing countries even worse off. Although these price effects are estimated to be small, the situation of developing countries will deteriorate as their production potential decreases and trade balance will shift towards more food import.

However, from the work of (Masters, Baker and Flood (2010) agriculture and food distribution also affect climate change, principally through the production and release of greenhouse gases such as CO_2, methane and nitrous oxide (approximately 18% of UK greenhouse gas emissions come from industrial agriculture and the food distribution system) but also by altering land cover, which changes the absorption or reflection of heat and light, thus contributing to radiative forcing (a key process of the greenhouse effect). Deforestation and desertification, together with fossil fuel burning, are major anthropogenic sources of CO_2; agriculture itself is a major contributor to increasing atmospheric methane and nitrous oxide concentrations.

2.6 Causes of Climate Change

Natural activities such as interaction of the oceans and the atmosphere, changes in the earth’s orbit, changes in energy received from the sun, melting of ice in the Arctic region and volcanic eruptions have a lot of effects on World climate. According to Muheneel et al (2005) research shows that in the last 140yrs, human activities have constituted the major cause of climate change.

Life is sustainable on Earth because the sun warms it up while evaporation and precipitations occur to cool the temperature when it is in excess. The emission of greenhouse gases over time prevents or reduces evaporation and precipitation, thereby keeping the earth surface warmer than it should be naturally. This is global warming.

According to Stern (2007), climate change impacts negatively on every sector and country, especially the less developed countries (LDCs) of the World. Unfortunately those who suffer the impacts of climate change most, more often contribute less to its cause. Given its inherent link to natural resources, agricultural production is also at the mercy of uncertainties driven by climate variation, including extreme events such as flooding and drought, (Kurukulasuriya and Rosenthal, 2003).

Macroeconomic and other numerous factors also shape and drive the agricultural sector output. Market fluctuations, changes in domestic and international agricultural policies (such as the form and extent of subsidies, incentives, tariffs, credit facilities, and insurance), management practices, terms of trade, the type and availability of technology and extension, land-use regulations and biophysical characteristics (availability of water resources, soil quality, carrying capacity, and pests and diseases) are among the set of primary influences.

Furthermore, Kurukulasuriya and Rosenthal (2003) stated that over the last decade or so, climate change (in terms of long-term changes in mean temperature or precipitation normal, as well as an increased frequency of extreme climate effects) has gradually been recognized as an additional factor which, with other conventional pressures, will have a significant weight on the form, scale, and spatial and temporal impact on agricultural production in general and livestock production in particular. The general consensus that emerges from the literature is that in the absence of adequate response strategies to long-term climate change as well as to climate variability, diverse and region-specific impacts will become more apparent. Some impacts are expected to be adverse while others may be favorable. Impacts of climate variability and change on the agricultural sector are projected to steadily manifest directly from changes in land and water regimes, the likely primary conduits of change. Changes in the frequency and intensity of droughts, flooding, and storm damage are expected. climate change is expected to result in long-term water and other resource shortages, worsening soil conditions, drought and desertification, disease and pest outbreaks on crops and livestock, sea level rise, and so on, (Kurukulasuriya and Rosenthal, 2003).

Vulnerable areas are expected to experience losses in agricultural production, primarily due to reductions in crop yields, (Rosenzweig et al, 2002). Increasing use of marginal land for agriculture (especially among smallholder farms) is anticipated as the availability and

productivity potential of land begin to decline. In contrast, climate change is also expected to result in some beneficial effects, particularly in temperate regions, (Mendelsohn, 1999).
Consequently, the likely impacts of climate change on the agricultural sector have prompted concern over the magnitude of future global food production ((IPCC, 1996, Bindi and Olosen, 2000). Early global estimates predict (without consideration of CO_2 fertilization effects or adaptation) a 20–30 percent reduction in grain production, (Darwin et al, 1995).

Based on agronomic research in low latitude countries, (Reilly et al 1994, 1996) approximate global welfare changes in the agricultural sector (without adaptations) between losses of US$61.2 billion and gains of US$0.1 billion. This is in contrast to losses of US$37 billion to gains of US$70 billion with appropriate adaptations in place. Under the most severe scenarios of climate change, however, significant losses are expected worldwide, (Fischer et al; 1993 and 1996); Rosenzweig et al, 1993; Rosenzweig and Parry, 1994; Darwin et al, 1995and1996; Tsigas et al, 1996; Reilly, 1999 and Rosenzweig, 2000).
Given the range of warming predicted by environmental scientists, regional and local variation impacts on the agricultural production is likely to be high. However, a rapidly emerging consensus is that the worst impacts will be in tropical regions, (Rosenzweig et al, 1993; Mendelsohn, 2000; IPCC, 2001 and Sachs, 2003).
From the works of (Kurukulasuriya and Rosenthal, 2003),the concern with climate change is heightened given the linkage of the agricultural sector to poverty. In particular, it is anticipated that adverse impacts on the agricultural sector will exacerbate the incidence of rural poverty. Impacts on poverty are likely to be especially severe in developing countries where the agricultural sector is an important source of livelihood for a majority of the rural population. In Africa, estimates indicate that nearly 60–70 percent of the population is dependent on the agricultural sector for employment, and the sector contributes on average nearly 34 percent to gross domestic product (GDP) per country.
In West African Sahel alone, more than 80 percent of the population is involved in agriculture and livestock-farming in rural areas, and the two sectors contribute approximately 35 percent of the countries' GDPs, (Mohamed et al, 2002). With lower technological and capital stocks, the agricultural sector in such poorer developing countries is unlikely to withstand the additional pressures imposed by climate change without a concerted response strategy. (Crosson 1997). According to some estimates, the overall economic impact of climate change on the agricultural sector could be up to 10 percent of GDP, (Hernes et al, 1995; IPCC, 2001).

Many countries in tropical and sub-tropical regions of Africa, are expected to be more vulnerable to warming because of additional temperature increases that will affect their marginal water balance and harm their agricultural sector (Mendelssohn et. al., 2000). The problem is expected to be most severe in these and other African countries, where current information is the poorest, technological change the slowest, and the domestic economies depend heavily on agriculture, (Action aid, 2008).

The role of agriculture in economic development of most countries can hardly be over-emphasized. The contribution of agricultural growth to overall poverty reduction has been documented. According to the UN Food and Agriculture Organisation (FAO), climate change will directly affect future food availability, and compound the difficulties of feeding the world's rapidly growing population. In view of the importance of agricultural growth to economic growth, most researchers observed that rising agricultural productivity has been most important factor of successful industrialization. Agricultural production remains the main source of livelihood for most rural communities in developing countries and sub-Saharan Africa, in particular. Here, agriculture provides employment for more than 60 percent of the population and contributes about 30 percent of gross domestic product, (Kandlinkar & Risbey, 2000).
This study is focused on Livestock production because of the importance of the sector to the economic and social wellbeing of West African countries. Livestock production as a unit of general agriculture production accounts for the much needed animal protein needs of every society.

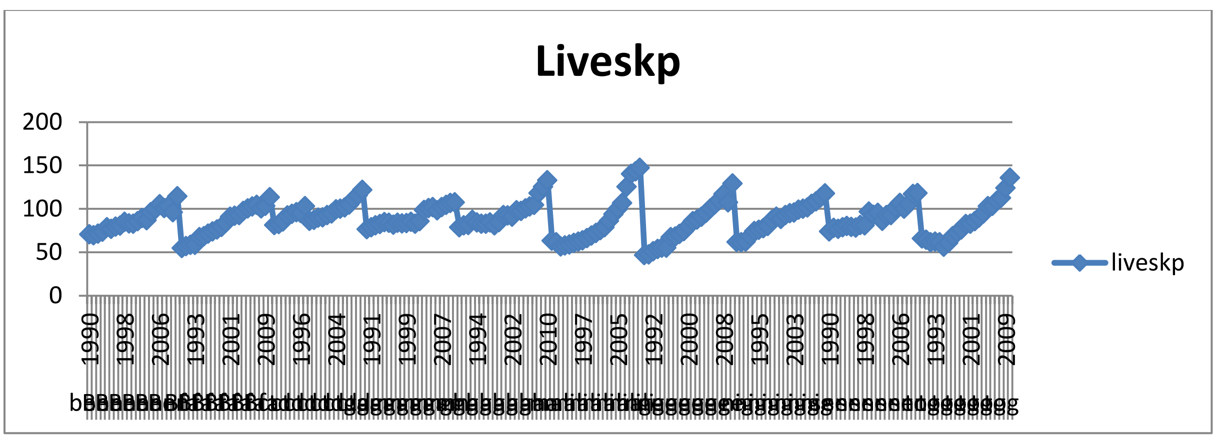
2.7 Live Stock Production in West Africa

Livestock production is a very important agricultural sector in West Africa. According to Jahnke (1982) Livestock are vital to subsistence and economic development in sub-Saharan Africa. In some countries they provide a flow of essential food products throughout the year. They are a major source of government revenue and export earnings and also sustain the employment and income of millions of people in rural areas. Also a publication of (The International Food Policy Research Institute (IFPRI) (2004) states that Livestock production accounts for about 30% of the gross value of agricultural production in Africa and seventy percent of the rural poor in Africa own livestock, including pastoralists living in arid and semi-arid zones. Of these, over 200 million people rely on their livestock for income (sales of milk, meat, skins) as well as draught power and fertilizer for crop growing. Livestock is also a major source of income for women and the landless and provides high-quality nutrition for most families.

Jahnke (1982) also said that the contribution of draught energy and manure for crop production are the only food and cash security available to many Africans. The sale of livestock and their products often constitutes the source of cash income in most rural areas, and hence the only way in which subsistence farmers can buy consumer goods, improved seeds, fertilizers and pesticides needed to increase crop yields. Researchers have observed that where livestock development has been successfully pursued, a steady increase in the productivity of food grain production and in the growth of service and consumer industries is clearly observable.

Researches show that West African livestock production has been declining in the past few years. According to Lansbury (1962) Livestock throughout West Africa, by temperate standards, have a low rate of growth and reproduction due largely to nutrition. Many of the traditional livestock production systems of Sub-Saharan Africa are now in decline.

Graph showing variability of livestock production in the ten selected West Africa countries



Source: Authors computation data from 2013 World Bank data

CHAPTER THREE

LITERATURE REVIEW

3.1 Theoretical Literature

Several theories have been developed to estimate the impact of climate change on agriculture. These theories employed methods that can be grouped into two main categories. (Bazzaz, 1997): theory advocating the structural modeling of the agronomic response based on controlled experiments (the production function approach), and modeling taking into account the link between crop production and the farmers' economic management decisions, based on theoretical specification (the Ricardian approach), (Ouedraogo et al, 2006).

3.1.1 The Production Function Approach

This approach is based on the existence of a production function for each crop, which links its yield to the physical, biophysical and biological environment. In explaining this approach, Ouedraogo (2006) opined that among the environmental factors which affect crop yield, climate is the most important. Former bioclimatic studies, undertaken by agricultural research teams, highlighted the determining role of some climatic factors such as the availability of rain water, the degree of heat, the sun's radiation, the evaporation capacity of the air, the air's CO_2 content etc. This approach directly estimates the variation in the crop yield using a crop response model. It measures the impact of the studied factor by using different application levels. Many studies have used this approach to evaluate the impact of the climate on crop production. For example, (Reilly et al, 1994; Rosenzweig and Iglesias, 1994 and Rosenzweig and Parry; 1994). Rao and Sinha (1994) used this method to assess the impact of climate change on wheat production in India. More recently, Kumar and Parikh, (2001) evaluated the impact of climate modifications on rice and wheat by using this method.

This approach can assess the impact of low to very low factor variations; however it overestimates the damage to crop yields due to climate change. (Mendelsohn et al, 1994), called this bias as the 'dumb farmer scenario', in other words, it does not take into account farmers' adaptations as a response to social, economic and environmental changes. Indeed, most of the studies using this model do not take into account farmers' adaptations but simply assess one or several factors involved in crop yield. According to (Ouedraogo et al, 2006), the Ricardian approach, however, compensates for the bias in the production function approach.

3.1.2 The Ricardian Approach

The theory behind the Ricardian Model is mainly rooted in the famous theory of 'economic rents' by (Ricardo, 1815; Fonta, Ichoku and Urama, 2011), but its application to climate-land value analysis draws extensively from Mendelsohn *et al*, (1994). The Model simply examines how climate in different places affects the net revenue or value of land. The Ricardian approach is a cross-sectional model applied to agricultural production. It is based on land rent which is seen as the net revenue from the best use of land. The land rent reflects the net productivity of farmland. Farm value consequently reflects the present value of future net productivity, Ouedraogo et al, (2006). Seo and Mendelsohn (2007) explained the structural Ricardian model as a micro econometric model in which a land agent (farmer) makes a choice from many alternatives in the first stage. He then maximizes net revenues in the second stage depending on the choices he made in the first stage. Choices available to them include one of the following farm types: crop-only dry land farm, crop-only irrigated farm, mixed (both crops and livestock) rain-fed farm, mixed irrigated farm, and livestock-only farm. It is assumed that the farmer chooses the farm type which maximizes his net revenue where net revenue includes his own consumption.

Some of the advantages of the Ricardian Model according to (Seo *et al.* ,2005) as quoted by (Fonta et al, 2011) include:

a) it accounts for the direct impacts of climate on yields of different crops.

b) it accounts for the indirect substitution of different inputs, introduction of different activities, and other potential adaptations by farmers to different climates.

That is why Mendelsohn and Dinar (1999) states that the greatest strength of the model is its ability to incorporate the changes that farmers would make to tailor their operations to Climate Change. That is it incorporates the adaptation measures that the farmers would undertake.

Though the Ricardian Model has the advantages mentioned above over other alternative climatic impact models such as the Production Function Model (PFM), the Agronomic-Economic Models (AEM) and the Agro-Ecological Zone Model (AEZM), it has been extensively criticized on the following grounds:-

(i) crops are not subject to controlled experiments across farms as the case with the AEM and AEZM,

(ii) it does not account for future changes in technology, policies and institutions,

(iii) the model assumes constant prices which is really the case with agricultural commodities since other factors determine prices; and,

(iv) it fails to account for the effect of factors that do not vary across space such as carbon dioxide concentrations that can be beneficial to crops Hassan, (2010) as cited by Fonta et al (2011).

Even though the Ricardian Model suffers these major disadvantages, it has been widely used by many environmental and economic analysts in both the developed and developing countries to predict the impacts of Climate Change with remarkable success. These include Mendelsohn and Nordhaus, (1996), Mendelsohn and Dinar (1999 & 2003), Mendelsohn (2000), Kumar and Parikh, (2001), (Deressa *et al.,(* 2005), Deressa (2006), Seo *et al., (*2005), Seo and Mendelsohn (2006), Ouedraogo *et al. (*2006), Seo and Mendelsohn, (2008a, 2008b, 2008c), Hassan, (2008), Mendelsohn *et al.* (2009), Fonta et al (2011).

3.2 Empirical Literature

(Fonta, Ichoku and Uramah 2011), used the Ricardian cross-sectional Model in their study of the "impact of climate change on Plantation Agriculture in Nigeria" and the result showed that most of the climatic, household and other variables have significant impacts on the net revenue per hectare. Their analysis also showed that climate change is damaging to net revenue in some states.

Using Granger causality test analysis, Ayinde et al, (2010) in their study of Agricultural production and Climate Change got a regression result which shows that there is positive impact on agricultural output at 5% significant level. This means that the increase and decrease in the rainfall pattern affects the current output that leads to a rise or fall in output. The effect, implies that a 0.24 increase change in rainfall will likely result in a unit increase change in agricultural output and vice versa.

The effects of climate change on the grain production were estimated by Huang et al (2008) using first the ordinary least square(OLS)-non-spatial models, and then a spatial econometric modeling that employed the Maximum Likelihood Estimation approach. The analysis results indicated that the climate change has certain impact on the grain production of China. By doing spatial econometric analysis, they estimated the elasticity of climate change on grain production in China consistently and efficiently.

The analysis of their results indicated that the effects of climate change on the grain production could be accurately estimated on the spatial dimension. Spatial lag/error model built on the rational of spatial econometrics might be an alternative to capture the effects of the spatial effects from the dependent as well as the independent variables.

Sowunmi and Akintola (2010) examined the changes in climatic elements and agronomic parameter (maize, hectare and output) for maize production in different ecological zones of Nigeria from 1980 - 2002. Their study also evaluated the degree of variability in these parameters and revealed that there are significant differences in average annual rainfall, temperature, maize, hectare and output in the seven identified ecological zones ($p<0.05$). Less variability was shown by annual temperature and rainfall over the years and annual maize, hectare and output exhibited high variability in the ecological zones.

In a study on crop yield variability as influenced by climate, Chi-Chung et al. (2004) submitted that precipitation and temperature are found to have opposite effects on yield levels and variability of corn (maize). Furthermore, they reasoned that more rainfall can cause yield levels to rise, while decreasing yield variance and that temperature has a reverse effect on maize production.

WMO/UNEP (1996) report, found out that overall global warming is expected to add in one way or other to the difficulties of food production and scarcity. The report also stated that reduced availability of water resources would pose one of the greatest problems to agriculture and food production, especially in the developing countries.

The regression results from Ouedraogo, Somé and Dembele (2006) show that the signs of seasonal climatic variables are the same for all the estimated models in Burkina-Faso. They found that temperature or precipitation affects agricultural productivity and that water is the main factor that explains the low productivity in Burkina Faso.

The study by Ajewole, Ogunlade and Adewumi, (2010) used descriptive statistics and Granger causality test as the analytical tools. It was observed that there was continuous rise in output from 1987 to 2000 before it dropped in 2001 and the Granger causality approach revealed that changes in rainfall (climatic parameter) positively affects agricultural production in Nigeria. They therefore, recommended that if agricultural production will be increased and sustained, irrigation is the most suitable mode of water provisions, which would not have negative influence on the environment.

To assess the impact of climate change on agriculture over Tamil Nadu in India, Ramaraj et al (2010) used outputs of PRECIS Regional Climate Model and DSSAT crop simulation model. PRECIS Regional Climate Model was used for downscaling of a domain over the whole Tamil

Nadu with a horizontal resolution of 0.22° (25km). The PRECIS was run from 1960 up to 2098 continuously. They found that the level of CO_2 enrichment had increased the yield of both crops compared to normal level of CO_2 (330ppm). There was no definite trend of impact of predicted temperature on both rice and groundnut yield.

3.3 Limitations of Previous Studies

Although some studies on the impacts of climate change on livestock production have been done in some West African countries, some of these studies were either in a limited area or for the yield of a single crop, such as rice, wheat or maize. Sagoe (2006), Ouedraogo, Somé and Dembele (2006), Ramaraj, Jagannathan and Dheebakaran (2010). None has gone further to do a general comparative study of the impact of climate change on Livestock production across countries.

CHAPTER FOUR

THEORETICAL FRAMEWORK AND METHODOLOGY

4.1 Theoretical framework

The theoretical framework for this study is based on the production function approach, which is being adopted as the general framework to model the effects of climate change on livestock production. As expressed in the theoretical literature, the selection of this approach was based primarily on issues related to data availability: more specifically, data were only available on an aggregate basis for the selected countries. Consistent time series of climate data (rainfall and precipitation) were not available for the selected countries in West Africa hence the use of Renewable Internal Fresh Water Resources. However, the available data did not allow other competing models to be utilized.

According to Mendelsohn, Nordhaus and Shaw (1994), production function models use empirical or experimental production functions, which include climate variables as inputs, to estimate the impact of climate change by examining the yield of specific agricultural output under different climate scenarios. These models, however, have an inherent bias because they assume little or no adaptation by farmers, but this study does not incorporate adaptation.

In an attempt to identify the effect of climate change, the analysis controls for price effects and typical agricultural factors such as area harvested, labour, machinery, fertilizer and pesticides, where applicable. Moreover, a long-run equilibrium relationship is expected between agricultural output, on one hand, and their climate factors, on the other.

A model based on a panel structure provides the ability to analyze a dataset consisting of both time series (different periods) and cross sections (different entities), each with one dependent and possible multiple independent variables. Broadly speaking, panel estimation can be divided into two approaches: fixed effects model and the random effects model approach. The fixed effects model approach assumes that intercepts across cross-sections may differ, whereas the slope estimates are fixed over time. The random effects model allows different parameters cross-sectional. Risse and Brooks (2008). Cross-country regressions help us determine whether cross-country variation in climate change can help explain cross-country variation in agricultural production. We would do this by exploiting the time-series variation of the data. Furthermore, panel data analysis helps us to control for bias due to unobserved country-specific effects.

We adopt the fixed effect model for a balanced panel data from ten West African countries. As stated earlier, the choice of these countries is based on trading blocs and agrarian characteristics of the other countries in West Africa.

The relationship between agricultural output and climate change in this study is analyzed with a balanced panel fixed effects model. The assumption of a constant slope and changing intercepts cross-sectionals and over time is held through the use of dummy variables for cross-sections and time-series. The panel is balanced because all observations are adjusted in such a way that every cross-section follows the same regular frequency, with the same start and end date.

4.2 Model Specification

The panel covers ten west African countries for the time periods from 1990 to 2010. Econometrically, the setup is to investigate the relationship between climate change and Livestock production.

Based on the production function approach and modifying the model used by the United Nations Economic Commission for Latin America and the Caribbean (ECLAC, 2010) for related studies in Guyana, the functional form specification of the equation is shown below;

LVSTKP = f (CO_2E, POP, GDPGR, RIFR, CASSAVA)...1

Equation 1 can be transformed in the form,

$$y_{it} = \alpha + \beta x_{it} + u_{it} \qquad i = 1, \dots . . N \qquad t = 1, \dots . . T \qquad ....2$$

To specify the fixed effects model, equation one is modified by decomposing the disturbance term u_{it}. The disturbance term is divided into an individual specific effect component, u_i, and a remainder disturbance, v_{it}, component that differs over cross section (countries) and time (year).

$$u_{it} = u_i + v_{it} \quad ....3$$

Equation (2) is now rewritten by substitution for u_{it} from equation (3) to find the fixed effect equation. Thus, the equation for the fixed effects model becomes:

$$y_{it} = \alpha_i + \beta X_{it} + u_i + v_{it} \quad ....4$$

which form the model below,

$$(LVSTKP)_{it} = \alpha_i + \alpha_1(CO_2E)_{it} + \alpha_2(POP)_{it} + \alpha_3(GDPGR)_{it} + \alpha_4(RIFR)_{it} + \alpha_5(CASSAVA)_{it} + u_i + v_{it} \; ....5$$

where, α_i (i=1….n) is the unknown intercept for each country (n country-specific intercepts). LVSTKP is the dependent variable (DV) representing aggregate livestock output in each country, where i = country and t = time

X_{it} represents one independent variable (IV).

β_1 is the coefficient for that IV,

u_{it} is the error term (the individual-specific time-invariant effects).

A dummy for each variable to take care of level at which it affects Livestock production is introduced in the model to give

$(LVSTKP)_{it} = \alpha_i + \alpha_1 D1(CO_2E)_{it} + \alpha_2 D2(POP)_{it} + \alpha_3 D3(GDPGR)_{it} + \alpha_4 D4(RIFR)_{it} + D5(CASSAVA)_{it} + u_i + v_{it}$....... 6

where

LVSTKP = Livestock Production

CO_2E = $C0_2$ emission.

POP = population

RIFR = Renewable Internal Freshwater Resources-proxy for rainfall (renewable internal freshwater resources refers to internal rivers and ground water from rainfall).

GDPgr **=** Gross Domestic Product growth Rate

CASSAVA **=** Cassava production

4.3 Justification of the model.

As stated before, the selection of the production function approach was based on issues related to data availability: more specifically, data were only available on an aggregate basis for the selected countries. Consistent time series of some climate data (rainfall and precipitation) were not available for the selected countries in West Africa. Hence, the use of renewable internal fresh water resources as a proxy for rainfall. However, the available data did not allow other competing models to be utilized.

The composition and the size of agricultural outputs, population and other explanatory variables used in this study highly differ among countries and are subject to many factors. Therefore, the compositions of these explanatory variables differ cross-sectionally. Thus, the econometric reasoning behind the applied model is explained by suitability for the attained sample. Research often focuses on the dynamic change of variables or the dynamic relationship between variables. However, in order to conduct any meaningful hypothesis test solely by the use of time-series data requires an extensive sample. Nevertheless, by applying a panel structure the number of degrees of freedom increases and thus the power of the test (Brooks,2008). In addition, this approach is highly suitable since the pool of cross sections and time series data replicates the problem of heterogeneity of the analyzed samples.

4.4 Estimation procedure.

The relationship between climate change and agricultural production in this study is analyzed with a balanced panel fixed effects model. The assumption of a constant slope and changing intercepts cross-sectionals and over time is held through the use of dummy variables for cross-sections and time-series. The panel is balanced because all observations are adjusted in such a way that every cross-section follows the same regular frequency, with the same start and end date.

4.5 Source of data

The data is drawn from the World Bank data base , the Nigerian Bureau of statistics, Food and Agricultural Organization data and consists of ten West African Countries; structured according to the fixed effects least-squares method in which ten cross sections are identified; Nigeria, Ghana, Burkina-Faso, Mali, Niger, Benin, Senegal, Gambia, Togo and Cote D'voire with 21 observations each, for the years ranging from 1990 to 2010.

CHAPTER FIVE

DATA ANALYSIS AND EMPIRICAL RESULTS

5.1 Presentation of Results

Carbon Dioxide emission is one of the major climate change indicators. Its effects on the environment especially in the Less Developed Countries with poor adaptation measures for mitigation is always devastating.

Fig 5.1 below shows CO_2 emission distribution in the West African countries under study. The graph shows a steady CO_2 emissions in all the countries between 1990 and 2008 with Togo, Senegal and Nigeria having higher volumes of emissions than the other seven countries during the period under consideration. The three countries also exhibited significant fluctuations over the years in their emissions levels. Burkina Faso and Benin Republic have the lowest levels of CO_2 emissions among the countries studied.

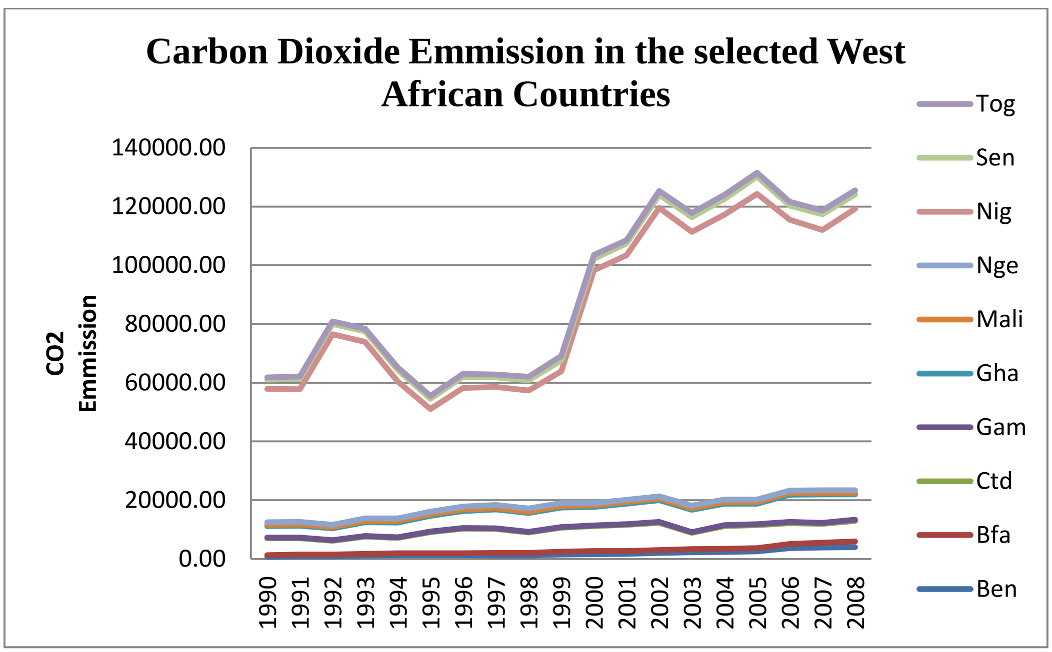


Fig: 5.1: Source. Author's Expression (2015)

Variations in Carbon Dioxide Emissions in these countries can also be observed clearly from Fig. 5.2 below. A large percentage of total emissions over the years studied is accounted for by Nigeria. This obvious considering her size and level of technological development. The country has more cars, industries and gas flaring sites than any other country in the sub-region.

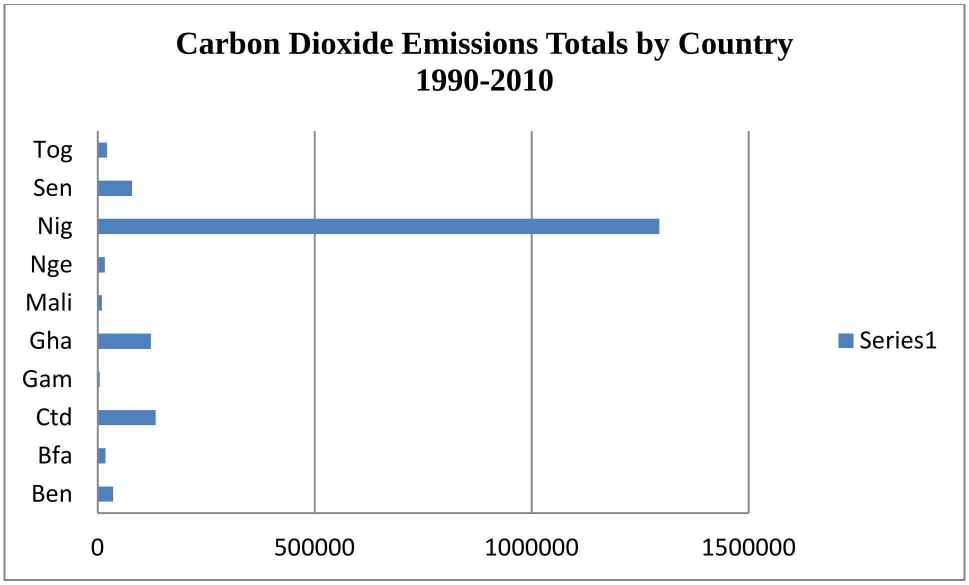


Fig: 5.2: Source. Author's Expression (2015)

Fig. 5.3 below shows a steady decline in Renewable Fresh Water Resources availability in all the countries. From the figure, availability of Renewable fresh water Resources in these countries can be grouped into three, based on volume. Mali, Niger, Nigeria, Senegal and Togo have between 12000 and 32000 cubic meters ; Cote d'voire, Gambia and Ghana have between 6000 and 15000 cubic meters then Benin Republic and Burkina Faso have between 1000 and 4000 cubic meters.

Total Renewable Internal Fresh Water Availability by Country (1990-2010)

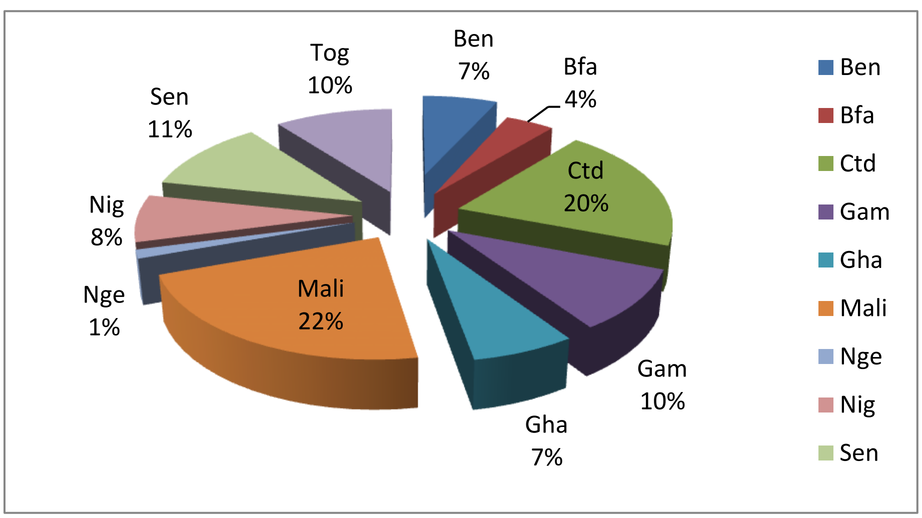


Fig: 5.3: Source. Author's Expression (2015)

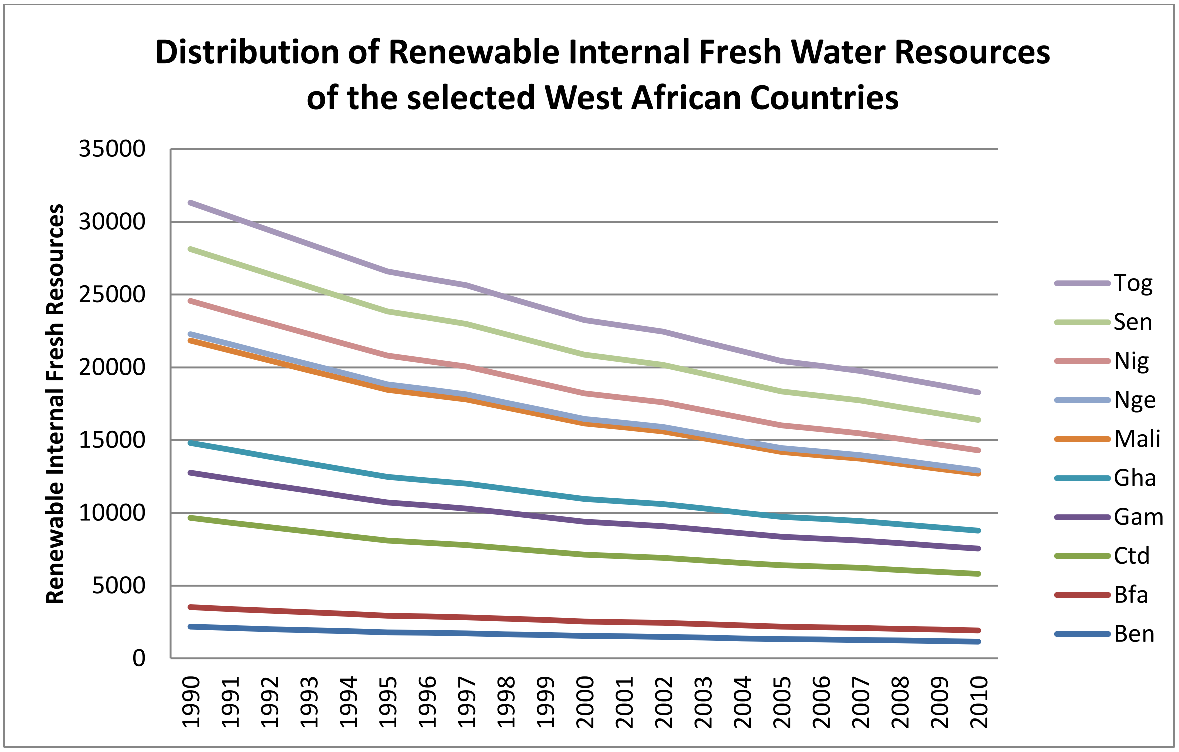


Fig. 5.4: Source. Author's Expression (2015)

The estimated fixed effect result with country specific coefficient

From the fixed effect pooled result (see Appendix II on Pg 44), carbon emission (CO_2E) an indicator of climate change has a significant negative impact on livestock production only in Burkina Faso and Nigeria. The t-statistic of CO_2E in Burkina Faso is -2.8659 with a probability value less than 5% which shows a significant impact at 5% significant level. In Nigeria, CO_2E has a t-value of -2.0735 at a probability of 0.04%. This implies that an increase in carbondioxide emission in Burkina Faso and Nigeria will lead to a decrease in livestock production. The result does not show a significant impact of climate change indicator (CO_2E) on livestock production in the rest of the countries studied. Hence, for this study only Burkina Faso and Nigeria are experiencing a significant impact of climate change on livestock production. However, both countries do not exceed the threshold point of 350ppm as shown by the value of their coefficient.

Moreover, population have a significant positive impact on livestock production in Burkina Faso, Gambia, Ghana, Mali, Niger and Togo. The t-statistics of population in these countries are highly significant, which shows that population affects livestock production in the six countries. This implies that an increase in population in these six countries will lead to an increase in livestock production. The result does not show a significant impact of population in the rest of the countries under review. Hence, for this study the population of Burkina Faso, Gambia, Ghana, Mali, Niger and Togo cause an increase in livestock production.

The only country where GDP growth rate affects livestock production is Cote d' Ivoire. From the result, an increase in GDP growth rate by a unit will lead to an increase in livestock production by 1.22 units.

Again, renewable fresh water have a significant impact on livestock production in four of the countries used in this study-Ghana, Mali, Nigeria and Togo. However, the impact varies, while it has positive impact in some countries (Ghana, Mali and Togo) it has a negative impact in Nigeria.

The F-probability shows how important and significant the overall model is, from the result, the f-probability is highly significant showing the independent variables across the countries have a significant impact on the dependent variable.

The fixed effect regression result with common coefficient

Variable	Coefficient	Standard Error
CO2E	0.0004451 (2.83)	0.0001571 (0.005)
Cassava	3.78e-07 (0.13)	2.80e-06 (0.893)
Population	1.33e-06 (5.51)	2.42e-07 (0.000)
Rifr	0.0202159 (10.05)	0.0020125 (0.000)
GDPgr	0.2707532 (1.40)	0.1931189 (0.163)
DumCO2	-3.783708 (-0.50)	7.555762 (0.617)
-Cons	109.4105 (13.77)	7.944285 (0.000)
R^2: within = 0.6026 between = 0.0126 overall = 0.0163		
Prob > F = 0.0000		

The results of the regression suggest that 60.26% of the explained variation in the dependent variable accounted for by all explanatory variables. With an F probability of 0.0000 the result suggests that the model used is strongly significant at 1% significant level. Considering the independent variables which include CO_2E, Population, RIFR, GDPgr, and $DumCO_2E$ we observe that climate change variables namely: CO_2E and RIFR exhibit positive relationship with livestock production at 5% confidence level. This means that with a t-value of 2.83 which is greater than

1.96, an increase in CO_2 emission increases livestock production by 0.0004 units in the ten West African countries. Also a unit increase in renewable internal fresh water resources, having a t-value of 10.05, will increase livestock production by 0.02 units.

However, beyond the CO_2E threshold of 350ppm, CO_2E becomes negatively related to livestock production in the countries studied. Under this situation, a unit increase in CO_2E with a t-value of -0.05. will decrease livestock production by 3.78 units.

A consideration of the other macroeconomic variables in the model viz:- Population and GDPgr (GDP growth rate), shows that while population has a positive relationship with livestock production, GDP growth rate does not have a significant relationship with livestock production in the countries under study. Population has a t-value of 5.51 and significant at 5% level but GDP growth rate has a t-value of 1.40 which is less than 1.96. Hence, a unit increase in population increases livestock production in those countries by 1.33e-06

Evaluation of Working Hypotheses

Test of Hypothesis 1

H_o: There is no significant difference in Livestock production in the West Africa countries studied.

H_1: There is significant difference in livestock production in the West African countries studied.

Decision

From Figures 5.1 to 5.4 we see that there are marked variations in the values of climate change variables in the West African countries studied. While Nigeria has the highest CO_2 emission in the sub-region totaling about 1294201.64 within a decade, Mali has the least.

However, Mali has the highest volume of Renewable Internal Fresh water Resources compared to other countries studied.

We, therefore , reject the null hypothesis and conclude that there are variations in values of climate change variables (indicators) among the ten West African countries studied.

5.3.2 Test of Hypothesis 2

H_o: Climate change indicators are not major determinants of variations in Livestock production in the West Africa countries studied .

H_1: Climate change indicators are major determinants of variations in Livestock production in West African countries studied.

Decision

The climate change indicators considered by the researcher are Carbon dioxide emissions and renewable internal fresh water resources (RIFR). The p-values for CO_2E and RIFR are 0.005 and 0.000 respectively which show both to be less than 0.05 and are therefore statistically significant, hence we reject the null hypothesis and conclude that CO_2E and RIFR are major determinants of Livestock production in the West African countries studied. The regression result shows that the Macroeconomic variables considered in the study which are Population , GDP growth rate and cassava have p-values of 0.000, 0.163, and 0.893 respectively. The p-values of GDP growth rate and Cassava are greater than 0.05 meaning that they are not significant at 95% percent implying that they are not determinants of Livestock production in these countries under study. But the p-value of Population shows that it is significant at 95% meaning that population is a determinant of Livestock production in these countries.

Result Findings

From the fixed effect result, carbon emission (CO_2E) an indicator of climate change have a significant negative impact on livestock production only in Burkina Faso and Nigeria. This implies that an increase in carbon emission in both Burkina Faso and Nigeria will lead to a decrease in livestock production. The result does not show a significant impact of climate change indicator (CO_2E) in the rest of the countries of study. Hence, for this study only Burkina Faso and Nigeria are experiencing a significant impact of climate change on livestock production.

The result generally implied that climate change in West Africa has not yet had a devastating effect on livestock and other agricultural productions in the region. Thus, the decline in agricultural production, livestock production in particular, may likely be due to some other domestic and macroeconomic factors. From the result it can be seen that some of these factors (GDP growth rate and population) have a significant impact on livestock production.

There are meant to be variations in the effect of climate change and other control variables on livestock production used in the study due to the fact that the individual countries have specific domestic problems peculiar to them. This was uphold in the study as the impact of climate change and other independent variables on the dependent variable used in the study differ.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Summary of Findings

This study has examined the effect of climate change indicators on livestock production in ten West African countries. The study used the production function approach to model the effects of climate change on livestock production. From the fixed effect result, carbon emission (CO_2E) an indicator of climate change have a significant negative impact on livestock production only in Burkina Faso and Nigeria. This means that an increase in carbon emission in the Burkina Faso and Nigeria decreases livestock production.There is no significant impact of Carbondioxide Emmission (CO_2E) in the rest of the countries the study.

This means that an increase in CO_2 emissions will decrease livestock production in Burkina Faso and Nigeria but beyond the tipping point(threshold) an increase in CO_2 emissions will increase livestock production. The study also suggests that the other climate change indicator which is renewable internal fresh water resources also has a positive relationship with livestock production in some countries but a negative impact in Nigeria. The result equally found that population has a significant impact in six out of the ten countries in study. So, the decline in agricultural production and particularly livestock production may be likely due to other domestic and macroeconomic factors, as shown in the result where some of these factors (e.g. GDP growth rate and Population) have significant impact on livestock production.

Thus, countries in West Africa should look inwardly within their country and vigorously pursue policies that will improve agricultural production (particularly livestock production) as it concerns their climatic conditions and other internal factors that may be affecting the livestock production. While countries like Nigeria and Burkina Faso should look into their CO_2E emission, countries like Togo, Mali, Ghana and Niger should look into their renewable fresh water and populations policies to improve their livestock production.

6.2 Policy Implications of Findings and Recommendations

The results of this study emphasize the need for reduction carbon dioxide emissions in most West African countries in order to save their economies especially livestock production. This can be achieved through the following measures:-

i) a coordinated and sustained policy on carbon dioxide emissions reduction measures such as a ban on bush burning, importation of rickety vehicles and industrial machinery.

ii) Carbon tax should be introduced in the oil producing countries in the region to to encourage oil companies to reduce gas flaring.

iii) The countries can also purse "Green Economy" measures such as solar energy for their industrial and domestic power needs.

On depletion of Renewable Internal Fresh water Resources through drought and other natural phenomenon like climate change, governments should develop irrigation and grazing sites for the agricultural production needs of their economies.

6.3 Suggestions for further Research

Climate change study is relatively new in Economic literature especially in this part of the globe. The importance of this study cannot be overemphasized as agricultural production in general and livestock production in particular is a significant determinant of total wellbeing of many economies. It is , therefore, very important that other agricultural sectors in West African countries could be studied, the aim being to reduce effect of climate change on agricultural production in the sub-region.

Studies of climate change effect on livestock production could also be focused on a country or on other African Economic blocks.

Climate change has been said to impact mostly adversely, all sectors of every economy. This same study can also be carried out in other sectors of the economy of these countries to proffer solutions to the impact of climate change in those sectors in those countries, especially those with very high climate change vulnerability.

Adaptation and mitigation studies of climate change are other areas that are begging for exploration especially in Africa.

These suggested studies if and when carried out will go a long way to stimulate the debate on the subject, raise confirmations and disagreements to the results, and above all build a body of literature on the subject which is lacking but highly needed in this part of the World.

6.4 Conclusion

Agriculture is the mainstay of most less developed countries of the World of which West Africa is a part. Its contribution to the economic well being of these countries is very significant. Agriculture in the form of crop production, livestock breeding, fishery and forestry is the primary sector of the economy of many West African countries.

However, declining agricultural production has become a general problem facing many Developing countries especially Sub-Saharan African countries where majority are engaged in rain-fed agricultural activities because of climate change and other macroeconomic, environmental and policy issues.

This study, therefore, examined the determinants of livestock production in an attempt to proffer policy recommendations that we believed can forestall the decline of livestock production in West African countries. Findings from the study suggests that climate change indicators namely: CO_2 emissions, renewable internal fresh water resources and population are significant determinants of livestock production. However, beyond CO_2 emission tipping point, it affects livestock production negatively implying that CO_2 emissions hence climate change adversely affects livestock production in the countries studied.

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Apendix I

```
. xtset id year
       panel variable:  id (strongly balanced)
        time variable:  year, 1990 to 2010
                delta:  1 unit

. gen dumco2e = .
(210 missing values generated)

. replace dumco2e=1 if co2e<=350
(17 real changes made)

. replace dumco2e=0 if co2e>350
(193 real changes made)

. . xtreg liveskp co2e cassava pop rifr gdpgr dumco2e, fe

Fixed-effects (within) regression               Number of obs      =       190
Group variable: id                              Number of groups   =        10

R-sq:  within  = 0.6026                         Obs per group: min =        19
       between = 0.0126                                        avg =      19.0
       overall = 0.0163                                        max =        19

                                                F(6,174)           =     43.97
corr(u_i, Xb)  = -0.9692                        Prob > F           =    0.0000

------------------------------------------------------------------------------
     liveskp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        co2e |   .0004451   .0001571     2.83   0.005      .0007552    .0001349
     cassava |   3.78e-07   2.80e-06     0.13   0.893      5.91e-06    5.15e-06
         pop |   1.33e-06   2.42e-07     5.51   0.000      8.54e-07    1.81e-06
        rifr |   .0202159   .0020125    10.05   0.000     -.0241879   -.0162439
       gdpgr |   .2707532   .1931189     1.40   0.163     -.1104039    .6519103
     dumco2e |  -3.783708   7.555762    -0.50   0.617     -18.69645    11.12904
       _cons |   109.4105   7.944285    13.77   0.000       93.7309      125.09
-------------+----------------------------------------------------------------
     sigma_u |  54.677549
     sigma_e |  9.9815721
         rho |  .96774905   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(9, 174) =    29.54              Prob > F = 0.000
```

t - statistics in parentheses under coefficients and p-values in parenthesis under the standard error
*** p<0.05, ** p<0.01, *** p<0.001**

Apendix II

Dependent Variable: LIVESKP?
Method: GLS (Cross Section Weights)
Date: 04/24/15 Time: 22:16
Sample: 1990 2008
Included observations: 19
Number of cross-sections used: 10
Total panel (balanced) observations: 190

Variable	Coefficient	Std. Error	t-Statistic	Prob.
_BEN--CO2E_BEN	0.002371	0.002716	0.872947	0.3842
_BFA--CO2E_BFA	-0.017280	0.006029	-2.865946	0.0048
_CTD--CO2E_CTD	-0.001015	0.001107	-0.916382	0.3610
_GAM--CO2E_GAM	-0.073250	0.081307	-0.900909	0.3692
_GHANA--CO2E_GHANA	-0.002549	0.001741	-1.464611	0.1453
_MALI--CO2E_MALI	-0.007413	0.071703	-0.103391	0.9178
_NGE--CO2E_NGE	-0.001864	0.005839	-0.319256	0.7500
_NIG--CO2E_NIG	-7.18E-05	3.46E-05	-2.073482	0.0400
_SEN--CO2E_SEN	-0.001187	0.002759	-0.430327	0.6676
_TOG--CO2E_TOG	0.001453	0.004746	0.306103	0.7600
_BEN--POP_BEN	7.01E-06	6.54E-06	1.070840	0.2861
_BFA--POP_BFA	9.26E-06	2.93E-06	3.154539	0.0020
_CTD--POP_CTD	6.79E-06	5.20E-06	1.304890	0.1941
_GAM--POP_GAM	0.000120	5.14E-05	2.333770	0.0210
_GHANA--POP_GHANA	1.06E-05	3.02E-06	3.503293	0.0006
_MALI--POP_MALI	3.99E-05	2.71E-06	14.72154	0.0000
_NGE--POP_NGE	9.58E-06	1.16E-06	8.238309	0.0000
_NIG--POP_NIG	1.38E-07	2.08E-07	0.662256	0.5089
_SEN--POP_SEN	8.04E-06	5.71E-06	1.407567	0.1615
_TOG--POP_TOG	6.52E-05	5.03E-06	12.97246	0.0000
_BEN--GDPGR_BEN	-0.332326	0.266146	-1.248661	0.2139
_BFA--GDPGR_BFA	-0.170457	0.184196	-0.925411	0.3563
_CTD--GDPGR_CTD	1.225735	0.413508	2.964234	0.0036
_GAM--GDPGR_GAM	-0.073726	0.366552	-0.201135	0.8409
_GHANA--GDPGR_GHANA	0.960414	1.201878	0.799094	0.4256
_MALI--GDPGR_MALI	-0.212612	0.226121	-0.940256	0.3487
_NGE--GDPGR_NGE	0.088624	0.138969	0.637729	0.5247
_NIG--GDPGR_NIG	0.043768	0.067318	0.650167	0.5166
_SEN--GDPGR_SEN	-0.082268	0.537034	-0.153190	0.8785
_TOG--GDPGR_TOG	-0.070835	0.094983	-0.745762	0.4571
_BEN--RIFR_BEN	-0.002794	0.017582	-0.158936	0.8739
_BFA--RIFR_BFA	-0.028664	0.024517	-1.169154	0.2443
_CTD--RIFR_CTD	0.011527	0.016796	0.686316	0.4936
_GAM--RIFR_GAM	0.028949	0.015771	1.835597	0.0685
_GHANA--RIFR_GHANA	0.064626	0.025984	2.487105	0.0141
_MALI--RIFR_MALI	0.047143	0.007434	6.342015	0.0000
_NGE--RIFR_NGE	-0.015852	0.037883	-0.418437	0.6763
_NIG--RIFR_NIG	-0.056356	0.012849	-4.385846	0.0000
_SEN--RIFR_SEN	0.001372	0.017619	0.077844	0.9381
_TOG--RIFR_TOG	0.074632	0.009976	7.480936	0.0000
Fixed Effects				

_BEN--C	41.49783		
_BFA--C	15.65526		
_CTD--C	-65.70101		
_GAM--C	-106.8124		
_GHANA--C	-202.0489		
_MALI--C	-580.7104		
_NGE--C	-20.37535		
_NIG--C	176.3816		
_SEN--C	14.21104		
_TOG--C	-413.1045		
Weighted Statistics			
R-squared	0.992295	Mean dependent var	96.10948
Adjusted R-squared	0.989599	S.D. dependent var	31.57766
S.E. of regression	3.220512	Sum squared resid	1452.037
Log likelihood	-444.6755	F-statistic	462.3261
Durbin-Watson stat	1.742936	Prob(F-statistic)	0.000000
Unweighted Statistics			
R-squared	0.970454	Mean dependent var	84.57963
Adjusted R-squared	0.960113	S.D. dependent var	16.12535
S.E. of regression	3.220512	Sum squared resid	1452.037
Durbin-Watson stat	1.760669		

Appendix III

Climate Data

year	country		gdpgr	exchr	Cassava	co2e	liveskp
1990	Ben	1	7.04	272.2648	937313	715.07	70.42
1991	Ben	1	4.21	282.1069	1046450	828.74	69.25
1992	Ben	1	2.97	264.6918	1040840	905.75	71.2
1993	Ben	1	5.83	283.1626	1146600	1133.10	73.14
1994	Ben	1	-1.77	555.2047	1145800	1265.12	78.45
1995	Ben	1	10.13	499.1484	1237850	1327.45	76.8
1996	Ben	1	4.33	511.5524	1456610	1265.12	79.39
1997	Ben	1	5.73	583.6694	1918440	1217.44	80.41
1998	Ben	1	3.96	589.9518	1989020	1213.78	84.59
1999	Ben	1	5.34	615.6991	2112960	1562.14	82.8
2000	Ben	1	4.86	711.9763	2350210	1617.15	82.69
2001	Ben	1	6.25	733.0385	2703460	1738.16	85.65
2002	Ben	1	4.42	696.9882	2452050	2053.52	89.22
2003	Ben	1	3.88	581.2003	3054780	2321.21	86.75
2004	Ben	1	3.12	528.2848	2955020	2398.22	95.7
2005	Ben	1	2.87	527.4681	2861370	2566.90	99.18
2006	Ben	1	3.75	522.8901	2524230	3729.34	105.13
2007	Ben	1	4.626396	479.2668	2849060	3879.69	100.71
2008	Ben	1	5.018473	447.8053	3611210	4066.70	102.82
2009	Ben	1	2.66651	472.1863	3996420		95.95
2010	Ben	1	2.552781	495.277	3596000		114.27
1990	Bfa	2	-0.6089	272.2648	4440	586.72	54.68
1991	Bfa	2	9.073959	282.1069	3000	627.06	56.79
1992	Bfa	2	0.22792	264.6918	1500	630.72	58.27
1993	Bfa	2	3.467879	283.1626	500	627.06	58.27
1994	Bfa	2	1.310832	555.2047	1000	645.39	67.06
1995	Bfa	2	5.717828	499.1484	2000	627.06	68.21
1996	Bfa	2	11.01475	511.5524	1364	707.73	70.94
1997	Bfa	2	6.316834	583.6694	1379	806.74	73.62
1998	Bfa	2	7.307714	589.9518	1542	861.75	76.04
1999	Bfa	2	6.241682	615.6991	1572	931.42	78.74
2000	Bfa	2	1.888474	711.9763	2147	1041.43	83.78
2001	Bfa	2	6.613406	733.0385	2848	997.42	90.48
2002	Bfa	2	4.352964	696.9882	3006	1004.76	91.76
2003	Bfa	2	7.802494	581.2003	3213	1078.10	92.48
2004	Bfa	2	4.478452	528.2848	3337	1103.77	97.17
2005	Bfa	2	8.661873	527.4681	3492	1125.77	100.38
2006	Bfa	2	6.253146	522.8901	3731	1360.46	102.45
2007	Bfa	2	4.111398	479.2668	4606	1646.48	104.16
2008	Bfa	2	6.400003	447.8053	4500	1855.50	100.28

2009	Bfa	2	3.241294	472.1863	3967		102.99
2010	Bfa	2	5.805268	495.277	4100		112.93
1990	ctd	3	-1.23043	272.2648	1393000	5797.53	80.89
1991	ctd	3	0.056625	282.1069	1465000	5636.18	82.22
1992	ctd	3	-0.62252	264.6918	1502000	4624.09	85.05
1993	ctd	3	-0.39863	283.1626	1509000	5892.87	92.22
1994	ctd	3	2.144082	555.2047	1564080	5251.14	93.95
1995	ctd	3	7.052897	499.1484	1608000	7132.32	95.69
1996	ctd	3	6.745098	511.5524	1653000	8379.10	95.11
1997	ctd	3	5.681656	583.6694	2141230	8173.74	102.8
1998	ctd	3	5.128851	589.9518	2127520	6912.30	85.89
1999	ctd	3	1.943262	615.6991	2113890	6266.90	86.93
2000	ctd	3	-2.66828	711.9763	2100350	6791.28	89.51
2001	ctd	3	0.1	733.0385	2086900	7726.37	89.88
2002	ctd	3	-1.6	696.9882	2073540	7286.33	92.33
2003	ctd	3	-1.7	581.2003	2060260	5460.16	94.4
2004	ctd	3	1.6	528.2848	2074060	7664.03	98.96
2005	ctd	3	1.8	527.4681	2197990	7825.38	99.7
2006	ctd	3	1.2	522.8901	2267140	7139.65	101.34
2007	ctd	3	2.3	479.2668	2342160	6384.25	104.51
2008	ctd	3	3.8	447.8053	2531240	7014.97	110.76
2009	ctd	3	0	472.1863	2262170		115.2
2010	ctd	3	2.568203	495.277	2306840		121.74
1990	gam	4	3.592753	7.882675	6316	190.68	76.2
1991	gam	4	2.879226	8.80265	8832	198.02	78.65
1992	gam	4	3.512542	8.8875	9609	198.02	80.65
1993	gam	4	3.19235	9.128833	9945	209.02	82.25
1994	gam	4	1.562023	9.57555	10259	209.02	84.29
1995	gam	4	0.518378	9.54625	10551	216.35	83.53
1996	gam	4	4.248503	9.788951	10759	216.35	81.45
1997	gam	4	0.419773	10.20016	11178	216.35	83.69
1998	gam	4	3.654609	10.6431	11406	234.69	82.8
1999	gam	4	6.845964	11.39509	11630	256.69	83.33
2000	gam	4	6.134648	12.78763	7500	275.03	84.63
2001	gam	4	5.78409	15.68716	7690	282.36	82.5
2002	gam	4	0.45755	19.91825	8116	315.36	85.47
2003	gam	4	2.302593	27.30587	8674	315.36	98.35
2004	gam	4	9.209583	30.03012	9009	322.70	100.59
2005	gam	4	-0.89402	28.57543	9428	322.70	101.53
2006	gam	4	1.623116	28.06586	10074	337.36	97.89
2007	gam	4	4.669522	24.87513	7800	396.04	101.64
2008	gam	4	5.585901	22.19235	8360	410.70	104.44
2009	gam	4	6.263937	26.64435	7346		106.5
2010	gam	4	6.075639	26.94583	8189		107.17

1990	gha	5	3.328818	0.032616	78.46	3931.02	78.46
1991	gha	5	5.281826	0.036763	80.54	4044.70	80.54
1992	gha	5	3.879419	0.043685	81.15	4096.04	81.15
1993	gha	5	4.85	0.064871	86.98	4664.42	86.98
1994	gha	5	3.269206	0.095568	84.15	5071.46	84.15
1995	gha	5	4.023405	0.119914	82.7	5427.16	82.7
1996	gha	5	4.596154	0.163547	82.7	5757.19	82.7
1997	gha	5	4.198244	0.204796	83.88	6395.25	83.88
1998	gha	5	4.69375	0.231166	80.76	6409.92	80.76
1999	gha	5	4.428504	0.266643	84.47	6560.26	84.47
2000	gha	5	4.205555	0.544919	92.4	6299.91	92.4
2001	gha	5	4.539052	0.716305	92.22	6919.63	92.22
2002	gha	5	4.793643	0.792417	90.73	7414.67	90.73
2003	gha	5	5.224149	0.866764	97.99	7601.69	97.99
2004	gha	5	5.353001	0.899495	97.36	7279.00	97.36
2005	gha	5	6.195754	0.906279	100.29	7007.64	100.29
2006	gha	5	4.551795	0.916452	102.36	9350.85	102.36
2007	gha	5	6.459591	0.935248	104.17	9636.88	104.17
2008	gha	5	8.430638	1.057858	117.88	8591.78	117.88
2009	gha	5	3.991354	1.4088	125.13		125.13
2010	gha	5	7.718001	1.421667	132.52		132.52
1990	mali	6	2.410011	272.2648	62.82	421.71	62.82
1991	mali	6	-0.19611	282.1069	61.19	436.37	61.19
1992	mali	6	9.688634	264.6918	56.52	443.71	56.52
1993	mali	6	6.229921	283.1626	57.49	454.71	57.49
1994	mali	6	0.912162	555.2047	58.47	462.04	58.47
1995	mali	6	6.209005	499.1484	60.35	469.38	60.35
1996	mali	6	3.218406	511.5524	61.76	487.71	61.76
1997	mali	6	4.900269	583.6694	63.4	524.38	63.4
1998	mali	6	8.076115	589.9518	66.12	517.05	66.12
1999	mali	6	5.700939	615.6991	68.77	539.05	68.77
2000	mali	6	-3.27573	711.9763	71.75	542.72	71.75
2001	mali	6	11.85434	733.0385	75.33	546.38	75.33
2002	mali	6	4.315697	696.9882	78.55	553.72	78.55
2003	mali	6	7.617708	581.2003	85.91	539.05	85.91
2004	mali	6	2.250991	528.2848	93.6	568.39	93.6
2005	mali	6	6.132869	527.4681	99.79	568.39	99.79
2006	mali	6	5.251356	522.8901	106.61	568.39	106.61
2007	mali	6	4.297161	479.2668	125.15	579.39	125.15
2008	mali	6	4.979164	447.8053	140.11	594.05	140.11
2009	mali	6	4.462806	472.1863	142.86		142.86
2010	mali	6	4.460846	495.277	147.07		147.07
1990	nge	7	-0.76534	272.2648	46.32	832.41	46.32
1991	nge	7	0.362711	282.1069	47.19	821.41	47.19

1992	nge	7	0.207963	264.6918	51.01	784.74	51.01
1993	nge	7	0.930238	283.1626	53.47	880.08	53.47
1994	nge	7	2.673745	555.2047	55	872.75	55
1995	nge	7	3.284556	499.1484	54.87	920.42	54.87
1996	nge	7	5.089437	511.5524	67	1015.76	67
1997	nge	7	0.496016	583.6694	67.62	1012.09	67.62
1998	nge	7	12.71185	589.9518	70.9	1074.43	70.9
1999	nge	7	0.993998	615.6991	74.04	1059.76	74.04
2000	nge	7	-2.58363	711.9763	79.61	795.74	79.61
2001	nge	7	7.517874	733.0385	85.51	759.07	85.51
2002	nge	7	5.276938	696.9882	87.19	814.07	87.19
2003	nge	7	3.39943	581.2003	90.49	880.08	90.49
2004	nge	7	-0.8215	528.2848	94.97	880.08	94.97
2005	nge	7	7.420992	527.4681	100.28	825.08	100.28
2006	nge	7	5.776191	522.8901	104.75	817.74	104.75
2007	nge	7	3.146624	479.2668	109.48	872.75	109.48
2008	nge	7	9.587673	447.8053	116.67	850.74	116.67
2009	nge	7	-0.90563	472.1863	107.13		107.13
2010	nge	7	7.467653	495.277	129.12		129.12
1990	nig	8	12.76601	8.038285	61.4	45375.46	61.4
1991	nig	8	-0.61785	9.909492	61.03	45247.11	61.03
1992	nig	8	0.433725	17.29843	61.91	64883.90	61.91
1993	nig	8	2.090378	22.0654	68.17	60061.79	68.17
1994	nig	8	0.909763	21.996	74.07	46658.91	74.07
1995	nig	8	-0.30747	21.89526	75.7	34917.17	75.7
1996	nig	8	4.993706	21.88443	77.5	40421.34	77.5
1997	nig	8	2.802256	21.88605	79.99	40190.32	79.99
1998	nig	8	2.71564	21.886	87.04	40182.99	87.04
1999	nig	8	0.474238	92.3381	90.47	44788.74	90.47
2000	nig	8	5.318092	101.6973	87.89	79181.53	87.89
2001	nig	8	4.411066	111.2313	92.6	83350.91	92.6
2002	nig	8	3.784648	120.5782	94.52	98125.25	94.52
2003	nig	8	10.35418	129.2224	95.25	93138.13	95.25
2004	nig	8	33.73578	132.888	98.75	97047.16	98.75
2005	nig	8	3.444667	131.2743	99.89	########	99.89
2006	nig	8	7.531735	128.6517	101.37	92225.05	101.37
2007	nig	8	5.093682	125.8081	105.49	88605.72	105.49
2008	nig	8	2.332722	118.546	108.34	95756.37	108.34
2009	nig	8	-8.27805	148.9017	112.73		112.73
2010	nig	8	2.758827	150.1867	117.35		117.35
1990	sen	9	3.904177	272.2648	73.69	3182.96	73.69
1991	sen	9	-0.39659	282.1069	77.84	3424.98	77.84
1992	sen	9	2.213524	264.6918	76.69	3479.98	76.69
1993	sen	9	-2.21841	283.1626	78.5	3593.66	78.5

1994	sen	9	2.869683	555.2047	80.07	3901.69	80.07
1995	sen	9	4.72596	499.1484	78.84	3494.65	78.84
1996	sen	9	5.220934	511.5524	78.22	3740.34	78.22
1997	sen	9	3.124033	583.6694	80.96	3263.63	80.96
1998	sen	9	5.898673	589.9518	80.72	3428.65	80.72
1999	sen	9	6.359843	615.6991	96.71	3700.00	96.71
2000	sen	9	3.186639	711.9763	92.74	3938.36	92.74
2001	sen	9	4.580916	733.0385	95.15	3938.36	95.15
2002	sen	9	0.654804	696.9882	85.91	4547.08	85.91
2003	sen	9	6.67084	581.2003	92.56	5012.79	92.56
2004	sen	9	5.883067	528.2848	92.54	5280.48	92.54
2005	sen	9	5.622607	527.4681	101.06	5859.87	101.06
2006	sen	9	2.46157	522.8901	106.4	4789.10	106.4
2007	sen	9	4.938485	479.2668	99.97	5372.16	99.97
2008	sen	9	3.24205	447.8053	105.35	4976.12	105.35
2009	sen	9	2.19507	472.1863	116.75		116.75
2010	sen	9	4.244276	495.277	118.06		118.06
1990	tog	10	5.897244	272.2648	65.54	773.74	65.54
1991	tog	10	0.22639	282.1069	64.05	843.41	64.05
1992	tog	10	-3.27932	264.6918	61.31	836.08	61.31
1993	tog	10	-16.3285	283.1626	61.79	865.41	61.79
1994	tog	10	13.93435	555.2047	61	832.41	61
1995	tog	10	6.770839	499.1484	56.08	953.42	56.08
1996	tog	10	7.662858	511.5524	60.42	1059.76	60.42
1997	tog	10	3.808757	583.6694	68.27	986.42	68.27
1998	tog	10	-2.31096	589.9518	72.1	1166.11	72.1
1999	tog	10	2.621452	615.6991	75.87	1536.47	75.87
2000	tog	10	-0.96333	711.9763	82.29	1356.79	82.29
2001	tog	10	-1.27335	733.0385	82.55	1162.44	82.55
2002	tog	10	-1.27355	696.9882	85.32	1232.11	85.32
2003	tog	10	4.847954	581.2003	89.54	1463.13	89.54
2004	tog	10	2.53608	528.2848	94.17	1397.13	94.17
2005	tog	10	1.238503	527.4681	102.78	1338.46	102.78
2006	tog	10	3.901154	522.8901	103.05	1221.11	103.05
2007	tog	10	2.083562	479.2668	109.06	1316.45	109.06
2008	tog	10	2.356917	447.8053	112.51	1419.13	112.51
2009	tog	10	3.599645	472.1863	123.97		123.97
2010	tog	10	3.711923	495.277	135.52		135.52

year	country		gdpgr	exchr	Cassava	co2e	liveskp
1990	Ben	1	7.04	272.2648	937313	715.07	70.42
1991	Ben	1	4.21	282.1069	1046450	828.74	69.25
1992	Ben	1	2.97	264.6918	1040840	905.75	71.2
1993	Ben	1	5.83	283.1626	1146600	1133.10	73.14
1994	Ben	1	-1.77	555.2047	1145800	1265.12	78.45
1995	Ben	1	10.13	499.1484	1237850	1327.45	76.8
1996	Ben	1	4.33	511.5524	1456610	1265.12	79.39
1997	Ben	1	5.73	583.6694	1918440	1217.44	80.41
1998	Ben	1	3.96	589.9518	1989020	1213.78	84.59
1999	Ben	1	5.34	615.6991	2112960	1562.14	82.8
2000	Ben	1	4.86	711.9763	2350210	1617.15	82.69
2001	Ben	1	6.25	733.0385	2703460	1738.16	85.65
2002	Ben	1	4.42	696.9882	2452050	2053.52	89.22
2003	Ben	1	3.88	581.2003	3054780	2321.21	86.75
2004	Ben	1	3.12	528.2848	2955020	2398.22	95.7
2005	Ben	1	2.87	527.4681	2861370	2566.90	99.18
2006	Ben	1	3.75	522.8901	2524230	3729.34	105.13
2007	Ben	1	4.626396	479.2668	2849060	3879.69	100.71
2008	Ben	1	5.018473	447.8053	3611210	4066.70	102.82
2009	Ben	1	2.66651	472.1863	3996420		95.95
2010	Ben	1	2.552781	495.277	3596000		114.27
1990	Bfa	2	-0.6089	272.2648	4440	586.72	54.68
1991	Bfa	2	9.073959	282.1069	3000	627.06	56.79
1992	Bfa	2	0.22792	264.6918	1500	630.72	58.27
1993	Bfa	2	3.467879	283.1626	500	627.06	58.27
1994	Bfa	2	1.310832	555.2047	1000	645.39	67.06
1995	Bfa	2	5.717828	499.1484	2000	627.06	68.21
1996	Bfa	2	11.01475	511.5524	1364	707.73	70.94
1997	Bfa	2	6.316834	583.6694	1379	806.74	73.62
1998	Bfa	2	7.307714	589.9518	1542	861.75	76.04
1999	Bfa	2	6.241682	615.6991	1572	931.42	78.74
2000	Bfa	2	1.888474	711.9763	2147	1041.43	83.78
2001	Bfa	2	6.613406	733.0385	2848	997.42	90.48
2002	Bfa	2	4.352964	696.9882	3006	1004.76	91.76
2003	Bfa	2	7.802494	581.2003	3213	1078.10	92.48
2004	Bfa	2	4.478452	528.2848	3337	1103.77	97.17
2005	Bfa	2	8.661873	527.4681	3492	1125.77	100.38
2006	Bfa	2	6.253146	522.8901	3731	1360.46	102.45
2007	Bfa	2	4.111398	479.2668	4606	1646.48	104.16
2008	Bfa	2	6.400003	447.8053	4500	1855.50	100.28
2009	Bfa	2	3.241294	472.1863	3967		102.99
2010	Bfa	2	5.805268	495.277	4100		112.93
1990	ctd	3	-1.23043	272.2648	1393000	5797.53	80.89
1991	ctd	3	0.056625	282.1069	1465000	5636.18	82.22
1992	ctd	3	-0.62252	264.6918	1502000	4624.09	85.05
1993	ctd	3	-0.39863	283.1626	1509000	5892.87	92.22
1994	ctd	3	2.144082	555.2047	1564080	5251.14	93.95
1995	ctd	3	7.052897	499.1484	1608000	7132.32	95.69
1996	ctd	3	6.745098	511.5524	1653000	8379.10	95.11