An analysis of environmental data and corresponding stakeholder perceptions with respect to climate change and crop production in Nigeria.

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Abstract

The Nigerian agricultural sector is threatened by climate change and its impacts, and this work investigated how environmental forcing influenced crop productivity over a 30-year period. Decadal variations of key staple food crops were assessed based on annual yields, and directly compared with environmental components: precipitation, humidity and extreme temperatures. Eight States that are key Nigerian staple crop producers which substantially contribute to the economy, were used for the study. Statistical tests and analyses were undertaken in the context of agro-ecological zones using data provided by the Federal Ministry of Agriculture and the Nigerian Meteorological Agency. For example, temporal and crop yield data were analysed using Kolmogorov-Smirnov tests and trend analyses, with significances (p) identified. In addition, questionnaires were designed to evaluate perceptions and awareness of different groups of the Nigerian population to impacts of climate change on agriculture. Three different, but comparable, questionnaires were distributed among farmers, the general public and government officials. There were 227 questionnaire responses from farmers; 401 from the general public and 50 from government officials. All questionnaire data were analysed using the Statistical Package for the Social Sciences (SPSS) software, WinSTAT Statistics Software Add-In for Microsoft Excel and Microsoft Office Excel spreadsheets, to identify correlations within and between questionnaire groups.

Results showed that between 1971 and 2011 maximum average temperatures, minimum average temperatures and precipitation increased in all States and across all agro-ecological zones. The central States of Edo, Kwara and Benue all showed statistically moderate correlations for maximum average temperatures, with R^2 values ranging between 30% and 40% ($p < 0.01$). Similarly, between 1971 and 2011 precipitation rose in all assessed States and agro-ecological zones. Statistically, Kano State showed the highest temporal correlation with an R^2 value that explained 50% of data variation. Humidity also displayed a positive correlation indicative of increasing temporal trends with Kwara State displaying the highest correlation. A total of ten major crops were assessed within the eight States and agro-ecological zones, with data acquisition covering the period 1980 to 2010. Statistical analyses showed varying results throughout, for example, Kwara and Benue displayed decreasing bean yields highlighted by negative correlations, while Kogi State exhibited the highest positive correlation indicative of increasing yam yields. Results further showed that both Kwara and Kogi States are most suitable with Kano and Ogun States being least favourable for rice production. Further crop assessments showed: Kano State having the highest positive correlation for groundnut production; Kwara and Kano States having the highest negative correlation for maize production; Kwara and Ogun States being negatively correlated for cassava production; and Niger State having high negative correlations, indicative of decreasing Guinea corn yields.

Questionnaire evaluations showed that most Nigerian farmers were fully aware of climate change and its impacts, with most complaining that due to higher costs there was little or nothing they could do to address the issues. Furthermore, 64% of Nigerian farmers trusted information received from mass media, while the majority attributed climate change to anthropogenic factors (41%). Results showed that most farmers were more concerned about increasing rainfall and drought than other environmental issues. Interestingly, the majority of the Nigerian public believed that climate change was

caused by both natural and human-induced factors, with >71% thought that the Nigerian climate has already been affected. Most of the public believed they were experiencing climate change issues such as drought, pollution, flooding, soil erosion, desert encroachment and heavy rainfall. Similarly, the majority of government officials questioned believed that climate change was already affecting Nigeria and, similar to the public, believed that climate change was caused by both anthropogenic and natural factors. The majority of government officials (61%) thought people should be encouraged to reduce energy consumption and their major concerns were the impacts on coastal zones, agricultural areas and water availability. However, much has already been done in the areas of flood protection, drought mitigation and coastal protection. In all, the three groups showed a high degree of understanding of climate change impacts and effects. Consequently, the thesis concludes by recommending crop diversification as a way of mitigating and adapting to climate change, with information sharing between academics, scientists, and government officials on how to mitigate and adapt. In conclusion, policy-makers must ensure that local farmers are supported and their institutions improved, as well as being educated on the threats, uncertainties and opportunities of climate change.

Chapter 1: Introduction

1.1 Preface

Climate change is attributed to numerous natural, economic, environmental, ecological and biological factors. Climate change has become a serious issue, which needs to be addressed at local, national and international levels. According to Pachauri, (2014), increased human population and a higher use of fossil fuels, coupled with over-fishing, deforestation, habitat degradation and fragmentation are causal factors of climate change. Scientific consensus has emphasised that the earth has changed rapidly, particularly following the industrial revolution of the 20th and 21st centuries. In contrast, others have emphasised that climate change results from long-term shifts in weather patterns, due to changes in humidity, precipitation and temperature through natural processes (Bernstein *et al.*, 2007).

Over decades, human activities have resulted in an increase in atmospheric CO_2, mainly through increased use and burning oil, gas and coal, coupled with widespread deforestation in many parts of the world, such as Nigeria (Bernstein *et al.*, 2007). Additionally, methane contributes to the effects of climate change, and increased mining, waste disposal and agricultural practices have further accelerated the warming effect. Climate change is impacting global agriculture and threatening food security. As a result, there is a need for governments in every country to implement mitigation and adaptation polices. Climate change can impact crop yield, but beyond food production, it will also contribute to desertification, pollution, water scarcity, habitat fragmentation, soil degradation as well as human health impacts (Haines *et al.*, 2006). In some regions, there will be higher temperatures, while in others, increased precipitation, leading to flooding, soil erosion and depleted nutrients availability. Increased temperature in turn leads to drought, desertification, and increased pest and disease. Prevalence climate change will also alter water availability and water supply, required for irrigation (Scholes *et al*., 2014). In many parts of the world, extreme weather events have threatened humans, wildlife and ecosystems, but research will focus on the impact of climate change on Nigerian agriculture.

1.2 Case Study

Nigeria is a country located in West Africa with population of over 180 million people (Figure 1.1). An increase in human population has resulted in higher demand for human resources and over-exploitation of natural resources, resulting in environmental degradation. Nigeria is ranked the eight largest producer of oil and gas and in recent years there has been an increase in the use of flaring gas and fossil fuels (Jike, 2004). However, in accordance with the Kyoto Protocol, there have been policies put in place in governing the oil and gas sector and environmental conservation.

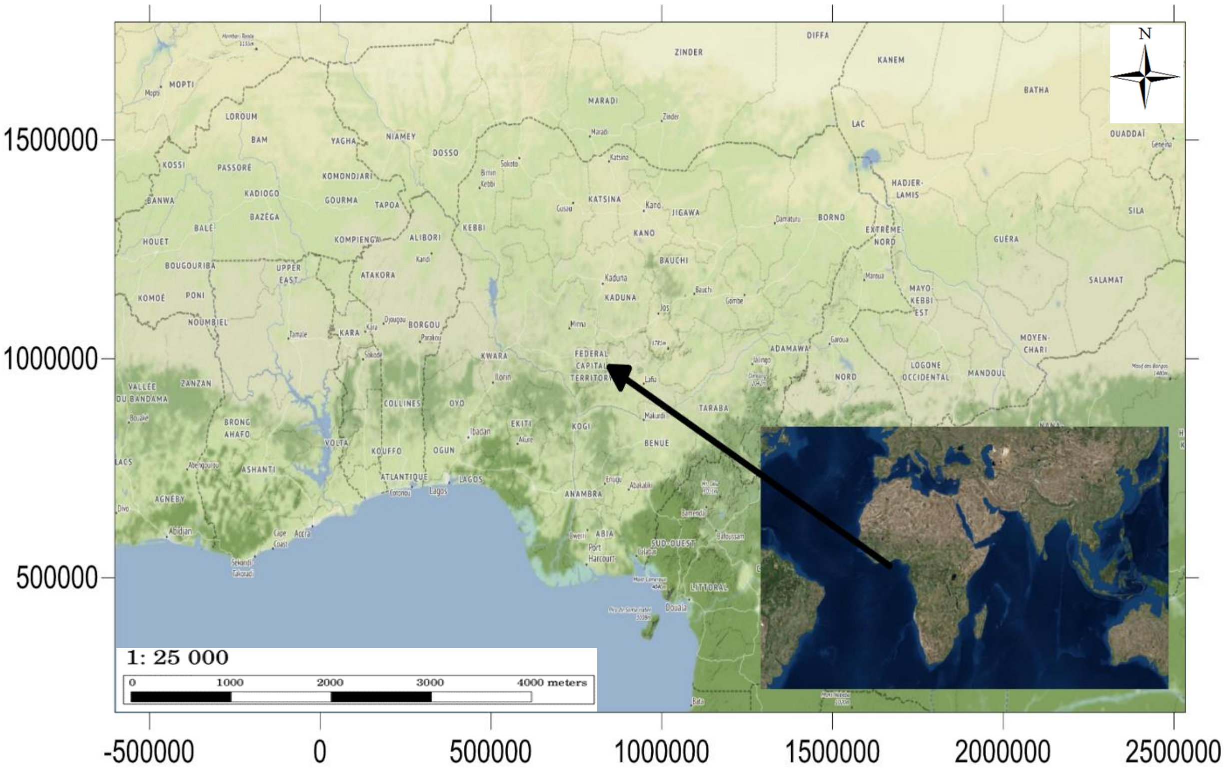


Figure 1.1: Nigeria Location Map

Higher use of fossil fuel has resulted in numerous environmental constraints. It is upon this that climate change mitigation and adaptation measures need to take in account of, based on international standards and negotiations, so that Nigeria and others can cope with the impacts and its vulnerability. The agricultural sector in Nigeria accounts for one of the largest sectors, providing employment to millions. However, there are numerous challenges, such as poor education, poor technology, lack of research, environmental issues and climate change and its vulnerability (Sayne, 2011).

This research examines the impact of climatic variables against food production in Nigeria from 1970-2011, together with crop yield and fertilizer use from 1980-2010. It was also necessary to investigate the perception of climate change from farmers, public and governmental perspective. The data were analysed using Excel and SPSS. The use of perception was to aid to understand how people perceptive climate change which will aid towards policy making mitigation and adaptation to climate change.

1.3 Research Rationale

In Nigeria, food production is highly dependent on environmental resources such as, rainfall, humidity and temperature, because most of the farming areas are rain-fed. As a result, food production will be adversely affected climate change significantly impacts these variables because it will alter both crop quality and quantity. According to Keane (2004), developing countries are more vulnerable to impacts because most of the developing nations lack the technological capacity of tackling climate change and its vulnerabilities. Nigeria is one such nation. By the utilisation of derived crop yield and environmental data, alongside questionnaires, research papers and publications, climate change effects were analysed.

1.4 Aim of the research

To analyse climate change impacts on crop production, perception and adaptation in Nigeria.

1.5 Objectives of the research

To achieve the aim following the objectives were established.

1) Analyse existing crop yield data derived from government sources for the period between 1981 and 2010.
2) Analyse existing environmental data including extremes of temperature, humidity and precipitation for the period between 1970 and 2011.
3) Assess questionnaire responses and interviews in order to understand the population's perceptions of climate change.
4) From an analysis of physical and perception data, appropriate adaptation and mitigation measures will be recommended.

The research inputs, outputs and outcomes are shown schematically in Figure 1.2

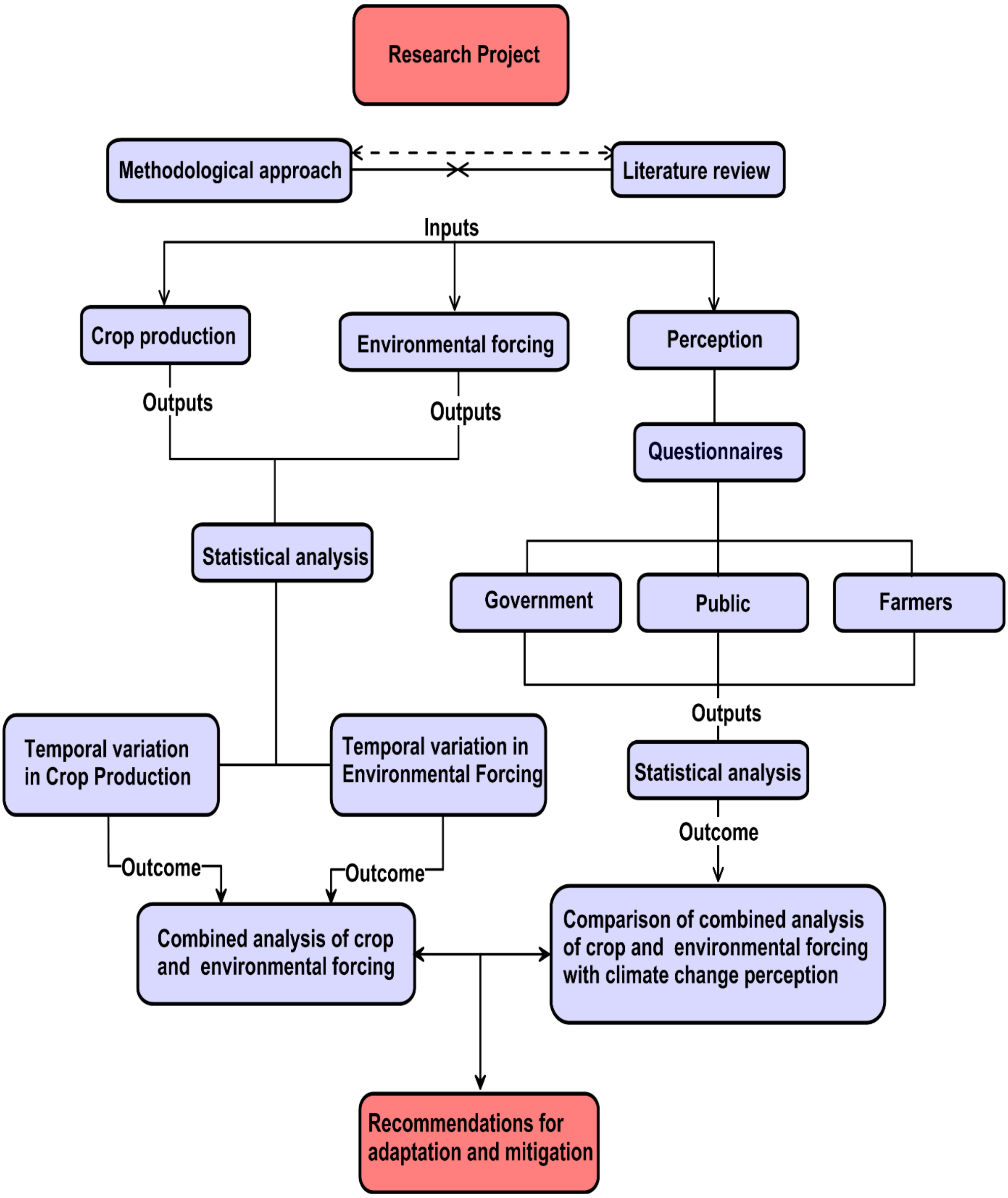


Figure 1.2: Synopsis of methodological inputs, outputs and outcomes

Chapter 2: Climate Change: Causes and Impacts

2.1 Introduction

This chapter aims to explore in-depth the causes and effect of climate change both at a global, national and regional level. Furthermore, it also considers ways by which the international communities have been involved in the reduction of CO_2 emissions. Since climate change is a global phenomenon, it is essential that this should be addressed from a global perspective, filtering down to the national and regional levels (Riti *et al*., 2017). In addition, the chapter explores how the developed and developing countries are experiencing and coping with climate change impacts. As the use of fossil fuels continues to increase, so CO_2 concentration will continue to rise in the atmosphere and this can only be addressed through mitigation and adaptation strategies (Chambwera & Stage, 2010). Developed countries improved ways of tackling such issues, through improved policies and legalisation. However, this is not the case for developing countries, where weak policies, legislation and governance is impacting on addressing climate change mitigation and adaptation strategies. This is what this chapter aims to address.

2.2 Climate change

Climate change has attracted the attention of scientists, academics, government and non-governmental organisations across the world (Crate & Nuttall, 2016). Scientific consensus is that global warming leads to impacts, such as rising sea levels, desertification, biodiversity and habitat loss, poor agricultural productivity, poor human health, increased migration levels, economic loss, changing landscapes, flooding and drought (Pachauri, 2014). Earth's physical, chemical and biological cycles are highly dependent on climate and any alteration to this will result in changes to the Earth's natural processes (de las Heras, 2014). During the last one hundred years, an increase in fossil fuel consumption, a consequence of human development, has accelerated changes in global temperatures. From a chemistry perspective, the primary gases within the atmosphere consist of nearly 79% nitrogen, 21% oxygen and other trace gasses such as chlorofluorocarbons (CFCs), ozone (O_3), carbon dioxide (CO_2), methane (CH_4), carbon monoxide (CO) and nitrous oxides (NO_x) (de las Heras, 2014).

It is known that an increase in these trace elements leads to changes in global temperatures.

Water is also important; the atmosphere contains between 0.5% and 4% water vapour with 40% to 90% of cloud cover reflecting around 83% of the heat from the sun (de las Heras, 2014). Higher global temperatures will increase evaporation rates placing more water into the atmosphere, which itself is a forcing agent. Figure 2.1 graphically demonstrates some of the climate anomalies experienced because of such atmospheric warming.

According to the Intergovernmental Panel on Climate Change (IPCC), these effects will have an increasingly devastating impact on human existence in years to come. Over the last 30 years, there has been increase in summer heat waves, notably in western and central Europe leading to excess of 20,000 deaths (Conti *et al.*, 2005; Michelozzi, *et al*., 2005). Furthermore, the period of 1995 to 2007 was ranked having the highest average global temperature on record (Haines *et al.*, 2006). While storm surges were experienced by countries such as Belgium, The Netherlands and northern France during the same period.

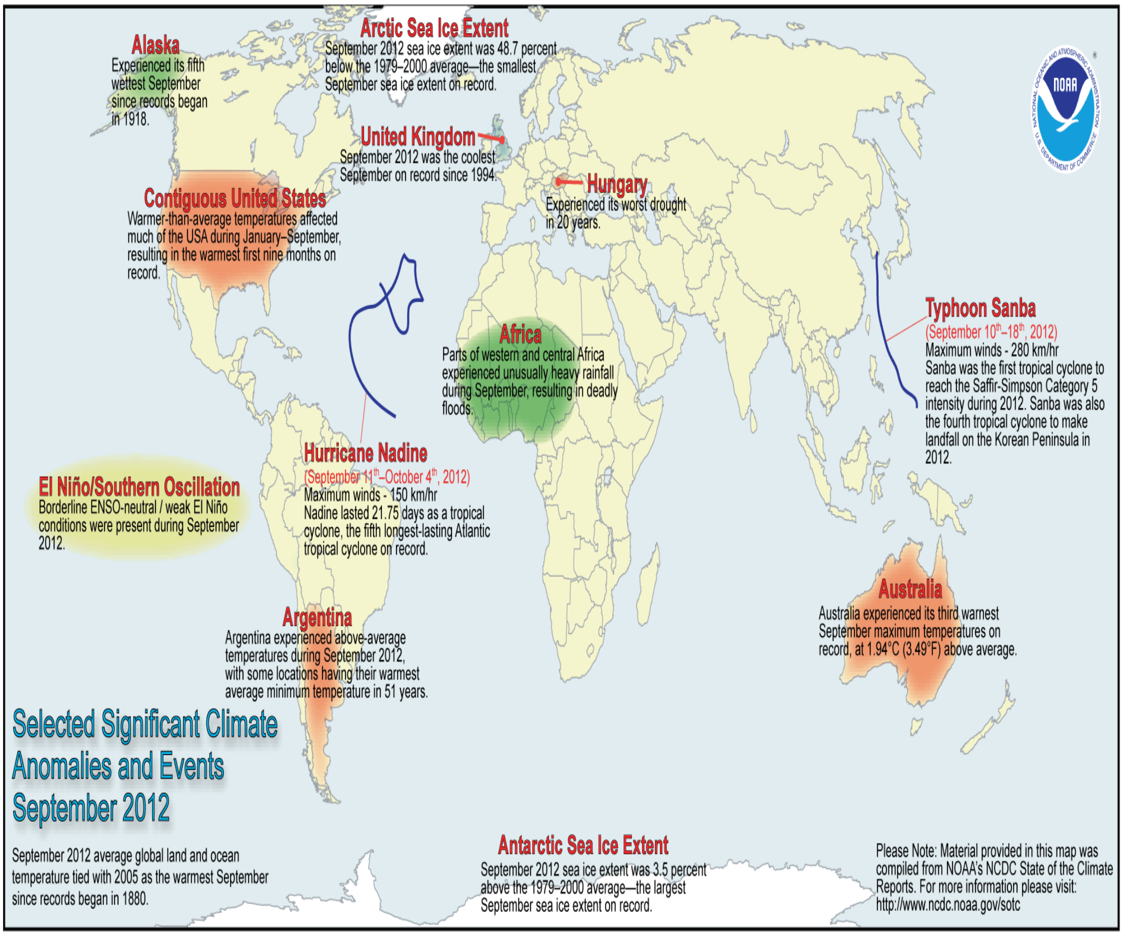


Figure 2.1 : Significant worldwide climate anomalies and events in 2012 (NOAA, 2012).

Using various temperature records such changes can be demonstrated. The most significant average temperature increase occurred during the mid-20th century, resulting in numerous anomalies, such as arctic shrinkage, which is turn led to an increase in storm prevalence in the northern hemisphere. As global temperatures accelerate, there is every possibility of physical changes across the globe which may benefit some areas and impact others (Smith *et al.*, 2001).

In 2007, the IPCC predicted that certain regions would experience an increase in heat waves leading to drought and other extreme weather conditions, such as hurricanes and tsunamis (Pachauri, 2014). Such changes are not new as, according to Hippocrates (*circa* 400 BC), a health epidemic was the result of rapidly changing weather events. Similarly, in the fourteenth and fifteenth century, climatic change led to starvation and the spread of disease causing social and economic collapse. More recent changes have led to extreme weather increasing the number of infectious diseases, especially vector borne diseases, something particularly evident in some developing countries mainly across Africa (Egbendewe-Mondzozo, *et al*., 2011; Tanser *et al*., 2003). This is because the transport of infection is highly dependent on, surface water, wind, and temperature allowing pathogenic organisms, such as bacteria, viruses, protozoa and flukes, to increase.

2.3 Atmospheric CO_2 Concentration

The IPCC Scientific Assessment Working Group has provided estimates of past and current CO_2 emissions and, as a result, it is anticipated that concentrations will increase in the next few decades (Houghton *et al.*, 2001). In addition, many experts and scientists have developed modelling techniques and improved technologies to calculate and monitor greenhouse gas emissions; the findings indicate that the increase in CO_2 contributes the most to climate change, and that this is expected to continue (Houghton *et al.*, 2001). In 2001, according to the report "Radioactive Forcing of Climate Change of the Intergovernmental Panel on Climate Change", it is evident that anthropogenic factors, contribute towards increasing CO_2 emissions when compared to natural CO_2 emissions and other gases (WHO, 2001). This is due to higher levels of energy consumption, transportation, industrialisation and intensive agricultural practices.

The IPCC have emphasised that one way to reduce the impact of greenhouse gases is through stabilisation, as it is more profitable to mitigate the issues of climate change and global warming. However, this is difficult to achieve given the accelerating rate of change currently being witnessed (Houghton *et al.*, 2001). The scientific credibility of CO_2 emission projections has been peer reviewed among experts and tends to be uniform across various researchers. Recently, the use of carbon cycling modelling has been used to evaluate CO_2 emissions from pre- to post-industrial eras, detailing atmospheric CO_2, fossil fuel emissions, net carbon flux from, land-use changes, net carbon uptake by the ocean, net flux associated with CO_2 enhanced growth, residual-sink term and other associated climatic variability in terms of molecular weight of carbon (Evans *et al*., 2005).

To reduce CO_2 emissions, stabilisation calculations have been put in place to help compare results from different models and data sets with which experts are able to quantify the amount of emissions from different sectors (Pachauri, 2014). Delaying the reduction in emissions is not helpful and the aim should be to reduce emissions now and continue to do so into the future.

2.4 The UNFCCC and Kyoto Protocol

The UN established the UNFCCC based on three international treaties during the UN Convention on Environment and Development in Rio, Brazil, in 1992 (Manolas, 2013). It established the Kyoto Protocol, which requires countries to combat issues of climate change, and both have clearly stated what is expected to safeguard the environment and contribute to a more sustainable world. The major issues highlighted were based on climate change mitigation and adaptation, and towards building and technological transfer among countries in other to share information of climate change and other forms of disaster outbreak. Other relevant treaties include the UN Conventions on Desertification (UNCCD) and Biological Diversity (CBD), which are associated with the issues of climate change and its potential impacts (IPCC, 2014). These Conventions generally aim to achieve the following:

- Gather information and share knowledge on greenhouse gas emissions at local, national and international levels.
- Develop national strategies for addressing issues of greenhouse gases and to tackle the potential impacts of climate change through best available policies and practices.
- Launch national strategies for adaptation through funding, financial and technological transfer mainly within developing countries.
- Develop measures for mitigation and adaptation approaches to tackle the impacts of climate change.

In general, developed nations are obliged to cut down their greenhouse gas emissions below the 1990 baseline while developing nations should be supported through funding and technology to reduce their emissions (Oberthür, 2011). In addition, the Kyoto Protocol established the carbon market tool which has now been deployed by countries as a means of reducing greenhouse gas emissions on a global scale (Grubb *et al.*, 2007). In 2006, this was estimated to have cost US$30 billion. Other aspects include involvement and investment in sustainable development projects mainly within developing countries, such as developing a green market and engaging with industry to reduce emissions. An adaptation fund focuses on adaptation projects and development programmes also mainly in developing countries (Pachauri, 2014).

2.5 Developing Countries in Negotiations

According to the international community, developing countries poorly equipped to cope with the impacts of climate change are assumed to be the most vulnerable (Najam *et al.*, 2003; Rubbelke, 2011). Therefore, it is essential these countries prepare adaptation strategies at an early stage on both national and sectorial development activities. This thesis aims to develop mainstream adaptation approaches to climate change examining the agricultural sector in a developing country, such as Nigeria.

Nigeria is considered to be one of 49 developing countries in the world as its *per capita* Gross Domestic Product (GDP) is below $900, meaning it has a lower state of financial, social, health care, infrastructural and technological development. Developing countries are expected to increase by a further 10% by 2050 (Von Braun, 2007). From 1990 to 1998, GDP increase for developing countries was estimated at 3.2% per year, which was the same as it was during the 1970s and 1980s (Von Braun, 2007).

In 1981, the first UN conference on developing countries was held in Paris by the UN General Assembly with the aim of considering the Substantial New Programme of Action (SNPA) for adaptation. This was to provide assistance where possible to help economic, social and technological developments within these countries but, despite all efforts, many countries did not see any financial improvement. A second UN conference was held in Paris in 1990 aimed at formulating national and international policies on how to improve and accelerate the development of such countries.

Developing countries are more vulnerable to the impacts of climate change and still lack the adaptive capacity to cope with all of the effects. Most of these countries already suffer from natural disasters such as flooding, drought and rising sea levels (El-Batran, 2015). However, various initiatives and strategies have been put in place; for example, between 2001 and 2010 funds were given for poverty reduction and improvements in sustainable development. In some cases, countries have unlimited implementation of such tasks, whereas other countries have been successful in improving sustainable development and limiting impacts such as carbon capture, improving green energy as well as improving polices for tackling climate change (Haszeldine, 2009).

Typically, adaptation to policies has become a key concept for international negotiation and, as such, this has helped experts prepare guidelines for implementation of better integrated concepts for national sustainable development strategies such as involving countries in addressing climate change worldwide through education and information sharing (El-Batran, 2015). For example, in two developing countries; Mali, (Africa) and Bangladesh, (Asia). These countries have now implemented polices for tackling climate change at a national level.

Accordingly, the vulnerability of climate change in these countries for mainstream adaptation into national policies and development planning was analysed and key concepts and lessons identified were as follows (IPCC, 2014).

- Research the potential impacts of climate change and a better need to support countries with the implementation of better policies.
- Involve the general public in the issues of climate change.
- Identify and focus on countries that need to build their national adaptive capacity.
- Improve dialogue between countries to improve adaptation and funding.
- Develop strategies to improve negotiation capacity between countries.
- Engage all administrative institutions and governments as well as informing civil societies of the importance of climate change adaptation and mitigation.

The major focus has since been the Millennium Development Goals with the expectation of the UN and other international organisations to improve capacity building by 2020. Commitments of the UN emphasise how to improve economic stagnation, although many of these countries still lacking in improvement because they are dependent on external finance (Keohane & Victor, 2011). Overall, there should be more focus on better ways to improve the economic future through better policies at a national level. The central role should be through sustainable development via proper governance to international standards, as well as investment in healthcare, education and other social-economic infrastructure, supporting GNP and GDP growth (Gowland-Mwangi, 2014).

2.6 Adaptation and Mitigation in Response to Climate Change

The IPCC held a meeting in Geneva to discuss the impacts, adaptation measures, vulnerability of climate change and various uncertainties which could occur. The aim of the adaptation and mitigation programme focused on how to reduce the impacts of climate change called 'Dangerous Impacts' by UNFCCC (Metz, *et al*., 2005; Keohane and Victor, 2011).

This is because across the globe, climate change results in numerous natural disasters and health issues, such as spread of diseases, heavier precipitation and rainstorms, drought flooding, raising sea levels and rapidly by increasing temperatures (Victor, 2011). As a result, it was concluded that all nations should participate in addressing climate change at local, national and international levels. However, the ability of many disadvantaged nations to cope and adapt will require focus on education, wealth distribution, and access to resources, management capacity and technology. Klein *et al*. (2005) have emphasised that, by the year 2050, if the developed nations can cap greenhouse gas emissions then this will help developing countries towards adaptation.

As earlier mentioned, it would be easier to mitigate the issues rather than apply adaptation measures; mitigation is the ability to agree and implement policies and approaches that can be followed to tackle climate change through effective policy and decision making. However, mitigation will not happen quickly where there are weak governmental policies and inadequate financial capacity to deal with the impacts (Twomlow, 2008; Willamson *et al*., 2012).

It is difficult to estimate the financial resources required for many developing countries, although in the last few decades' billions of dollars have been spent. In the years leading up to 2020, donor countries have pledged to spend over $100 billion per year to assist developing countries with adaptation programmes (Ayers & Huq, 2009). Additionally, Klein *et al*. (2005) also stated that cost-benefit analysis can be used to calculate the optimal balance of costs, impacts, vulnerabilities, adaptations and mitigations relevant to climate change, but it is very difficult to estimate future damage incurred across the globe.

2.7 Global Climate Change and Agriculture

Agricultural productivity is mainly determined by weather, climate, soil fertility and water. As a result, there has been growing concern regarding the effects of long-term climate change on global land crop productivity, especially given human population expansion resulting in loss of agriculture, global food security issues, and hydrological imbalances (Li Rui-Li & Geng, 2013).

While most focus is given to the negative impacts, an increase in temperature and changes to weather patterns could result to negative impacts on crop yields (Scholes *et al.*, 2014; Keane *et al.*, 2009), and higher CO_2 concentrations could result in a higher photosynthesis rate causing water loss.

Agriculture and its related processes also contribute to climate change, with an approximate 2% yearly increase in anthropogenic greenhouse emissions mainly from nitrogen fertilizers, flooding rice fields and biomass burning. Changes in land use to accommodate a growing need for agricultural space has led to deforestation, with CO_2 being produced during clearing. In some parts of the world, large amounts of crop residue are burned adding further to CO_2 levels. Advancements in agricultural science and technology are contributing towards further greenhouse gas emissions (Lobell & Field, 2008). Methane is another major gas released during agricultural practises (Section 2.2) mainly in the area of livestock production, but also from paddy fields and the burning of agricultural waste. China produces the highest proportion of CH_4 amongst Asian countries at 16% of global emissions, largely due to a higher use of fertilisers, water and a larger amount of land cultivation (Li Rui-Li & Geng, 2013). Methane emissions are also associated with large amounts of fibrous grasses which buffalo and cattle utilise, which can contribute up to 80% each year (Beauchemin, *et al.*, 2007).

Further to this, another gas, nitrous oxide is produced by the use of fertilisers, animal waste products and cropping cultivation as well as from the burning of biomass. Many farmers across the globe use nitrogen fertilisers to improve their crop yields, which tends to leach into the surrounding environment, ground water and into the atmosphere via evaporation, although this is highly dependent on microbial activities in the soil. For example, rice production absorbs a larger proportion of nitrogen fertilisers than most other crops (Li Rui-Li & Geng, 2013).

A reduction of organic fertilisers by using other mineral fertilisers could be considered an appropriate means of mitigation could be beneficial for reducing soil disturbances. For example, through the shift from traditional and mechanised farming processes. For larger livestock, such as cattle, the process of improving their diet has resulted in lower CH_4 emissions.

Through the treatment and proper management of animal waste, as well as reducing biomass burning, CH_4 emissions can be reduced a further 15 to 56% (Cline, 2007). However, this is considered to be expensive and is not carried out in many parts of the world.

Climate change impacts on agriculture differ in different parts of the world and the overall picture is complex. For example, changes in temperature and rainfall influence CO_2 levels and impacts are felt more acutely in tropical regions, such as Nigeria (Coppolai & Giorgi, 2005). However, the anticipation is that crop productivity will also be affected by the accelerated spread of pests and diseases in West Africa. In addition, areas considered suitable for cultivation may undergo geographic shifts as a result of climate change (Walther *et al*., 2002). Such changes potentially affect crop and grain production causing a decline in world cereal productivity meaning that low income earners with isolated agricultural systems and practises will be more vulnerable to the effects of hunger and starvation (Mortimore & Manvell, 2006). This is expected to happen mainly in dry lands situated in arid and semi-arid areas such as Southeast Asia and Africa, increasing the number of people affected by it. Hence, in some cases, a relatively small climate change in temperature can put substantial pressure on agriculture production due to the gap between current farming systems and prevailing climatic resources. Adaptation is widely recognized as the major response to climate change. However, the level or degree by which climate change affects agricultural productivity is determined by the ability to adapt to these changes (Egbule, 2015).

Climate change has the potential to alter agricultural production across the globe (Mortimore & Manvell, 2006). Droughts will result in a reduction of groundwater and that available for irrigation. There will also be land loss due to rising sea levels and an increase in factors associated with salinization. Geographical shifts will result from changes to temperature, cloud cover and soil moisture causing erosion, leaching of soil nutrients and loss of organic soil matter. As a general consequence, there will be a wider spreading of weeds, insects and disease, resulting in an increased use in pesticides and insecticides and subsequent loss of biodiversity (Hoffmann & Sgrò, 2011).

According to Lobell & Field, (2008), CO_2 fertilisation may result in increased agricultural productivity, notably that atmospheric CO_2 has had a positive impact on this. Under some circumstances, crop plants may be able to utilise water more with higher CO_2 levels (Lobell & Field, 2008) and, in some parts of the world, an increase in temperature may be beneficial to certain types of crops such as groundnuts. However, higher rainfall may also have benefits for irrigation practices and improved crop production, such as rice and wheat (Cline, 2007). As the human population increases, there will be an increase in land demand for agricultural land but such cultivation in turn could to an increase in CO_2, CH_4 and other greenhouse gasses. This will inevitably require adaptation and mitigation. Adaptation through improved irrigation systems, water management and changes in crops and crop varieties will be essential and other processes, such as the appropriate use of mineral fertilisers and other agricultural practises, will be needed as well as technological and socio-economic considerations (Ilukor, 2010).

2.8 Global Adaptation to Climate Change Impact

There are quite a number of organisations which are building partnerships with governmental agencies across the globe for climate change adaptation. It is clear that worldwide, agriculture is impacted due to higher temperatures, changes in weather patterns and changes in rainfall and with the population of developing countries increasing at an accelerating rate, food security will become at risk. As food scarcity will undoubtedly increase prices and costs of production, cereal and other staple goods will become unaffordable for many (Mortimore & Manvell, 2006). It is thought that many countries are already facing agricultural challenges, for example, in Africa such impacts are already causing droughts leading to child malnutrition. The international community, such as the Food and Agricultural Organisation of the United Nations, have been supporting countries with the aim of reducing hunger in Asia and Africa and are working in partnerships at local, national and global levels, as well as providing policies for the governance of natural resources and land management (Mortimore & Manvell, 2006).

The international community involvement includes key partnerships with the FAO and other UN agencies, civil society organisations, public and private sectors, and academic and research institutions.

In all, this is to eradicate hunger and improve food security as a global post-2015 development agenda. This includes the implementation and design of development programmes and policies which will support agricultural sustainability as well as including investments in agricultural productivity such as technology (Keohane & Victor, 2011). The Food and Agriculture Organisation of the United Nations (FAO), has also built a membership within the programme framework to promote and improve small-scale farming skills across Africa and to help reduce poverty and food insecurity. One of the major initiatives to enhance agricultural productivity is the Green Revolution which focuses on job creation, poverty eradication and enhancing rural infrastructure. Adaptation to climate change varies across regions and other factors including education and access to information, resource and wealth, infrastructure and institutional capacity, and efficiency affect a country's response (Adger *et al.*, 2009).

Most developed countries are able to cope with the impacts of climate change because of their wealth; however, this is not the case in developing countries as most of their focus is on indigenous practises as a means of adaptation which could be outdated. However, there are other non-climatic stressors which affect adaptation to climate change in Nigeria including poverty, lack of good education and poor technical facilities (Adger *et al.*, 2009). Adaptation requires helping communities understand more of the impacts and providing management strategies and global adaptation will involve a high level of risk-based approaches dealing with future uncertainties. Coping with the agricultural impacts of climate change is not only something which farmers should be involved with, but also other sectors such as researchers, stakeholders and policy makers. The right information is a vital requirement for successful adaptation to climate change, and mitigation remains the focus at every level (Howden *et al.*, 2007; Stokes & Howden, 2010).

2.9 Summary

This chapter considers climate change impacts at a global scale. It also considers the impacts of climate change on agricultural production as well as climate change mitigation and adaptation. Given the fact that developing countries, such as Nigeria, are more vulnerable to climate change. Mainstreaming adaptation approaches to the issues of climate change and other environmental factors is required at international, national and local standards in Nigeria. The following chapters discusses climate change and Nigerian agriculture. Section 2.6 considers that climate change adaptation and mitigation is crucial and should be adapted globally. This is essential given the increase in human population, and greater use of fossil fuel.

Chapter 3: Climate Change and Agriculture in Nigeria

3.1 Introduction

There are 36 States in Nigeria, and these States are classified under different agro-ecological zones, with various staple crops are cultivated. Nigeria is increasingly threatened by climate change, as well as environmental issues, such as drought, desertification and deforestation. It is therefore necessary to consider such issues, (forestry, water resources, fertilizer use, pest and insect management, soil fertility, land use and tenure system, and agricultural funding and extension programmes) in addition to climate change. Agriculture is a very important sector in the country, because it contributes to economic growth, as well as providing employment for many. As a result, it is essential that studies are conducted in this sector, in order to improve reliance mitigation and adaptation to climate change. The international community and other organisations have invested in the agricultural sector, yet, there are several economic, social, environmental and legislative challenges to resolve.

3.2 Drought and Desertification

Climate change has contributed to intensive drought and desertification from 1950 to 2006, this has seriously impacted several agricultural States in Nigeria. According to Mortimore & Manvell, (2006) the drought crisis was caused by lower rainfall over decades. Since the 1950s, weather patterns have forced communities to reassess their traditional agricultural practices as lower rainfall and crop productivity have led to increased mortality and poverty. Based on this, the Inter-Governmental Panel on Climate Change (IPCC), and the United Nations Environmental Programme (UNEP) have emphasised that Africa is the second most badly affected continent faced with drought and desertification after Asia, especially the Sub-Saharan regions. This in turn has an impact on a large number of the population in these regions, as summarised in Table 3.1.

Table 3.1: The effects of drought on population by region (Climate Variability, Environment Change and Food Security (source: Obioha, 2009).

Source: Underlying data from Reuveny (2005)

Region	Total number affected, 1971-2001 (millions)	No of people affected per occurrence (millions)
Africa	22.1	0.87
Asia	1095.83	9.36
Latin America	47.89	0.72
Oceania	8.65	0.39
Europe	6	0.27
North America	0.03	0.0025

The key indication is that climate variability results in drought and it is currently estimated that the Sahel area in Africa, for instance, parts of northern Senegal, central and southern Sudan, extreme north of South Sudan, the extreme south of Algeria, central Chad and the extreme north of Nigeria is losing over 351,000 sq. km with most of the landmass turning into deserts advancing south at approximately 0.6 km per year. In addition to this, sand dunes and aeolian deposits have increased by approximately 425% between 1976 and 1995, constituting loss of land and vegetation (Fasona & Omojola, 2005). This signifies that many parts in Africa is losing its farm lands and such situation is impacting livelihood. Previous studies in the savannah regions have shown that increasing drought has resulted in conflict, violence and population drift and, as a result, food security has been threatened with a drop of over 60% in farm yield and over 300,000 animal deaths per year (Fasona & Omojola, 2005). It is obvious that there is a need for Nigeria to consider such issues as a high population faced with a shortage of resources will lead to chronic poverty and other serious problems. Understanding the interconnection between environmental changes, increased population and food security is essential and, without government intervention, it may be very difficult to address these environmental issues.

According to the Nigerian Meteorological Office, some Sahel States are more affected, such as Sokoto, Borono and Kastina. In these areas, the dry land consists of 450 to 700m undulating plains compared to other arid and semi-arid areas across the world (Obioha, 2009). The consequences of droughts combined with deforestation, poor irrigation and other socio-economic factors are having impacts on humans, wildlife and ecosystems.

The Federal Ministry of Environment (2010) have emphasised that the full impact of climate change has not yet been fully documented due to minimal research conducted throughout Nigeria. The most pressing issues is the accelerating decline of the flora and fauna in Nigeria (Sayne, 2011). According to Obioha (2009), the cost of such losses from an economic and ecological perspective is estimated at over US$ 5.1 billion each year. Supporting this, the UNDP emphasised that the issue of drought and desertification in Nigeria would limit the achievement of development goals by 2015 and this has proven to be the case. In conclusion, the Nigerian Government must be able to identify key States that are vulnerable to drought and desertification as a result of climate change. This can be achieved through research and education. If possible, climate change mitigation and adaptation measures should be borrowed from other countries where it has been possible to adapt.

3.3 Agriculture and Forestry

In Nigeria, based on land use and forestry, it is expected that by 2030 the carbon sequestration in planted forests will be about 7.5 million hectares with an average incremental rate of over 16 MtC (Momodu *et al.*, 2011). The volume of carbon sequestered in forested land is estimated at a net emission of 427.4 and 58.5 MtC at 1.3% to 2.6% deforestation rate. The average cost to retain/establish a hectare of land costs approximately $500 with an average unit cost of over $13.4/tC. This cost implies that over 40 years, over $3.8 billion will be spent with an annual cost of around $94 million. The implication is that Nigeria should be able to sequester over 233 MtC by 2020 and should expand to 46 MtC by 2050, with an accumulated cost of over $1.78 billion to 2.98 billion from 2020 to 2050 for adaptation of agroforestry (Momodu *et al.*, 2011). Another issue is that, with the high levels of forest depletion in Nigeria, forest resources are quickly disappearing. Tackling climate change is very costly and it is essential for the country to provide detailed assessments for mitigation and adaptation measures. Giving detailed vulnerability assessments and analysis will be integral to responses for understanding the issue of climate change in terms of socio-economic development and strategic responses (Momodu *et al.*, 2011).

Nigeria needs a more comprehensive means of approaching the issues of climate change covering local, national and international adaptation and mitigation strategies (Adesina & Odekunle, 2011). Such methods will not only require financial resources, but also technological capacities currently lacking across the country, in spite of UNFCCC investments. A lack of appropriate departmental uptake has also propagated climate change vulnerability. In this context, Nigeria requires a stronger sectorial mitigation and adaptation policy for advancing national sustainable development taking into consideration developments and environmental challenges (Smit & Skinner, 2002). Despite Nigeria being a signatory to the UNFCCC, adaptation to current and future trends of climate change vulnerability is still minimal. In 2003, the First National Communication Network for specifically addressing forestry issues was introduced and was completed by 2010 but there were limitations (Dixon *et al*., 2003). In Nigeria, climate change is already influencing demand for timber coupled with the expansion and clearing of land for agricultural purposes.

Development plans should consider adaptive capacity by allocating land to people via local level capacity and improving access for regeneration and reforestation programmes. In other parts of the world, such as in Asia, Forest Based Climate Change Adaptation (FBA) has been implemented, forest for adaptation, and is a way of strengthening every sector relevant to forestry to deal with climate change and support livelihood strategies (Bationo *et al*., 2002). Adaptation approaches for systematic management of forests should consider the following: livelihoods, watersheds and agriculture. This is a way of conserving natural resources and controlling over-exploitation. This should also include limiting and reducing the impacts of logging, introduction and maintaining programmes for restoration, implementing programmes to tackle invasive species, and the threats of pests and diseases (Adesina & Odekunle, 2011). As forests are a main source of food, fuel and medicine, it is important to protect all of its natural resources. Forestry plays an important role in global carbon cycles and the process of photosynthesis and, as such, reforestation and afforestation has been seen as a means of tackling climate change (Farley *et al*., 2005).

As a result, international regimes should encourage indigenous communities in the importance of reforestation and afforestation. The process of tackling climate change and its potential impacts should be aimed at protecting natural resources, improving social well-being and protecting equality (Bucagu *et al*., 2013).

A practical example for forest adaptation and mitigation is in Bangladesh with the National Adaptation Plan for Action (NAPA), created in 2005; the government initiated the Climate Change Strategy and Action Plan with the ultimate goal of afforestation and reforestation (BCCSAP, 2009). The programme also provided approaches to tackle invasive species and to conduct vulnerability analysis. A lack of inter-social planning may influence not only forestry but other sectors, such as agriculture, energy and mining and without proper social and environmental safeguards there will be a negative role on forestry (Odemerho, 2014). In this case, the Nigerian government should ensure that any international funding for climate change is properly used and managed.

The Rio Summit produced Agenda 21, which contains the principles of forest use, maintenance and protection applicable to both temperate and tropical climates (Lafferty & Eckerberg, 2013). In line with this, the Intergovernmental Panels on Forest (IPF) and UN Commission on Sustainable Development (UNCSD) in collaboration with the Intergovernmental Working Group on Forests have produced a binding report for key forestry management for conserving biological and socio-economic processes. Nigeria is currently involved in tackling depletion of forestry. The Forestry Research Institute of Nigeria (FRIN) in collaboration with the UN Commission on Sustainable Development (UNCSD), have now been involved in address overexploitation of forestry and climate change.

3.4 Water Resources and Irrigation Practises

The current Nigerian water management scheme is unable to cope with the impacts of climate change and it is important to understand the vulnerability of water resources to develop adaptive measures to tackle this (Sayne, 2011). Changes in weather patterns further complicate the situation impacting areas such as agriculture, recreation, national ecosystems and industrial production.

In 2008, the IPCC commented that Nigeria is seriously threatened by water shortage in the future (IPPC, 2014).

According to Wilby *et al*., (2004), climate models the cost of improving Nigerian water resources will increase from 2 to 11% of GDP by 2020. Most water is sourced from rivers, lakes, ponds and streams all of which will be affected by increasing temperature and reduced rainfall. According to the United Nations Millennium Development Goal 7, which focuses on improving access to clean and safe drinking water, it has been observed that the initiatives and strategies in place will not achieve this in Nigeria because of increased flooding and droughts (as a result of climate change) and poor governance (OECD, 2006). However, numerous dams have been constructed across several Nigerian States which include; Sokoto State - Goronoyo Dam (942 million m^3, 2,000 hectares) and Bakolori Dam (450 million m^3, 8,000 hectares); Adamawa State - Kiri Dam (615 million m^3, 11,500 hectares); and Kano State - Tiga Dam 1,874 million m^3, 17,800 hectares (Thomas, 1996). Farmers need these for irrigation and water supplies but climate change will impact water availability influencing crop production and output (Ajetomobi *et al*., 2010). The UNFCCC have suggested that one way of achieving improvements in national agriculture is by enhancing irrigation and water supplies. This is particularly relevant as developing countries will be faced with more extreme weather resulting in water shortages, flooding and other factors impacting on local and national agriculture.

3.5 Fertilizer Use and Crop Productivity

Fertilizer use is classified as either organic or inorganic and adds to and supports soil improvement, provides nutrients to crop and improves yields and productivity (Otu, 2006). Chemically synthesised inorganic fertilisers are widely used in commercial farming across Nigeria, supplied either by the Federal or state governments (Eze *et al*., 2013). This fertilizer typically consists of macro-nutrients, such as sulphur, calcium, magnesium, nitrogen, potassium, and micro-nutrients such as zinc, molybdenum, manganese, copper, chlorine, nickel and boron.

The size and income of a farm plays a fundamental role in agricultural output as smaller farms have lower income and cannot afford efficient fertilizers. In a study conducted by Liverpool-Tasie *et al*. (2014), it was observed that farmers with a lower income could not afford fertilizers and this have an impact on farming and agriculture. In conclusion, the increase in cost of fertilizers has had a big impact on the ability of farmers, as well as lack of knowledge for the correct use and application. In this case, farmers should be educated on what type of fertilizer to use in order to improve their crop yield. As way of mitigation, the government should address such issues to increase crop yield by increasing subsidies, assessing the time to distribute fertilizers, reducing costs and improving extension services.

3.6 Pest and Insect Management

Climate change causes an increase in agricultural pests with billions of dollars of damage attributed to infestations worldwide. Scientists have identified that pest behaviour is associated with temperature changes, as higher temperatures increases the chance of pest and insect survival (Paul, 2007). In higher latitudes, climate change causes seasonal changes which increase the risk of pest damage even further. There are numerous other biological, physiological and environmental factors that can be attributed to pest infestation something faced by the Nigerian agricultural sector (Uyigue & Agho, 2007). Rice and wheat being mainly affected, and it is anticipated that pest and disease outbreaks will become more frequent during drought and flooding (Paul, 2007). Other studies have shown that there are different insects and diseases in different agro-ecological zones, with pesticides being recommended to tackle the spread (Atehnkeng *et al*., 2008). However, some pesticides could cause crop pollution, impacting crop yield and lead to financial losses, and this has already been experienced in some farms in Nigeria, such as in Enugu State and Kano State.

3.7 Soil Fertility and Crop Yield

Soil is the outermost part of the earth which supports crop and yield (Bationo, 2001), and soil fertility and quantity can be affected by a number of factors including climate change and soil composition. The study of soil fertility is complex as it involves chemical, biological and physical components which can directly or indirectly affect yield.

Plants use topsoil to obtain water and nutrients but flooding and drought can affect this by drying out or washing away minerals and organic substances, although certain types of crop such as root and tuber crops can cope under certain extreme weather conditions (Uwah *et al*., 2009).

Low soil fertility leads to lower crop yield, consequently, resulting to higher use of fertilizer (Chukwuka & Omotayo, 2008). In many parts of the world, soil conservation strategies have been used as a means of improving soil fertility which includes reduced tillage, manure application and tree planting (Tittonell *et al*., 2005). The processes of precipitation and irrigation are also used to allow water to penetrate down into the soil. Deforestation and the clearing of grassland adversely affect soil fertility, for instance in Enugu State (Nzeh, 2011).

3.8 Land Use, Size and Tenure

The land tenure and ownership systems play an important role for farming in Nigeria as the majority of land is owned by the Federal government with very few private owners (Eze *et al.*, 2011). An issue faced by farmers is the cultivation of small plots using traditional farming systems, and land ownership can take a very long time. Ancestral land ownership also influences agricultural productivity as land is handed from one generation to another meaning that farmers may not be able to cultivate the major commercial crops needed. Under the Nigerian Land Use Act of 1978, the government oversees passing land ownership from person to person. For adaptation to improve agricultural productivity in Nigeria, as a result, there is a need to consider issues such as land tenure reformation, provision of credit and improving farming technologies and techniques (Mabogunje, 2010).

Land tenure systems include private and public mortgages, tenants and landlords, labourers and operators, inheritances, purchases and leases, among others (Eze *et al.*, 2011), although it can all be grouped under individual ownership, communal ownership and public state / Federal government. Individual ownership of land is often by small scale farmers, communal for community and commercial purposes whereas public land is used for large-scale commercial farming with hired experts. Typically, farm size is an indication of the land tenure system, which influences agricultural outputs and is affected by factors such as changes in weather patterns, fertiliser application and climate change.

3.9 Agricultural Funding and Extension Programmes

In recent times, the Nigerian government has made efforts towards financing agricultural policies and improving rural development through improved institutions, programmes and schemes (Eze *et al.*, 2010). The system also includes agricultural financing policies aimed at farmers to upgrade rural infrastructure and tackle corruption. It is upon this that the international community, such as the Food and Agricultural Organisation of the United Nations and the World Bank, have become involved.

In the past, there have been failures in financing schemes for rural development within Nigeria, although these have now improved through infrastructure development and the programmes are now available for the improvement of skills. However, whether all Nigerian farmers can benefit from financial schemes remains a challenge. The international community, such as the World Bank, has been assisting Nigeria and agricultural technology has been used as a means of enhancing agriculture but this has its limitations as there are issues with technology delivery (Adejo *et al.*, 2012). The private sector is now playing a vital role and extending services throughout Nigeria. Farmers in rural communities have been unable to obtain the means to improve their productivity and poor staff training is one of the most common issues experienced (Cyprian *et al*., 2013). There should be improved legislation and information sharing among agricultural workers, even though Nigeria is still faced with institutional and administrative problems. However, under the former Head of State, Chief Olusegun Obasanjo, privatisation of extension services has been the only way to solve the issues faced in the Nigerian agricultural sector. In the past, there have been government programmes, such as the River Basin Development Authority (RBDA) and National Accelerate Food Production (NAFP), but NGOs are now providing a wide range of training including education and technical support (Adejo *et al.*, 2012).

3.10 Adaptation in Nigerian Climate Change Policy

With regards to adaptation at a national level, various development plans, policies and projects have now been put into place accounting for climate variability particularly in developing countries (Lim, 2005). Various agencies have been made to integrate climate change adaptation into national policy planning and in response to this the

OECD published in 2006 the 'Declaration on Integrating Climate Adaptation into Development Cooperation' for its member states. However, this is also applicable to non-member states with regards to integrating climate change adaptation into development planning. The policy guidance is grouped into three sections as follows: Part 1 is described as Understanding the Challenge; this is to identify human induced climate change in the context of natural climate variability and weather changes with discussions in key developing countries (OECD, 2006). Part 2 is described as Integrating Climate Change Adaptation at National, Sectorial and Project Levels which mainly focuses on taking the perspective of partner countries and discussing areas of accessing and addressing potential risk of climate change. Part 3 is described as Integrating Climate Change Adaptation at a Local Level which is specifically aimed at examining the challenges and opportunities which may arise because of climate change in rural and urban areas and how the government and community levels can address this in both contexts (OECD, 2006).

Climate change adaptation involves measures as well as the integration of adaptation considerations into existing development processes, actions and activities (Lim, 2005). In line with this, it examines the efforts of donors through supporting partner countries, institutions and the implementation of adaptations. Furthermore, as a way of avoiding maladaptation, the OECD have introduced a climate lens as a tool to measure the response of climate resilient development, which is expected to enable stakeholders and policy makers to plan and implement policies against the risk of climate change (OECD, 2006). In many developing countries, climate change adaptation has become an area of interest. Nigeria is actively participating in this but there are doubts that it will become one of the twenty best performing economies as outlined by 2020 to meet the Millennium Development Goals set by the UN (Rydin, 2012). Unlike any other developing countries, the Nigerian government is continually struggling to maintain social services for its citizens due, in part, to an accelerating increase in population and issues with the mixture of different cultural tribes (Eleri *et al*., 2012).

Mainstreaming climate change adaptation into the Nigerian economy will help to protect citizen property and limit vulnerabilities which, in the long run, will maintain resources in both urban and rural areas (Ibrahim, 2012). The major agencies participating in climate change issues in Nigeria are the UNDP, UNIDP and UNICEF, who help to promote an integrated approach towards mainstreaming and adaptation to climate change aimed at building proper governance systems (Ibrahim, 2012). Other key approaches taken into consideration are empowering women and children in the agricultural sector with the UNDP facilitating a systematic approach for capacity building by expanding funds for adaptation and supporting women leadership (UNDP, 2013). With this support, a National Adaptation Strategy was put in place and with the help of UNIDO, a small hydropower station was established for controlling flooding while providing irrigation and supplying electricity for local communities.

Tackling Nigerian climate change is highly dependent on various factors. Before any action is taken, the government must identify the areas which pose higher risk and damage, such as climate shifts and shortage of resources. Conflict is also important as over 10,000 Nigerians have been killed largely due to food and water shortage. In 2009, a DFID study identified losses of up to US$460 billion by 2050 leading to more conflict. The need to sustain peace should be incorporated by relevant stakeholders by addressing the issues of unemployment and resource competition as well as building social and economic values which should reflect upon dialogue, planning, research and investment (Sayne, 2011).

In 2009, Nigeria participated in the UN Climate Change Conference in Copenhagen even though its emissions are very small compared to industrialised nations with World Bank data shows that this is less than one-half of a percent of the total world emissions (Sasaki & Putz, 2009). However, there are still questions to be addressed in terms of adaptation and mitigation, particularly as climate change will increase poverty, lower crop yield, health related issues and conflict. Addressing adaptation can consider various uncertainties of climate change vulnerabilities such as the management of coastal ecosystems, tourism, irrigation and improving the livelihood of communities. Overall, at a national level, a proper policy guide framework is needed and the Nigerian government should adopt the Policy Guidelines of the OECD Framework implemented through budgetary allocations, which will help facilitate adaptation within and across different sectors (OECD, 2006). The national government should set up legislation and regulations which will directly and indirectly address the potential risk of climate change to natural resources, agriculture, forestry and land-use planning.

The World Bank has been able to support many developing countries in mainstreaming and adaptation of climate change programmes. For example, a five-goal programme was initiated in the Maldives to improve environmental practices, promote sustainable development and support government priorities and strengthen government capacity (OECD, 2006). Furthermore, Joint Assistance Strategies (JAS) have been put into place for supporting national adaptation in developing countries. This was developed in Tanzania and Kenya to provide awareness of global warming impacts and how to tackle climate change, and this should also be integrated into Nigerian climate change policy.

3.11 Summary

Climate change poses a threat to agricultural productivity across the world mainly in developing countries such as Nigeria. Drought and desertification has impacted on Nigerian agriculture with some States having lost large portions of their farm land. The challenges are that most Nigerian farmers are not adequately equipped to cope properly with adaptation and mitigation measures due to lack of information and access to resources. The higher demands for forestry products have also contributed to climate change and other environmental issues. In this case, Nigeria needs a comprehensive change of approach and climate change policy should be integrated into economic, institutional and political frameworks.

Chapter 4: Perception of Climate Change

4.1 Introduction

Perception is very crucial is understanding people beliefs, concerns and attitudes towards a particular issue. Climate change perception will aid towards developing polices and legislation in addressing environmental issues. In some developed countries, studies have been conducted using perception and awareness, to climate change related issues to improve mitigation and adaptation strategies and policy making (Moghariya & Smardon, 2011). Therefore, this should be integrated into the Nigerian climate change framework. As discussed in Chapter 3, Nigeria is faced with the increasing threat of climate change. Given that farmers are directly involved in agriculture, their responses will play an important role in improving farming techniques. Perception helps to provide an in-depth understanding of how individuals or groups perceive their environment and hence public perception is very important when it comes to the impact of climate change in Nigeria.

4.2 Farmer Perception

Several studies have been conducted on farmer's perception of climate change and agriculture in Nigeria (Abiodun, & Olabimpe, 2007). However, their perception differs between gender education, and experience. In Nigeria, most farmers are able to understand and identify the changing weather patterns and other environmental constraints, such as increasing flood, drought and desertification. According to Kuponiyi *et al.* (2010) and Falaki (2013), small-scale farmers in Nigeria are mostly impacted due to limited resources. In some regions, farmers have noticed the changes in rainfall distribution over decades, as well as the disappearance of small rivers due to intense drought, which impacts overall crop yield (Salau *et al.*, 2012). In order to address these issues, improved strategies are needed particularly at local level, since they are more vulnerable to the impact of climate change. Having said that, this study is focused on eight States in Nigeria.

Climate change is the main cause of wide spread starvation, poor and low crop yield, and malnutrition, which in turn is threatening food security (Egbule & Agwu, 2013). To gain expert understanding on this topic, there is a need for studies to be conducted on farmer's perception of climate change across the different agro-ecological zones in

Nigeria (Adesiji *et al.*, 2012). Such studies should take into consideration farming operation and techniques, soil and water management, education and extension service programmes, fertilizer application, pest and disease control, loans and finance, and household livelihoods as well as adapting to new technologies.

In a study conducted by Onubuogu & Esiobu, (2014) across agro-ecological zones in Nigeria, it was quite clear that large number of farmers admitted having noticed changes in weather patterns, more especially, changes in rainfall distribution, this corresponding with Nigerian meteorological information. As a result, farmer's perception is a key component to evaluate the physical changes in weather patterns, this is because they experience the changes that occur during crop production (Egbe *et al*., 2014; Moghariya & Smardon, 2011). Understanding indigenous knowledge and farming experiences is necessary. Farmers should be involved in climate change polices across Africa, were most people depend on agriculture as their major source of livelihood (Ebge *et al*., 2014). For instance, in Zimbabwe, small-scale farmers have been involved in policy making and have supported adaptation strategies. These have been integrated into the Zimbabwe National Climate Change Response Strategy, mainly as a result of their cultural belief, values and norms which have been integrated into policy making (Chinokwetu *et al*., 2015).

Since policies and legislation plays a vital role in shaping people's capacity to adapt to climate change (Ishaya & Abaje, 2008; Ofuoku, 2011), the Nigerian government should adapt a similar approach in their decision-making processes for climate change mitigation and adaptation. This can be attained through exploring farming communities as well as conducting studies on farming experiences, perception and awareness to climate change and environment related issues. According to Chinokwetu *et al*. (2015), Zimbabwe farmers have now acknowledged that their involvement in climate change polices, have improved their traditional farming practises and agricultural productivity. This is achieved through farming training, improved irrigation practises, improving fertilizer supply and application, and appropriate agricultural extension services. All of this began by conducting studies on farmer perception, concerns, knowledge and awareness to climate change.

4.3 Public Perception

There are several studies covering public perception of climate change across the world, including perception towards energy consumption, waste management, flooding and agriculture amongst others (Ologunorisa & Adeyemo, 2005). In developed countries, quite a number of studies have been conducted on the knowledge and attitudes of the public on energy consumption and their acceptance of new and innovative energy facilities, for example, the UK has implemented the legally binding Climate Change Act (Ciscar, 2011). Much of the public are now aware of the impacts of flooding and drought on agricultural productivity as well as the spread of disease. The public have also experienced various natural disasters, disease outbreaks and health impacts related to climate change (Elliott *et al.*, 1997).

Many studies have shown that the public have noticed shifts in rainfall and temperature over the years (Pettengell, 2010). Adaptation remains the only method for addressing climate change, and the public can help government form relevant policies. It should also be noted that strong cultural and personal factors can also influence perceptions. There is a lot of concern regarding the issues of the environment and climate change in Nigeria, as people start to understand its causes and effects (Pettengell, 2010). Many Nigerians are now experiencing the impacts of climate change either directly or indirectly, such issues as an increase in floods, drought, desertification, health problems, pests and disease (Adelekan, 2010).

Climate change has been happening over the years, and will continue into the near future. It threatens the environmental, social and economic state of Nigeria which, given to rapidly increasing population, mean that immediate action is required and policies have been put in place (Ojomo *et al.*, 2015). Public perception studies will aid towards the mitigation and adaptation to climate change by providing information of their experiences, should be taken into account by the government. According to the study of Ohwo (2015), many Nigerians had received some form of formal education are aware of the causes and impacts of climate change and its vulnerabilities. In this context, it is that education and information be made available to all Nigerians. Furthermore, the study also identified that many of the respondents admitted they often heard about weather and climatic characteristics from the media (Ohwo, 2015). This suggests that the media plays a vital role in providing information to the general public.

Many studies have emphasized that mitigation is the key for tackling climate change amongst the public. In the UK and other developed countries, cutting down CO_2 emissions have been emphasized as the best way of mitigating climate change. As a result, the Nigerian government should be involved in educating its citizens on the need to cut down CO_2 emissions as well as energy conservation. This will play a dynamic role in tackling climate change in Nigeria (Ohwo, 2015). Since the cause is mainly human-induced, the public should be informed on the need to reduce the use of fossil fuels. In the case of Nigeria, more studies should be conducted on public perception of climate change across the 36 states as this will undoubtedly help towards providing improved strategies on tackling the issues.

4.4 Government perception

Governments and stakeholders play a vital role in providing policies to address climate change with numerous governmental and nongovernmental agencies involved (Odemerho, 2014). Since the Kyoto Protocol, many countries worldwide have taken climate change issues more seriously. Across Africa, non-government organisations have been involved in various initiatives, projects and programmes to address the issues of malnutrition, poverty and poor agricultural output.

With regards to agriculture, involvement has helped local adaptation capacity in many communities and the international community sees this approach as a major step in addressing climate change (Odemerho, 2014). Non-governmental organisations also play a key role in monitoring and promoting climate compliances. The overall concept has been through mitigation focusing on greenhouse gas emissions to minimise the impacts of climate change. Second to this has been adaptation measures focused on coping with impacts and vulnerabilities. Both are needed to tackle effects such as increased temperature, sea level rise, extreme weather events, and a lack of natural resources and food production while, at the same time, improving economic and social wellbeing (Wheeler & Von Braun, 2013).

Achieving this demands immediate action at local, national and international levels, particularly as those who are most vulnerable to the impacts of climate change are also those who are the least responsible for it (Wheeler & Von Braun, 2013). In 2012, there were substantial commitments emphasising the need for political actions to take adaptation into account at all stages and the UNFCCC has been able to develop new steps to help facilitate comprehensive national adaptation strategies and standards. Fundraising has also been a way in which the international community could promote proactive adaptation approaches for countries vulnerable to climate change impacts (Toth, 2013). Adaptation is not a new phenomenon as, throughout history, communities and societies have been able to adapt to rapid changes such as alterations to settlements, agriculture patterns and environmental changes. In addition to this, humans have been able to adapt to hot semi-deserts, tropical rainforests, temperature grasslands, cold sub-arctic and small island regions (IPCC, 2014). However, modern human induced climate change must give rise to new adaptation approaches. According to IPPC (2014), Earth's climate and temperature has been changing dating back hundreds of thousands of years because of natural processes. However, in recent times, the earth's temperature has been changing rapidly due to increase in use of fossil fuel, deforestation, habitat degradation and the increasing in human population. The rate of change is predicted that the earth will be warm between 2 and 6 degrees Celsius in the next century (IPCC, 2014).

The level of human induced climate change is highly dependent on the degree of exposure and capacity to adapt, with the most critical elements being climatic conditions and human population with factors including the level of education, wealth, technological capacity and institutional strength (Antwi-Agyei *et al*., 2013; Wang *et al*., 2009). As developing countries have less capital, lower technological capacity and weaker institutions, there must be a focus on adaptation approaches depending on fishing, agriculture and tourism. According to the World Bank (2010), 40% of financial developments within developing countries are from concessional loans and overseas assistance and it is estimated that assisting climate change impacts in these countries will amount to over US$100 billion (Malik, 2013). The same strategies which have been used in developed countries have also been implemented in some developing countries, such as irrigation projects to reduce droughts, coastal defences against cyclones and the construction of dams to control flooding (Faulkner *et al*., 2007; Slomp, 2012).

Besides successfully managing the transition of climate change impacts, what else should be done for future uncertainties? In the near future, adaptation will be heavily dependent on the development of options and choices (Bours *et al.*, 2014). In other words, higher levels of development will require higher adaptive capacity though certain patterns may expose people to higher levels of climate risk. The international community still faces difficulties providing institutional context for adaptation on the global scale. As reactive adaptation is seen as a form of immediate action or direct experience, addressing future risk may be uncertain due to the extent and distribution of impacts across different regions (Bodansky, 2010).

Adaptation may also be considered as 'proactive' or 'reactive'; the proactive approach is required to reduce the exposure of climate change whereas the reactive approach focusses on aspects of maladaptation to investigate the measures and what has been achieved. However, adaptation strategies should give more priority for proactive actions which are helping to reduce future risks even though such actions require a high amount of initial investment. Other aspects include adaptive capacity and specific adaptations. Adaptive capacity is providing adaptation to climate risks for specific actions or projects, such as the construction of sea walls to protect low-lying coastal areas. Specific adaptation includes correcting maladaptation.

The ability of any society to be able to undertake action is highly dependent on its adaptive capacity and certain types of adaptive capacity may be crucial in the context of climate change (Williams *et al*., 2015). This includes the ability for project monitoring, the development of new technologies, income and education levels as well as governmental institutions and the ability to access information and technology. Climate change risk and the capacity for adaptation are closely related in their nature and development levels, and adaptation challenges extend down to every sector of the economy (O'Brien, 2006). Given this, the strategic response must be to extend resource, agriculture, economic, health and trading policies, amongst others.

Recently, there have been conventions for adaptation strategies started by the UNFCCC. The first was the Conference of Parties in 1995 which established a three-stage framework in order to address the issues of adaptation (Robbins, 2016). First was to identify countries that are vulnerable to the impacts of climate change, second was to provide measures for tackling the impacts, and third was the implementation of measures to help facilitate adaptation capacity for prolonged periods of time. This was mainly to create a building capacity for developing countries and for providing assistance to developing countries for assessing adaptation options (Lafferty & Eckerberg, 2013).

The UN Environment Programme has been working alongside a number of countries such as the US, UK, Japan, The Netherlands, Canada and Germany among others for providing bilateral assistance of over US$110 million for adaptation projects in 29 developing countries. To date, over 40 developing countries have received funding under such conventions to prepare a National Adaptation Programme of Action (Lafferty & Eckerberg, 2013). In 2007, the GEF also helped in providing over US$50 million for the Strategic Priority on Adaptation initiative. The World Bank also supported the adaptation approach with approximately US$50 million over a period of 5 years.

The future uncertainty of climate change adaptation was estimated to be over US$1 billion as of 2012. Adaptation strategies must be most effective when it comes to addressing the full climate risk, including all human induced factors (ProVention Consortium, 2009). With regards to funding, countries must follow the guidance of the various conventions and protocols towards achieving national strategies. Committing funding for the support of climate relief or other forms of insurance will help vulnerable countries towards regaining proactive action plans (Burton *et al.*, 2006). However, there may be constraints or limitations in some aspects which may require some degree of additional adaptation support. In this case, it makes sense to build an appropriate redirection in case of maladaptation. Institutionally, such approaches will help support proper development and improve adequacy for national plans.

4.5 Adaptation to Improve Agriculture

With respect to agricultural policies in Nigeria, there are various diverse practises due to a range of culture, institutional, economic, climate and environmental factors, meaning that there are a wide range of adaptation approaches and options (Adejuwon, 2006). The aim of this adaptation is to engage farmers, agribusinesses and policy makers on the best available adaptation capacity for existing agricultural systems with the purpose of providing effective management during any form of potential climate change risk which may occur in the near future (Adejuwon, 2006).

Taking adaptation approaches at an early stage will help farmers, agribusinesses and policy makers with the implications, uncertainties and the range of approaches to be taken which, in turn, provides a framework for both a short and long-term strategy by providing reliable information on the scale and nature of decision making (Heal & Millner, 2014). For example, farmers can adapt to short term climate change trends when they are aware of the trends and projections of climate change through weather and climate forecasting.

Some farmers may find limitations in adapting to both short and long-term projections due to uncertainties and lack of information. It is important that this is taken into consideration in policy and investment analysis for any such changes during extreme weather events, and significant information can be derived through short term response of adaptation strategies which can then be linked to long term options, so as to limit any future impacts (Ikehi, 2015). This is crucial for consideration in policy decisions which can be implemented over one to three decades and in order to cope it will be vital to identify key benefits and increase the focus on climate change adaptation. The polices that should be put in place for the agricultural sector should be relevant by understanding the basic issues of climate change adaptation through the situation by which it evolves via border sets of policies (McCarthy, 2001). This should be linked to existing policies which are already in place and take consideration of climate risks such as droughts and floods. Adaptations will require such policies to be more dynamic in order to cope with higher levels of uncertainty during the time or magnitude of any potential impacts (McCarthy, 2001). Furthermore, these policies should be linked to both human and natural environments, especially for sustainable development and natural resource management. This is known as mainstreaming of climate change adaptation into development planning and will help to reduce risks and improve sustainable development at local and national levels.

However, there have been debates over understanding climate change adaptation on a global scale. It is important to identify and evaluate the possible fundamental adaptation strategies to determine the basic dynamic climate policy options that will help tackle dangerous anthropogenic interference which is a major component of the UNFCCC Article 2. Maximising societal welfare against that of future risks will help both mitigation and adaptation approaches, although this will mainly depend on the monetary and cost-benefit analysis (Robbins, 2016). For example, the size and cost of adaptation for any risk is dependent on the economic level of the country and, as a result, the benefits of adaptation will be based on the nature of climate change and the scale of its impacts.

Adaptation achievements may be complex when mitigation impacts and adaptation are not integrated into public policy development, which may be a significant challenge for the scientific community. There is a need for interaction on aspects of science and policy which should be integrated together, with the most crucial aspect being the involvement of stakeholders and governments (Robbins, 2016). This will provide knowledge on the future in relation to climate change aspects and is applicable for long-term investments in the agricultural sector, and to provide effective measures such as quarantine programmes, forest plantations, flood mitigation works and cultivation programmes (Robbins, 2016).

4.6 Adaptation to Improve Cropping Systems and Farming Practises

There are several adaptation strategies with regards to cropping systems which include crop production management, timber growth and hardwood/softwood regions to minimise both fire and insect damage (Agwu, 2001). Such strategies could help control damage to crops in extreme weather, during insect outbreaks and/or poor harvests

For moderate climate change, taking proactive measures will help reduce losses to economic growth for the agricultural sector but there may be limitations for potential adaptation actions, for example, large scale agricultural industries may receive a more improved adaptation strategy when compared to small scale farmers. In 2001, the Nigerian Agricultural Policy was established aimed at achieving self-sufficiency based on food supply and the attainment of food security to improve production of raw materials for industry (Johnson & Masias, 2017).

Improvement in the production of export crops by improving production and processing technologies leads to employment gains in the agricultural sector. This will help tackle the impacts of drought, desert encroachment, flooding, and erosion as well as protecting and conserving the environment and improving the quality of life for rural farmers and communities (Johnson & Masias, 2017). The key features of this is to ensure minimal impact of climate change risk and uncertainty in the agricultural sector given that the policies cover agroforestry production, fisheries, pest control, water resources, irrigation and livestock production (Lehtonen & Purola, 2014). The policy also aims to improve hydrological risk and vulnerabilities as well as national water resource management. There have been mechanisms for forecasting and monitoring to tackle the issues of flooding and erosion which also reviews land use and creates public awareness and engagement.

One of the greatest challenges faced worldwide is to estimate the potential consequences of climate change when it comes to understanding how to adapt to agricultural systems. In many countries, specifically in Africa, adaptation by farmers to rapid changes has been challenging (Sekaleli & Sebusi, 2013). The deployment of technologies, fertilizers and improved irrigation practises has provided a wider understanding of the potential impacts and has helped farmers understand how climate sensitive factors can result in lower costs. As agriculture is a major source of livelihood for many local communities across Nigeria, it is essential to derive the best available adaptation strategy (Ugwu & Kanu, 2010). Measuring rainfall and weather patterns on agricultural land is important as this helps provide key information of basic technological innovations which can be put in place to improve productivity.

There is no doubt that climate change is already here and will impact upon food constraints and security, especially in developing countries. According to the International Food Policy Research Institute and Food Agriculture Organisation (FAO) in 2013, grain crops are one of the major sources of livelihood in many African countries accounting for one of the key economic sectors and a greater proportion of the GDP (Wheeler & Von Braun, 2013). To improve food production and GDP, there are steps which policy makers have to put into place from various adaptation strategies this can be achieved through empowerment, education and improving policy making and decisions.

4.7 Summary

Chapter 4 discusses the concern, awareness and perception to climate change. Climate change perception is a global phenomenon which needs to be addressed at all levels. Various groups have their perceptions and views of climate change, as a result, it is quite essential to understand this view in order to provide better mitigation and adaptation strategies to tackle climate change in Nigeria. As awareness on climate change grows, this makes adaptation to climate change much easier and provides future strategic approaches at every level. The following chapter discusses climate change in the context of Nigeria and what needs to be achieved.

Chapter 5: Background

5.1 Introduction

It is important to understand Nigeria in the context of its economy, history, population, location, geography and climatic factors. In addition to this, some background on Nigerian agriculture, farming systems and the national food security is necessary to provide an in-depth knowledge and understanding of the country and issues facing the agricultural sector.

5.2 Brief History of Nigeria

Nigeria is a West African country which first became a republic in 1963. Ever since then, it has been under both military and civilian leadership (Meredith, 2011). The country consists of landmarks as well as wildlife reserves. Nigeria has a long heritage in art, traditional dancing, music and oral literature. The Nigerian formal education was adopted from the British school system and is one of the most developed countries in Africa. Nigeria is a member of numerous international organisations such as IMF, WHO, World Bank, IPCC among others (Shinsato, 2005). While Nigeria mainly comprises of swamps and mangrove, there are also an array of other key habitats such as forests, lakes and rivers (Sowunmi & Akintola, 2010). The major tribes are Igbo, Yoruba and Hausa but there are over 250 ethnic groups and numerous kingdoms. Nigeria consists of agro-ecological zones which supports a variety of crops important for the nation. At present however, the key environmental issues are rapid deforestation, desertification and flooding and soil degradation.

In recent times, Nigeria has experienced large economic growth and it is expected to increase in the near future. There have been fast growing urban areas and cities such as Lagos, Abuja, Kano, Calabar, and Port Harcourt among others. Nigeria exports are estimated at US$ 53.8 billion of agricultural products such as palm oil, cotton and cocoa to other countries such as China, Brazil and the United States (Aliyu, 2008). It also imports from other continents from Europe, Asia and America items such as machineries, vehicles, computers, textiles among others. The two major religions in Nigeria are Christianity which is mainly practiced in the East and West and Islam in the North. The Ministry of Agriculture and Rural Development oversees Nigerian agriculture, which in turn is controlled by the Federal Government (Aliyu, 2008).

While Nigeria has huge agricultural potential, capable of feeding the Nation, there are numerous physical, environmental and social issues that have been affecting the sector. This research goes some way in addressing the challenges and offering some amelioration.

5.3 Nigerian Crops

There are quite a number of crops that are cultivated and produced across regions in Nigeria which includes rice, beans, millet, cassava, onion, maize, yams, soybeans and palm oil, among others. Given the wide range of agricultural diversification, it is quite essential to understand the productivity trends and where outputs have changed over the years (Omorogiuwa *et al*., 2014).

5.4 Location and Description

Nigeria was a British colony during the late nineteenth and early twentieth century until it gained independence on the 1st October 1960. It consists of 36 states, as shown in Figure 5.1, and 774 Local Government Areas (LGAs) located in West Africa between 4 and 14 degrees' latitude 3 and 14 degrees' longitude with a land mass of around 923,768 square km. The Country shares a border with Niger and Chad in the North, the Benin Republic in the West, and Cameroon in the East, with the Atlantic Ocean to the South. Its capital is the Federal Capital Territory Abuja (Aliyu, 2008).

Figure 5.1: A Map of Nigeria showing the 36 states (source: Essaghah, 2013).

The World Bank classifies Nigera as having a mixed economy; there are abundant natural resources generating major reveneues but maufacturing levels are low making the country highly dependent on imports. During the 1960s, agricultural production made up approximately 60% of the country's economy whereas oil and gas only contributed 1.2% (Shinsato, 2005). Today, the major exports are oil and gas, with other sectors including banking, legal, financial, transportation and telecommunication. In 2011, its GDP was ranked 31st in the world, but this is to increase towards 2050 (Shinsato, 2005). It is because of this that funding and loans are sought from the World Bank, Paris Club and IMF to improve living conditions. However, Nigeria is still one of the largest econmonies in Africa, after South Africa, despite using 40% of its revenue to repay the Paris Club creditors (Essaghah, 2013).

Nigeria is faced with numerious issues in terms of science and technology advancement, lacking in areas such as computer and software development, with imported technology from Europe and the USA being used to support internet services, agriculture, environmental protection, security, and construction. However, the government has launched four environmental satellites which have helped provide warnings of environmental and natural disasters and identify desertification in the northern part of the country, as well as being used for security purposes (Watts, 2013).

5.5 Geography, Environmental Issues and Climate Change

Nigeria is 923,788 km^2 (356,669 sq. miles) and is the worlds 32nd largest country (Ejobowah, 2000). Its main riverine areas are the River Niger and the River Benue, both of which feed into the Atlantic Ocean, with large river deltas comprising the Central African Mangrove Forest. In addition, there are various landscapes such as tropic rainforests with an average rainfall of 1,524 to 2,032 mm and expansive hills and valleys within the Niger and Benue River valleys, such as the Mambilla Plateau (Ejobowah, 2000). There are also salt water swamps in the region close to the Cameroon border, the coast is a forest ecoregion rich in biodiversity, and there are three savannah regions consisting of the Sudan, Guinean and Sahel savannahs. The average annual temperature is 27 ^{0}C with an average of 600 mm of rainfall (Odjugo, 2010). However, Nigeria is faced with numerous environmental issues locally, nationally and internationally, such as oil spills, sewage discharges, waste management issues, deforestation, habitat degradation, fragmentation and climate-related change (Odjugo, 2010). This has resulted in a high level of environmental conflict which is now impacting upon of the lives its citizens. In the north, increased desertification is causing higher levels of migration impacting on agriculture and creating food shortages (Thelma, 2015). Meanwhile, in the south and east, the release of hydrocarbons into the atmosphere and oil spills into rivers is causing numerous health issues and is leading to increased conflict among tribal groups and the government (Okerentugba & Ezeronye, 2003).

Presently, climate change is one of the biggest issues faced in Nigeria resulting in the loss of millions of both plant and animal species, causing the loss of ecosystems and biodiversity generally is crucial for human survival, and billions of US$ in economic losses are now being experienced (Enete & Amusa, 2010). According to the IPCC

(2014), the impact of climate change in African countries will be intensive following experiences in many countries, including Nigeria. Currently, the effects have already been experienced in various parts of the country such as flooding, intensity of seasonal changes and natural rainfall, increased droughts, and an increase in health-related issues. One major issue is that most Nigerians work and live in areas which are very vulnerable, and others are indirectly affected through economic losses, environmental degradation, and damage to infrastructural facilities (Odjugo, 2010).

In Nigeria, mitigation measures on how to tackle climate change have now been put into place with the help of the UNFCCC, IPCC, Federal Office of Statistics (FOS), Nigerian National Petroleum Cooperation (NNPC), National Electric Power Authority (NEPA), International Energy Agency (IEA), and the Department of Forestry and Agriculture, amongst others. This has been through the deployment of primary tools which are used to understand and access future energy systems, a model known as Market allocation and Analysis of Demand for Energy (MADE) (Akinbami, 2001). It is hence anticipated that the trend of Nigerian energy consumption will increase in the future due to population growth and an increase in demand for resource consumption.

5.6 Agro Ecological zones in Nigeria

In order to fulfil the aim of creating a mitigation and adaptation framework, it is necessary to investigate how Nigeria are impacted by climate change. These agro-ecological zones are areas of distribution with respect to agricultural production and different characteristics across each zone (Anuforom, 2009). There are various differences per zone in accordance with climate cropping systems and types of cultivation. The cropping practices across these regions are mainly mixed cropping, mono cropping, crop rotation and mixed farming (Anuforom, 2009). This study focuses on eight States diverse agro-ecological characteristics (This is discussed in depth in the methodological Chapter 7). The zones mainly consist of rainforest, derived savannah and monotonic zones. The agro ecological zones consists of the derived savannah, Sudan savannah, humid forest, Northern Guinea savannah among others (Akintola, 2001). The derived savannah has an increased rainfall, however, over grazing, cultivation and long-time forestry depletion have affected the region. Key crops planted across this region includes maize, millet, cocoyam, cassava, rice, cassava and yam.

The Sudan Savannah is found in the Northeast, where rainfall levels are lower when compared to the derived savannah. The vegetation in this region also experiences destruction due to land clearing for cultivation, and key crops from this region include cotton, groundnut, sorghum, maize, millet and wheat (Sowunmi, 2010). The humid forest has more rainfall when compared to other areas, and principal crops planted here comprise of yam, cocoyam, melon, groundnut, rice and maize among others. Most Nigerian cash crops are planted in this region, because the region favours the biological and physiological characteristics of crop growth (Sowunmi, 2010). The Northern Guinea Savannah consists of lower average rainfall, but the region has experienced increased pressure recently through rising human population. The lower rainfall has influenced crop production and landscape changes have also substantially impacted on agricultural production.

5.7 Study area

The research was conducted across agro-ecological zones which comprise the north, south, east and west of Nigeria, as shown in Figure 5.2. Nigeria is situated in the tropics with a generally seasonally, humid and damp climate consisting of large natural vegetative zones.

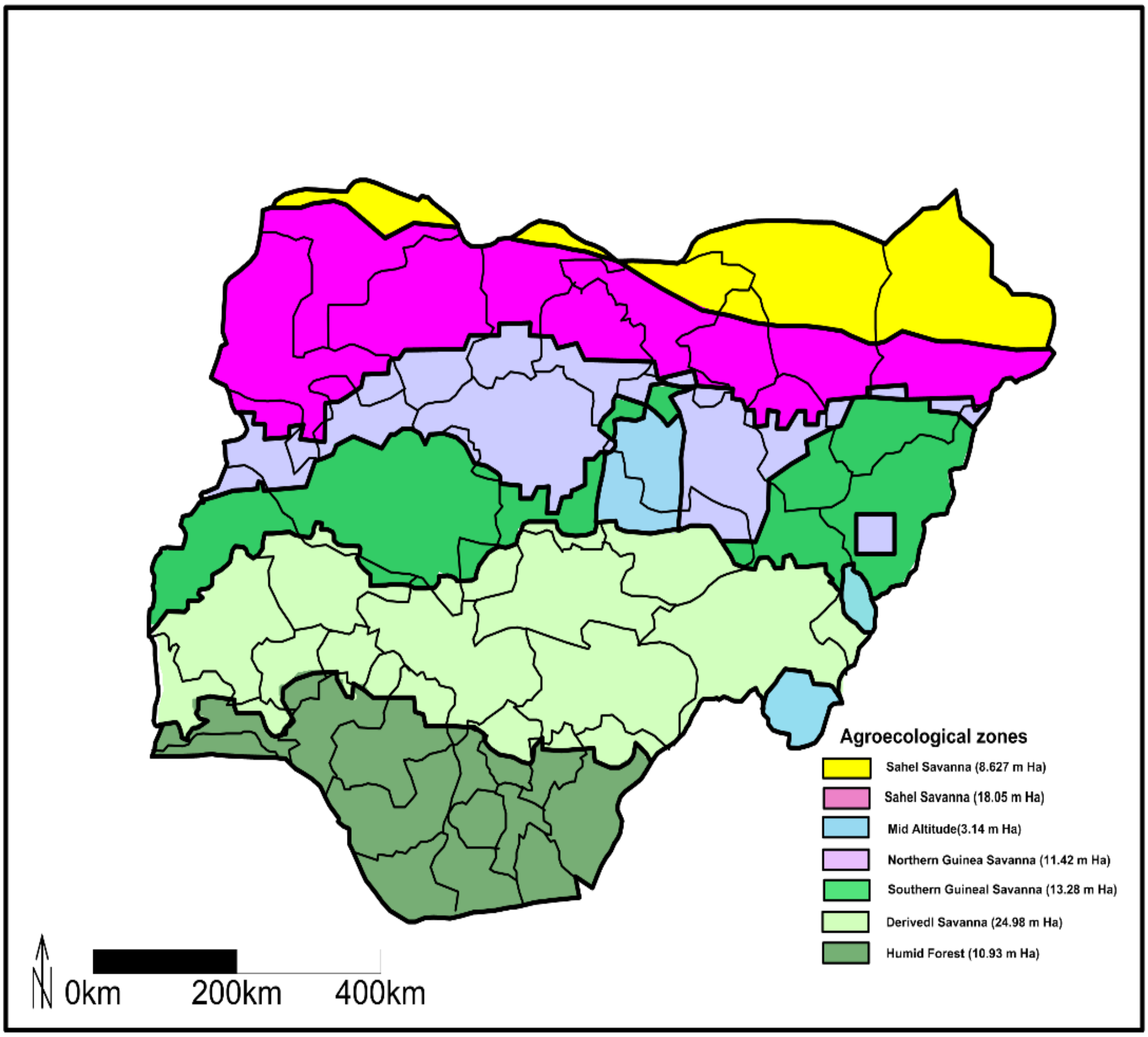


Figure 5.2 : Agro-ecological zones in Nigeria

The study considered the variability of rainfall, temperature and humidity over a period of thirty years. Nigeria experiences different temperatures, rainfall and humidity across different regions, so precaution is needed towards mitigation and adaptation to climate change (Akintola, 2001). Scholars have provided various strategies by which such approaches can be achieved and, with respect to agriculture, numerous factors have to be considered such as physical aspects, soil and biological characteristics. The rainfall trends differ due to the different regions and classification of different agro-ecological zones. However, Nigerian weather is classified under the wet and dry season.

5.7.1 Crop varieties

Various crops were compared during the study to determine which are affected and which are resistant to the impacts of climate change, and there are various factors to consider. Using crop varieties as an indicator against factors such as annual rainfall and drought will help provide clues on variations in plant growth (Horna *et al*., 2005). Generally, Nigeria is classified as North, South, East and West. The description of crops cultivated across the eight States is provided in the methodological chapter (Chapter 6).

5.7.2 Commercial Agriculture

Since 2009, an estimated US$ 185 million has been invested in commercial agricultural development projects in Nigeria, with core aspects of developing agricultural production and commercialisation, rural infrastructure and project administration (Ariyo *et. al*., 2011). This is used to develop and improve agricultural production system efficiency it is targeted at helping small and medium scale farms with the aim of supporting improvements in technology among rural farms, supporting the production of staple crops, and facilitating capacity for the agricultural sector. An example of commercial agriculture is given in Figure 5.3.

Figure 5.3 : An example of commercial agriculture in Nigeria (source: Raji, & Alamutu, 2005).

It is estimated that over 60% of the 167 million Nigerians are small scale farmers which, according to the Central Bank of Nigeria, accounts for over 41% of the GDP; this is expected to increase (Nzotta & Okereke, 2009) and an example is given in Figure 5.3. However, Nigeria still imports over 20 million tonnes of food, worth US$11 billion, each year. In 2010, an additional US$ 30 million was allocated to small scale farmers to improve their activities, including fertilizers, farm mechanisation and the use of agro-chemicals (Izuchukwu, 2011). There is an ongoing debate regarding the support of large scale commercial agriculture with the participation of the World Bank, UNDP and other agencies. Figure 5.4, example of subsistence agriculture in Nigeria.

Figure 5.4 : An example of subsistence farming in Nigeria (source: Anuforom, 2009).

5.7.3 Agro-Ecological Zones and Climatic Variability

Nigeria consists of different agro-ecological zones which promote agricultural production across various regions (Anuforom, 2009; Akintola, 2001; Sowunmi, 2010). This study considered these different zones using weather data from 1970 to 2011 to analyse different crop and staple outputs from 1980 to 2011 across 8 different States. This is because, this was the available dataset that was provided by the Nigerian

Metrological Agency and the Ministry of Agriculture. Different regions have different crops, and these can vary depending on the wet or dry seasons (Anuforom, 2009). There have been many studies based on agro-ecological zones but, in this context, this study will compare crop yields and productivity across these zones.

5.8 Climate Change and Agriculture

Climate change has resulted in diverse impacts across various physical, biological, economic and ecological systems resulting in rising sea levels, desertification, biodiversity and wildlife habitat loss, urban development, health problems, increase in migration, economic losses, changing landscapes, water and energy deficiencies, flooding and drought (Pachauri, 2014). Nigeria is particularly vulnerable to such impacts and helping to understand these issues will help combat them in the future. Agriculture is very vulnerable to the impacts of climate change, usually due to higher temperatures, eventually causing the reduction of edible and desirable crops alongside increased weed growth and pest proliferation (Apata, 2010; Tirado, *et al*., 2010).

As precipitation declines, the general agro-ecology of West Africa has shifted from the humid forests to the savannahs, and this has had adverse effects on cultivation and agricultural productivity starting in the savannahs and spreading across Burkina Faso, Senegal and northern Nigeria. This has forced farming systems, including livestock and crop production, to adapt to the imbalance within the agro-ecosystem affecting the livelihood of the general population (Haynes, 1980). In addition, a reduction in forest and savannah areas is altering farming systems causing an adjustment to general living standards (Ziervogel & Zermoglio, 2009). However, there is an increased awareness of deforestation and various government agencies are supporting initiatives for conservation and protection as a key component for conserving natural resources.

The major crops grown in Nigeria and its neighbouring countries, such as Mali, Burkina Faso and Niger, mainly consist of cereals such as rice, millet, maize and sorghum. Millet is the most abundant crop grown and is fairly resilient to drought and aspects of climate change (Yadav, 2010), followed by sorghum. Other crops, such as cowpea and groundnut, as well as root crops such as cassava and yam, are also cultivated across these regions, whereas coffee, cocoa and cotton are major cash crops. However, alongside the increase in demand for food across West Africa, farmers are faced with the threat of biophysical factors such as droughts, pests, diseases and soil acidity, amongst others.

5.9 Challenges of Climate Change on Food Security

From 2001 to 2005, the total agriculture budget was $2.2 million, and the National Economic Empowerment and Development Strategy (NEEDS) have also allocated millions of Naira for the development of the agricultural sector (Bello, *et.al*. 2012; Nwoko & Nege, 2007)). Furthermore, there has been a lack of research so funding has been provided to enhance farming, create research links to first world countries and help improve agriculture experimentation and training programmes. However, the current impacts of climate change will influence the general state of the economy. During the 1960s and 1970s, industry was the major source of foreign income but the decline in the 1990s and 2000s has put pressure on national food security and other socio-economic activities across the country (Bello *et.al*. 2012). According to Ayinde & Muchie, (2011) support climate and temperature changes as being the major factors affecting agricultural productivity in Nigeria. In 2001, overall agricultural production fell due to various issues such as land degradation, desertification and drought. In this context, every sector must be involved with the agricultural sector such as the government and other organisations to support national food security (Ayinde & Muchie, 2011).

The changes in weather and temperature have resulted in a situation whereby many farmers have had to abandon their farms and seek other forms of employment in order to survive. As the impacts of climate change are still likely to occur, one way in which the agricultural sector in Nigeria can improve is through the introduction of green technologies that will help crop production (Uyigue *et al*., 2007). The Nigerian government should be able to provide better policies to help improve the agricultural sector through funding and improved adaptation strategies (Ishaya & Abaje, 2008). Weather stations should be better equipped so that they can more accurately forecast weather changes across regions and there should be more investment in science and technology, such as transportation and irrigation pipelines. It is evident that changes in rainfall patterns are a major contributory factor to flooding in some Nigerian States (Atedhor *et al*., 2011). As a result, this has impacted a wide range of socio-economic sectors and the environment leading to water shortages and ground water pollution.

The most evident has been food shortages which is threatening national food security and is having an impact on the poor.

5.10 Summary

Nigeria is a country located in West Africa. Its economy is highly dependent on agriculture. However, the country is faced with numerous economic, social, physical and environmental issues. Nigeria consists of agro-ecological zones which supports different crop types. The agricultural system is classified as commercial and subsistence agriculture. It is acknowledged that Nigerian agriculture is vulnerable to climate change. More resources need to be invested in order to improve the agricultural system in Nigeria and will also include mitigation and adaptation approaches.

Chapter 6: Methodology

6.1 Introduction

The aim of the study was to compare and contrast crop yields in Nigeria and assess stakeholder responses in order to understand population perceptions of climate change. Consequently, the methodology was designed to assess decadal variations in key staple food crops, based upon annual yields. These can then directly be compared with environmental forcing components: precipitation, humidity and temperature extremes. This trend analysis is needed in the context of varying agro-ecological zones. Two datasets were utilised, firstly consultation of primary datasets characterising temporal and spatial variation were scrutinised for the period 1971 to 2011. Secondly, a questionnaire was designed to establish climate change perception among Nigerian farmers, the public and government.

6.2 Description of studied States

As detailed in Section 5.4, Nigeria has 36 States. For the purpose of this work eight agricultural States were selected for investigation. The rationale for the selection of the sites is as follows.

- The availability of the data provided by the Nigerian government.
- The eight States are classified as major agricultural zones.
- All agricultural commodities derived from the States mainly contributes to the Nigerian economy. As a result, these are the major reasons why the States were selected for the study.

The Central Bank of Nigeria (2015), estimates that agriculture provides 24% of the country's GDP and is the second largest industry after the oil and gas sector. Some zones such as Sahel Savannah are drier and mostly uncultivated and therefore only suitable as pasture land. By contrast, many northern States are occupied by semi-settled pastoralists and the cultivated areas are restricted to the growth of sufficient cereals to feed their immediate families (Ojogwu, 2009). The more humid, southern tropical forest zone generates more rainfall and is therefore capable of supporting various crops such as cocoa, oil palm, and staple crops like, yam, cassava, groundnut and rice maize, consequently, these staple crops tend to be concentrated along the southern/central belt. (Aregheore, 2009). Figure 6.1 shows a concentration of zones in South West quarters, areas of North + East are more difficult to access because of the conflict and paucity of available data. Figure 6.1 details their agro-ecological classification.

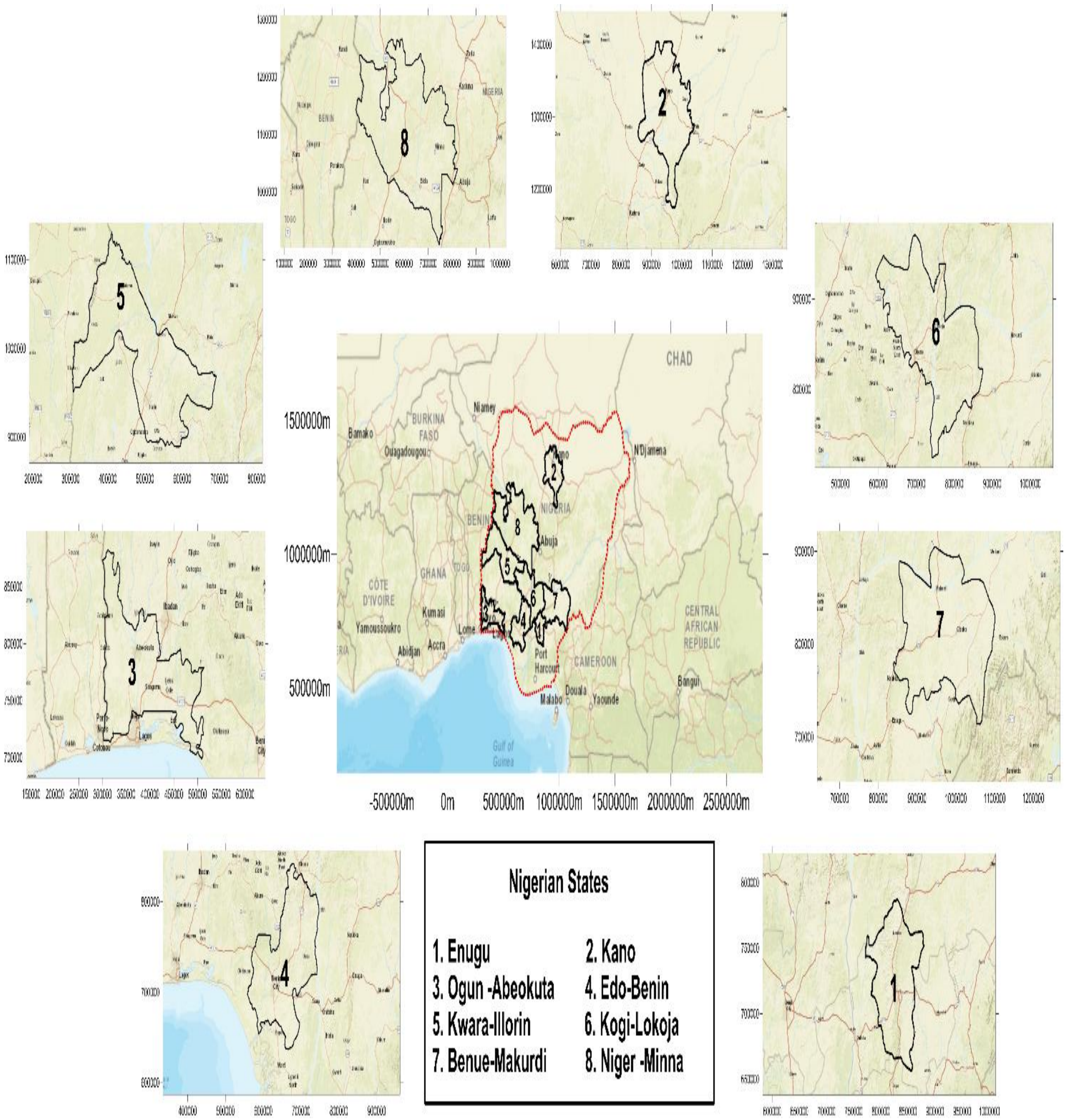


Figure 6.1 A map of Nigeria showing the different states used in this research.

Table 6.1: A map of Nigeria showing the different states used in this research.

Reference	Nigerian State	Agro-ecological Zone	Geographical location
1	Enugu	Derived savannah and Humid Forest	Central
2	Kano	Sudan savannah and Northern guinea savannah	Central North
3	Ogun - Abeokuta	Derived savannah and Humid Forest	South West
4	Edo	Humid Forest and Derived savannah	Central South
5	Kwara	Derived savannah and Southern guinea savannah	Central West
6	Kogi	Derived savannah	Central South
7	Benue	Derived savannah	Central East
8	Niger	Northern and southern Guinea savannah	Central/North West

6.2.1 Enugu State

Agro-ecologically, Enugu can be described as mainly Derived savannah and Humid Forest (Table 6.1), is located in the south-eastern part of Nigeria (Figure 6.1, State 1), and its population comprises over 722,664 people. Geographically, the topography of Enugu is mainly mountainous and hilly, but also consists of vast areas of vegetation and forest. Some vegetation and forest areas have been cleared for agricultural use as population increases (Enugu State, 2014). Communities are largely made up of farmers and to a lesser extent are employed in tourism. Enugu City was locally known as the coal city, because of its heavy reliance on coal extraction in the early 20th century. The State has relied on agriculture as a major source of income since the 1950s and suitable soil and favourable climatic conditions enable the area to produce many forms of cash crop. Additionally, a smaller proportion of livestock farming exists (Ajani *et al*., 2015).

6.2.2 Kano State

Kano State designated as Sudan savannah and Northern guinea savannah (Chapter 4), is located in North-west Nigeria and has a population of over 2.167 million. It is the 3rd largest State and one of the major commercial agriculture areas in Nigeria (Figure 6.1, State 2). Desertification results in high levels of irrigation (KSMANS, 2015). The major source of income is arable and livestock farming, both commercial and subsistence. The movement from the South West air masses which originates from the Atlantic Ocean causes wet seasons. The State is rich in faunal and floral resources (KSGB, 2015), together with large wooded areas, the trees helping to create drought resistance. The climate is classified under the wet and dry season. The dry season is usually very intense leading to drought, but the wet season provides water which nourishes the vegetation.

6.2.3 Ogun State

Like Enugu State, Ogun State is designated as Derived savannah and Humid Forest and located in the south-western part of Nigeria. It has a population of over 3.7 million (Figure 6.1, State 3) and again, its major source of income is agriculture (over 78% of the land is used for farming) (Propcom, 2015). The State is also involved in commercial and subsistence farming. Geographically, Ogun State consists of rain forest, derived savannah and swamp forest but rising urbanization and increased population is affecting the landscape with road enlargement projects particularly impacting agricultural practises. The State is famously known for its geology locally known as “Olumo rock” which attracts many tourists to the popular spring: “Osuuru spring” (Propcom, 2015). The River Oyan flows through coastal lagoons into the Atlantic Ocean and there is both temperature (during the wet and dry seasons) and soil/vegetation variations throughout the State.

6.2.4 Edo State

Edo State is designated as Humid Forest and Derived savannah and located at the southern part of Nigeria, where it has a population of over 3.5 million (Figure 6.1, State 4), while agriculture plays a critical role in the economy (Edo, 2015). The seasons are mainly wet and dry seasons and productivity centres around crop/arable farming. The State consists of rivers and freshwater which supports farming. Edo State is regarded as the food basket of Nigeria. It is also known as one of the oldest and ancient city due to its cultural heritage, and where ancient African civilization began. The State’s rich culture is a tourist hotspot, attracting visitors from all over the world (Edo State, 2015). It is known for its important bronze and brass ark work as well as its wildlife, such as leopards, buffaloes, antelopes and chimpanzees. The State has a number of wildlife conservation, resorts and parks, making tourism an important sector for this region.

6.2.5 Kwara State

Kwara State is designated as Derived savannah and Southern guinea savannah and located in western Nigeria. It has a population of over 2.37 million and is also a key agricultural State (Figure 6.1, State 5). Ever since the creation of the State in 1989, quite a number of strategies have been aimed at improving the agricultural sector (KSADP, 2015). This includes improving the standard of living among rural farming communities, making agriculture attractive for youths and improving education as well as providing jobs. Kwara State is known to be self-sufficient in its food production, but rich in natural resources, such as Kaolin, quartz, feldspar, marble, clay and granite. Therefore, as a result of its location and easy access to other States, Kwara has a number of industrial areas (Kwara State, 2014). The State has history of cultural heritage and generally is rich in vegetation, soils and rocks. Kwara State shares similar geography with Edo State, however, both areas have different cultures.

6.2.6 Kogi State

Kogi State is designated as Derived savannah and mainly known as the Confluence State, because River Niger and River Benue meet here (Figure 6.1, State 6). Agriculture is the major economic sectors, industries being steel, coal and of minerals production (Agbamu, 2015). The State was created in 1991 and has a population of over 2.15 million. Agriculture here involves both subsistence and commercial farming and is one area where the government have pledged to assist women in farming by providing grants and loans. It shares a boundary with Niger State and Enugu State. The State is well known for its traditional art and craft industries and, vegetation consists mainly mixed leguminous, woodland, forest savannah, and tropical forest (Kogi State, 2014). The soil is very fertile because of the riverine influence and this clearly benefits agriculture. However, during the wet season, the area is prone to flooding due to heavy rainfall.

6.2.7 Benue State

Benue State is designated as Derived savannah, and located at the mid-belt region of Nigeria, where it has a population of over 4.3 million. Agriculture is the major income source for the economy, but other industries exist particularly in the areas of gemstones, clay and coal extraction (Figure 6.1, State 7). It consists of both wet and dry seasons and the Lower River Benue goes through the middle belt region. In some parts, temperatures are very high but the rainfall helps support farming. Regional vegetation consists of tall grasses, palm trees and Guinea savannah. Benue State has a vast diversity of agricultural produce and it also has a fertile soil enabling it to achieve reasonable yields (Ayeomoni & Aladejana, 2016). During the dry season, the temperature is very high, resulting in farmers irrigating their land and during the rainy seasons, heavy rainfall causes flooding. The government have also pledged to support farmers in this State (Benue State, 2014).

6.2.8 Niger State

Niger State is designated as Northern and southern Guinea savannah and located in central Nigeria with a population of over 3.95 million. The State consists mainly of internal markets, rural farming, subsistence agriculture and raw material extraction for export. (Figure 6.1, State 8). Niger State experiences drought cycles and desertification. Rainfall amount varies, and recent changes in climatic conditions have resulted in food shortage as farming struggles to cope with drought conditions (NSDP, 2014). Nevertheless, the area does have a significant export market for its commodities. It has natural resources such as marble, iron, lead, limestone, columbite and kaolin among others. The physical geography consists of rivers, hills, dense vegetation, and forest. However, erosion and leaching of soil nutrients are impacting on agricultural activity (Niger State, 2014).

6.3 Physical Data

6.3.1 Sources of information

This section aims to provide how the sources of information was derived for the study. Table 6.2 provides a brief summary of the organisations, their roles and the data provided for this research. The Central Bank of Nigeria provided a statistical bulletin comprising of economic costs for agricultural commodities, produced from countrywide export to import data. They also provided foreign and local exchange rates. While, the Ministry of Agriculture and Water Resources in association with the National Survey of Agricultural Export Commodities, provided monthly and annual data related to various commodities exported from Nigeria. They also produce regional/State outputs for crop yield, fertilizer and pesticide use (CBN, 2013).

Table 6.2: A summary of the key organisations that provided data for this research

Organisation	Roles of Agencies	Data Type
Central Bank of Nigeria	The major roles and objectives of the CBN are to regulate and maintain both internal and external reserves of the country, as well as to promote all major monetary stability and to promote a sound financial environment. It is the 'back-bone' of all other institution in the country. CBN plays the role of banker of the last resort and financial adviser to both the State and Federal governments (CBN, Statistical Bulletin, 2012). CBN also provides detailed information for all local, national and international indicators for revenues, expenditures and other public debts for domestic and external bodies. Generally, the CBN documents a summary of all information of all other agencies across the country in its annual reports (CBN, Statistical Bulletin, 2012).	Annual reports and datasets
Federal Ministry of Agriculture	The role of the Federal Ministry of Agriculture is to promote national survey on agricultural commodities and to provide availability of reliable commodity statistics across the country. Additionally, to facilitate and plan on how to boost production, processing and marketing or exportable agricultural.	Agricultural production rate datasets for the studied states. The area of farm land for each State assessed was standardized.

	The Ministry mainly works in collaboration with the National Bureau of Statistics (NBS), Nigerian Meteorological Agency (NIMET) and Central Bank of Nigeria for funding and providing statistical information for agricultural commodities across the country. Overall, the Ministry monitors small scale and large scale agricultural production across the country. Finally, the Ministry monitors naturally occurring phenomenon which occurs in the country, and other adverse effects causing hydrological imbalance which is affecting land resources and other productions systems (NBS/CBN/FMA&WR/FM&I, 2010/2011).	
Nigerian Meteorological Agency (NIMET)	The role and responsibility of the NIMET and other statutory functions, is to observe and monitor the weather and climate of Nigeria. NIMET provides weather, climate and other related environment services all through the sectors on which includes water, agriculture, energy, health and transportation. This is to help reduce the risk and to derive better economic benefits. Additionally, the Agency provides rapid and earlier warnings and alerts that requires collaboration with the media and telecommunication providers. More especially, it helps to provide relating information concerning agricultural communities to aid, provide and improve production and to reduce risk and losses, and also to reduce costs and increase efficiency. The Agency aims at advising the '*Federal Government on all aspects of meteorology*'. More especially, in this current era of climate change, NIMET is mandated to provide weather and climate information for various weather-dependent sectors across the nation's economy (NIMET, Climate Review, 2012). Notably, in the areas of agricultural production and national food security sectors.	Meteorological datasets.

	Recently, the Agency targets at providing agro-climate-information which is usually targeted at farming communities so as to reduce the vulnerability of both past, present and future trends of events across the nation. NIMET is also in charge of providing information relating to daily, monthly and yearly weather forecasting, potential evapotranspiration, growing degree days, synoptic weather situations, rainfall and temperature with their anomalies, predication of disasters and agricultural activities among others (NIMET, Climate Review, 2012).	
Federal Ministry of Environment	Ever since the Ministry was established in 1999, their roles have been to address rising issues of environmental consciousness as well as to interface with the global environment best practises. Additionally, it focuses on developing practises and strategies so as to emphasise the use of environmental engineering as a veritable tool for tackling poverty, environmental degradation and other sustainable economic development, so as to improve the general living standards of the citizens. The Ministry also provides policies to ensure good governance at regional, national and global scales. The Ministry also ensures that environmental matters are always and adequately mainstreamed into all aspects of development activities. This includes all forms of protecting the environment and conservation of natural resources, which includes Environmental Impact Assessment of all development projects. Finally, to promote co-operation in environmental sciences and conservation technology.	Questionnaire responses and bulletins.
National Bureau of Statistics (NBS)	In charge of all numerical information in the country and also provide other agencies with statistical information.	Questionnaire responses

6.3.2 Meteorological data

The Nigerian Meteorological Office (NIMET) operates a series of weather stations located at approximately 50 km centres across Nigeria that calculate a variety of meteorological parameters (NIMET, 2011). For this research, they supplied environmental data that comprised of monthly average temperature extremes, humidity and precipitation for the period between 1971 and 2011. Previous studies have provided that, backdated environmental forcing agent dataset aids to provide vital information of the physiological and biological characteristics of crop output (Aikpokpodion, 2010). Table 6.3 gives an example of the maximum temperate raw dataset and full details of all variables used are given in Appendix 1. These data were important in the analysis of temporal trends, enabling direct comparisons to be made with temporal variations in both crop yield and fertilizer use within each of the studied states.

Table 6.3: An example of the monthly average maximum temperature data for Enugu State, supplied by NIMET (2011)

Jan – April (Dry Season) **May –September (Wet Season)** **October to December (Dry Season)**

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1971	33.1	34.2	34.4	33.2	32.1	30.3	29.1	28.9	29.8	31.1	32.4	33.3
1972	34.2	35.1	34.2	32.1	31.9	31.1	31.2	29.9	31.1	31.4	33.3	33.9
1973	34.1	35.8	35.2	33.8	32.9	31.2	29.8	29.9	30.3	32.4	33.3	33.1
1974	33.3	34.6	34.8	33.2	32.1	31.2	29.2	31.1	30.2	31.4	32.9	33.1
1975	33.1	35.3	35.4	34.1	31.9	31.4	29.1	29.8	29.2	31.2	31.9	33.2
1976	34.1	33.3	33.2	32.9	31.1	30.2	28.4	28.9	29.7	29.8	31.2	33.4
1977	32.1	34.1	35.4	33.9	33.1	29.8	28.7	28.9	29.6	30.8	33.9	33.2
1978	33.9	34.8	33.7	32.2	32.1	30.3	29.1	29.9	30.1	31.3	32.1	33.3
1979	34.9	34.1	34.3	34.9	31.7	29.8	29.9	29.1	31.2	31.3	31.9	31.7
1980	33.9	34.7	33.5	34.2	32.1	31.4	29.9	29.7	29.6	29.8	31.6	31.8
1981	32.2	35.4	34.9	34.6	30.9	30.5	29.1	29.4	30.2	31.3	32.1	34.2
1982	34.2	34.3	33.9	34.2	31.9	29.8	29.6	29.7	28.9	31.2	32.3	33.3
1983	32.2	35.8	36.5	36.7	30.3	30.2	29.4	29.8	31.5	33.7	33.2	33.1
1984	34.4	35.9	34.8	32.7	31.9	31.0	29.5	29.8	29.9	30.6	31.8	32.2
1985	34.2	35.4	34.2	32.1	32.3	30.3	30.2	29.6	29.9	31.2	33.3	32.4
1986	34.4	35.8	33.2	34.3	32.1	31.4	29.4	29.2	29.9	30.9	32.1	32.3
1987	34.4	34.9	35.2	35.4	33.9	30.8	31.2	29.9	31.2	32.1	34.4	34.2
1988	34.2	36.9	35.2	34.3	32.4	30.8	29.9	29.7	30.3	31.1	33.2	32.4
1989	33.3	35.2	35.9	33.8	31.1	31.4	29.9	29.4	29.8	30.5	33.3	33.2
1990	33.9	35.3	37.5	34.4	32.1	30.7	29.0	29.3	29.8	30.7	32.2	32.1

6.3.3 Crop yield and Fertilizer application

There are variations in cultivated crop type within States that have the same agro-ecological categorisation, and in order to understand temporal trends in the different crops types being used, production rate data are essential. Table 6.4 details crop characteristics alongside the ideal environment that enables maximum production rates to be achieved.

Table 6.4: Crop characteristics and environmental conditions suitable for growth and productivity

Description	Crop type and growing characteristics	State cultivated
Crop:	**Yam** (*Dioscorea*)	
Characteristics:	Requires a suitable amount of rainfall distribution and a higher amount of sunlight, with too much rainfall affecting productivity.	Enugu State, Ogun State, Edo State, Kwara State, Kogi State, Benue State, Niger State.
Environment:	Requires temperatures of 25 to 30^{0}C and ample moisture throughout the growing season but is resistant to severe weather conditions.	
Nutrition:	Contains water, energy, protein, fat, carbohydrates, fibre, sugar, calcium, iron, magnesium, phosphorus, potassium, zinc and copper (Abang, *et al*., 2002)	
Crop:	**Maize** (*Zea mays*)	
Characteristics:	Requires a lot of moisture and water, and is not very resistant to extreme weather conditions compared to other crops.	Enugu State, Kano State, Ogun State, Edo State, Kwara State, Kogi State, Benue State, Niger State.
Environment:	Requires temperatures of 18 to 32^{0}C and 12^{0}C during germination, as well as over 300mm of rainfall, but are dependent on other factors such as fertiliser and soil quality.	
Nutrition:	Contains carbohydrates, protein, crude fibre and ash (Iken, & Amusa, 2004).	
Crop:	**Guinea Corn** (*Sorghum bicolor*)	
Characteristics:	Native to both tropical and subtropical regions, it is resistant to extreme weather conditions and is a major source of food across Africa.	Kano State, Kwara State, Kogi State, Benue State, Niger State.
Environment:	Requires temperatures of 13 to 30^{0}C, can adapt to any weather condition and can grow without the use of fertilisers.	
Nutrition:	Contains energy, protein, vitamins and minerals (Chikoye, 2004)	
Crop:	**Cassava** (*Manihot esculenta*)	Enugu State, Ogun State, Edo State, Kwara State, Kogi State, Benue State, Niger State.
Characteristics:	A root crop cultivated in both tropical and sub-tropical regions across the world, and the third main source of food carbohydrates after rice and maize. It is very tolerant to extreme weather conditions and capable of growing in marginal soils.	
Environment:	Requires humid-warm climates between 25 and 29^{0}C and precipitation of 100 to 1500mm	
Nutrition:	Contains carbohydrates, protein, minerals, vitamins, calcium, riboflavin, thiamine and nicotinic acid (Tonukari, 2004).	
Crop:	**Millet** (*Pennisetum glaucum*)	
Characteristics:	A small seeded grass which is very important to semi-arid regions across Asia and Africa with	Kano State, Kwara State, Kogi State, Benue State, Niger State.

	97% of production in developing countries. The crop survives high temperatures and has a short growing season.	
Environment:	Requires temperatures of 26 to 29^{0}C and precipitation of 38^{0}C to 35^{0}C mm.	
Nutrition:	Contains water, energy, protein, fibre, fat, carbohydrates, sugars, iron and calcium (Craufurd, 2000).	
Crop:	**Melon** (*Cucumis melo*)	
Characteristics:	There are many varieties which are native to various regions such as Latin America, Asia and Africa.	Enugu State, Ogun State, Edo State, Niger State.
Environment:	Dependent on the variety and species, but generally temperatures of around 60 to 80^{0}C	
Nutrition:	Contains sugar, vitamins, potassium, proteins and minerals (Bankole *et al*., 2010)	
Crop:	**Groundnut** (*Arachis hypogaea*)	
Characteristics:	An annual herbaceous plant with many varieties which are native to various regions.	Enugu State, Kano State, Ogun State, Edo State, Kwara State, Kogi State, Benue State, Niger State.
Environment:	Requires five months of warm weather and rainfall between 500 to 1,000 mm, with soil of pH 6.0 to 6.5 helping to improve growth.	
Nutrition:	Contains energy, carbohydrates, sugar, fat, dietary fibre, protein, tryptophan, lysine and water (Mensah *et al*., 2006).	
Crop:	**Beans** (*Phaseolus vulgaris*)	
Characteristics:	Various species and varieties indigenous to various regions	Enugu State, Kano State, Ogun State, Edo State, Kwara State, Kogi State, Benue State, Niger State.
Environment:	Different species require different environments. In Nigeria, red and white beans require temperatures of 20 to 30^{0}C and precipitation of 400 to 2,600mm	
Nutrition:	Contains protein, fat, oil, sugar, vitamins, sodium and potassium (Aikpokpodion, 2010).	
Crop:	**Asian Rice** (*Oryza sativa*) and African Rice (*Oryza salberrima*)	
Characteristics:	A cereal grain crop widely consumed across the world, mostly cultivated in Asia and Africa.	Enugu State, Kano State, Ogun State, Edo State, Kwara State, Kogi State, Benue State, Niger State.
Environment:	Requires over 200 mm of monthly rainfall and average temperatures of 22^{0}C.	
Nutrition:	Contains carbohydrates, sugar, water, vitamins, sodium and potassium (Idiong, 2007).	
Crop:	**Cocoyam** (*Colocasia esculenta*)	
Characteristics:	An herbaceous perennial plant mainly cultivated across Africa, south India and southeast Asia.	Enugu State, Ogun State, Edo State,
Environment:	Requires average temperatures of 21^{0}C with soil of pH 4.2 to 7.5	
Nutrition:	Contains energy, carbohydrates, sugars, proteins, fats and dietary fibre (Anikwe *et al.*, 2007).	

The Nigerian Ministry of Agriculture (NIMoA) supplied annual crop yield and fertiliser use data for each of the studied States. The data for the important staple crops has been available since 1980, therefore, NIMoA supplied a dataset for the period between 1980 and 2011 (i.e. the start of this research project). Table 6.5 gives an example of the raw dataset for Enugu State and full details for the remaining States are given in Appendix 2.

Table 6.5: An example of the annually averaged crop yield and fertilizer use data for Enugu State, supplied by NIMoA (2011).

Timescale	Groundnut	Beans	Yam	Maize	Cassava	Rice	Melon	Cocoyam	Fertilizer (Tonnes)
1980	0.32	1.23	2345.56	78.56	23.45	65.34	0.70	23.34	400
1981	0.34	1.02	2445.76	78.89	23.47	45.70	0.69	24.34	423
1982	0.32	0.98	2455.67	86.56	24.34	55.78	0.77	23.43	385
1983	0.32	0.89	2456.67	76.56	24.45	54.65	0.75	23.54	467
1984	0.42	0.96	2345.56	78.56	23.56	56.76	0.88	34.23	483
1985	0.34	0.89	2453.55	77.56	23.55	45.45	0.78	35.45	465
1986	0.26	0.89	2456.34	68.67	29.45	62.34	0.87	32.43	478
1987	0.31	0.78	2451.12	56.67	24.45	56.55	0.89	34.35	488
1988	0.31	0.85	2455.23	61.23	24.44	45.45	0.79	40.21	490
1989	0.37	0.78	2456.34	68.56	25.34	56.73	0.87	41.23	478
1990	0.31	0.79	2333.34	67.56	23.45	56.45	0.97	42.23	499
1991	0.39	0.88	2356.56	78.98	23.54	56.78	0.78	33.23	467
1992	0.42	0.89	2453.34	79.56	23.55	57.77	0.78	36.56	480
1993	0.39	0.91	2335.34	76.56	31.23	54.67	0.86	34.56	410
1994	0.40	0.89	2452.32	78.91	33.00	57.56	0.67	35.23	400
1995	0.41	0.98	2345.12	78.45	32.34	56.64	0.78	34.56	418
1996	0.36	0.89	3065.18	86.99	32.44	56.66	1.25	35.54	487
1997	0.26	0.97	2828.74	99.52	46.91	56.74	1.43	35.56	460
1998	0.38	1.06	3040.74	104.14	31.45	56.83	1.15	36.34	554
1999	0.39	0.98	2127.00	74.23	39.34	56.45	1.06	31.23	590

In Nigeria, agricultural output is measured annually across each State. This is conducted by the Federal government in collaboration with the Ministry of Agriculture. This is aimed at deriving the quantity of crop yield from each State for both quantity and quality. Since agriculture is a major source funds for the economy, this exercise is compulsory and taken very seriously. Farmers are visited across the States by agricultural extension workers who conduct the exercise. They weigh each crop produced, record and document all produce for each State across Nigeria which is then published by the Ministry of Agriculture. According to the Ministry of

Agriculture, all agricultural States used for the study were measured equally, through a standardized approach. Standardized crop yield estimation methods aid accurate yield estimation, as well as estimating the total output for each crop type cultivated. In this case, total yield per unit area, is then calculated by total production, and then divided by the total harvested area for each of the agricultural States (CBN, Statistical Bulletin, 2012).

6.4 Questionnaires

6.4.1 Introduction

Three questionnaires were distributed to the agricultural, and urban population, as well as Nongovernmental and Governmental Organisations, contains copies of this paper questionnaire. The research was undertaken visiting farmers on farming site were the questionnaires were distributed. The majority of the farmers were willing to complete the questionnaires. Out of 300 questionnaires, 227 were completed by the farmers. Similar approach was used for the public, whereby 500 questionnaires were distributed, out of which, 401 was completed. While, for the government officials, this was undertaken through appointments whereby 50 questionnaires were completed. The general aim was to discover perception at all levels, using open and closed questions that included demographic, climate change and mitigation/adaptation. This formed the main element of data collection in order to meet a key project objective to establish which could then be analyzed using SPSS and Excel software.

6.4.2 Questionnaire Design

Questionnaire design is not an exact science, but the format must take account of end users and appreciate time constraints when completing the questionnaire (Malhotra & Birks, 2007; Mond *et al.*, 2006). Therefore, number of questions was carefully considered. The original questionnaire design was an iterative process since as Oppenheim (1992) remarked, such endeavours undergo revision rather than be created in a ‘perfect’ form first time and this process resulted in a final version suitable for this research project.

These questionnaires addressed a gap in knowledge concerning agricultural climate change perception and Likert scale questions using mixed answer ranges of 1-3, 1-5 and 1-6. The Likert scale aids in rating people's responses with issues related to perceptions (Whitmarsh, 2005). It also allows the degree of opinion of the respondents. The first draft was reviewed by both supervisors, and was sampled by a small group on campus for clarity and relevant information as a standard practise. Following that responses, minor changes were made to the phrasing and structure of the questionnaires. Robert (2014) suggested that cultural differences can result in diverse replies and can be exacerbated by question meanings lost in translation. In this research, English was used for direct communication and to construct the questionnaires as this was main Language used in the assessed States.

6.4.3 Questionnaires issued to an agricultural population (1)

Questionnaires were used to collect responses from farmers in order to assess crop production and practices across the region. In total, there were 28 questions aimed towards understanding knowledge and opinions regarding the impact of climate change on agricultural production, the questionnaire also had column for additional comments.

6.4.4 Questionnaires issued to urban population (2)

There was a total of 28 questions grouped into three sections. The first part comprised general information or socio-economic section, the second part was about climate change, and the final part was about behaviour and lifestyle. The survey was carried out in the Federal capital of Nigeria, Abuja. This was done by the researcher, and some volunteers. The questionnaire comprised of general socio-economic information which includes gender, age, occupation, education and employment and ways of travel. The second stage of the questionnaires comprised of issues of climate change and the environment.

6.3.10 Organisations (Non-governmental and Governmental) questionnaires (3)

The questionnaires were aimed mainly at those in government and non-government organisational positions that provide polices for farmers and the public. This was to support improved policies for adaptation, with the first section comprising of general questions, the second comprising questions about climate change issues, and the third comprises questions on attitude, beliefs and lifestyle.

6.5 Statistical analysis

Wheater and Cooke (2000), Phillips (2005) and Thomas (2012), have shown that most variables which are measured at continuous scales are generally normally distributed. Since the temporal meteorological, crop yield and fertilizer use datasets used in this research were measured at continuous scales, standard parametric tests were used. In order to support this assumption of normal distribution, Kolmogorov-Smirnov tests were used. The test calculates the maximum distance between the cumulative frequency curve of the dataset and that of the normal curve which also determines the significance (p) of the distances. In the case of a low p-value ($p<0.05$), it can be determined that the result is significant which signifies that the data is not normally distributed (see for example, Davies, 2002 and Field, 2005).

6.5.1 Parametric tests

Pearson's product moment correlation coefficient (r) was determined from:

$$\text{Correlation Coefficient } (r_{calc}) = \frac{N\sum xy - (\sum x)(\sum y)}{\sqrt{(N\sum x^2 - [\sum x)^2](N\sum y^2 - (\sum y)^2)}} \quad \text{..(equation 6.1)}$$

Where, n is the number of data pairs, x and y are data points on each axis (Wheater and Cooke, 2000).

According to Douglas and Crowell (2000), data analysis begins with an attempt to find associations between variables and regression analysis is the basic tool. Linear regression was utilised in this research, as determined from:

$$y = (c + mx) + \varepsilon \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(Equation 6.2)}$$

Where y is the independent variable; c is a constant; m the regression coefficient; and is the dependant variable; and ε is the error between model and actual results (Field, 2005: 157). Variables c and m are calculated from the following:

$$m = \frac{\sum xy \quad \frac{-\sum x\sum y}{N}}{\sum x^2 \quad \frac{-(\sum x)^2}{N}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\text{(equation 6.3)}$$

$$c = \frac{y}{n} - m\frac{x}{N} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{(equation 6.4)}$$

Proportional dataset variability is explained by the statistical model determined from the coefficient of determination, which is simply the square of the sample Pearson correlation moment coefficients (equation 6.5).

The significance of the regression line is given by the following formulae:

$$SS_{total} = \sum y^2 - \frac{(\sum y)^2}{N} \text{ ....(equation 6.6)}$$

$$SS_{regression} = \frac{\sum xy - \frac{(\sum x \sum y)^2}{n}}{\sum x^2 - \frac{(\sum x)^2}{n}} \text{ ....(equation 6.7)}$$

$$SSresidual = SStotal - SS\ regression \text{.......... (equation 6.8)}$$

Finally, the calculated F values are compared with a table of critical values according to degrees of freedom (df). If Fcalc < Ftab, the null hypothesis is accepted, and it is concluded that an insignificant amount of variation in y is accounted for by the variation in x. However, if Fcalc > Ftab, the null hypothesis was rejected, and it is concluded that a highly significant amount of the variation in y is accounted for by the variation in x. Martin and Bateson's (1994) informal interpretation of r values was utilised for result evaluation (Table 6.6).

Correlation can be described as a statistical measure by which the size and direction of the relationship between two or more variables is calculated. Causation on the otherhand can be described as the means by which one occurrence affects another. These two concepts are important, because they help identify the relationship between one variable and another (Martin and Bateson, 1994). In this context, correlation coefficient represents the degree of relationship between two variables, for instances time against crop yield.

The data was presented in an excel word document and was analysed through a scattered plot approach. As a result, the equation in 6.1 was used to analyse if there was any significant relationship between the variables (environmental forcing agents, crop yield and time).

Table 6.6: Interpretation of correlation data, modified from Martin and Bateson (1994)

r	R^2	Informal interpretation
<0.2	<0.04	Slight; almost negligible relationship
0.2-0.4	0.04-0.16	Low correlation; definite but small relationship
0.4-0.7	0.16-0.49	Moderate correlation; substantial relationship
0.7-0.9	0.49-0.81	High correlation; marked relationship
0.9-1.0	0.81-1.0	Very high correlation; very dependable relationship

6.5.2 Questionnaire statistical analysis

Data were analysed using the Statistical Package for the Social Sciences (SPSS) software, WinSTAT Statistics Software Add-In for Microsoft Excel and Microsoft Office Excel spreadsheet software, to reveal any correlation within and between the questionnaire groups. SPSS provides automation of many analytical tools designed to reveal significances in data. Excel was used where SPSS is unable to provide data in a final format for inclusion in this thesis. Characteristics of all respondents were assessed, followed by more specific analysis of demographic, climate change and mitigation/adaptation perception. The significances revealed during SPSS interrogation will be interpreted in conjunction with the literature review (Chapter 2 and 3), physical background (Chapter 5) and assessed against temporal trends leading to potential recommendations for climate change mitigation and adaptation strategies. Any recommendations made to aid policy decisions which will now be based on sound research rather than just instincts of policy makers (Malhotra and Birks, 2007).

6.5.3 Comparative analysis using Chi-square

Respondent answers were analysed to discover any statistically significant or highly statistically significant associations between variables. This was achieved by use of a Chi square test using SPSS software. A Chi Square result demonstrating a p-value of $p < 0.05$ or less indicates a 95% confidence in a statistically significant association and a p-value of 0.001 or less indicates a 99% confidence that there is a highly statistically significant association.

Although a Chi square test may reveal a highly statistically significant relationship between variables, further analysis was required to confirm which demographics produced this result. Chi square calculations of adjusted residuals for each variable enabled more specific associations to be discovered. Calculation of adjusted residuals can result in both positive and negative values with a positive value denoting a positive association whilst a negative result indicates a negative association. If an adjusted residual is ±1.96 (or higher), probability of an association is calculated at <0.05 (can occur 1 in 20 occasions and is equivalent to a 95% confidence). If an adjusted residual is ±2.58, the significance is measured at 0.01 (equivalent to a 99% confidence) and a chance occurrence would only happen in 1 out of 100 occasions (Tredoux *et al*., 2005).

6.6 Assessment of questionnaire responses

Following the completion of the questionnaire, responses were analysed as follows:

6.6.1 Demographics

Questions 1-7 were common to all questionnaires and enabled comparative analysis both within and between groups. The questions comprised of gender, ages and highest level of qualification. Demographics was explored and was applicable to all three groups. Its relevance was to identify and understand which groups are more involved or participate in farming it also helped identify those who might have greater awareness of climate change in Nigeria.

6.6.2 Climate change and Environmental Issues

6.6.2.1 Farmer's questionnaires

Questions related to climate change and agriculture were from 9-27, this comprising of which tenure system the farmers belong to, and how long they have been engaged in farming and agricultural activities, and they perceive of climate change.

6.6.2.2 Public questionnaires

Questions 9-26 related to climate change and environmental issues, while questions 27 and 28 related to climate change mitigation. These were directly analysed within SPSS to generate percentage responses for each category.

6.6.2.3 NGO and governmental questionnaires

Questions 9-21 related to climate change issues, while questions 22 and 23 related to climate change mitigation. In line with the aforementioned answers, were directly analysed within SPSS to generate percentage responses for each category. Chi square was also used was utilised to compare response variations between related questions from other questionnaire groups.

6.6.3 Likert scale answers

Bard & Barry (2000) used a Likert scale suggesting that it was ideal for farmer's assessment towards understanding risks, perception and awareness. Certain questions were constructed to enable analysis of a range of perception responses. This is an approach typically used by social scientists to assess attitudes, behaviour and opinions.

6.7 Multiple Regression

At the initial stage of the research, the use of multiple regression was considered but following data acquisition, it was decided not to pursue this option due to data requirements. The current use of data requires direct comparison between variables, for example, temperature against maize production. There were many such comparisons subsequently linked directly to questionnaire responses and as a result, multiple regression was not considered necessary.

6.8 Summary

The research objectives of the study influenced the two methodological approaches used in this research. Firstly, the temporal data collected from the Ministry of Agriculture and the Nigerian Meteorological Agency is aimed at providing approaches on data acquisition and analysis. While the second study was the use of structured questionnaires for three groups, namely farmers, the public, NGOs and governmental bodies. Using this method helps to have an in depth understanding on the subject of climate change in Nigeria. All data collected are all related to climate change and agriculture as well as the questionnaire used. Having detailed the methodological approaches used, the following chapter will present the results and initial discussion.

Chapter 7: Temporal Change (1971-2011)

7.1 Introduction

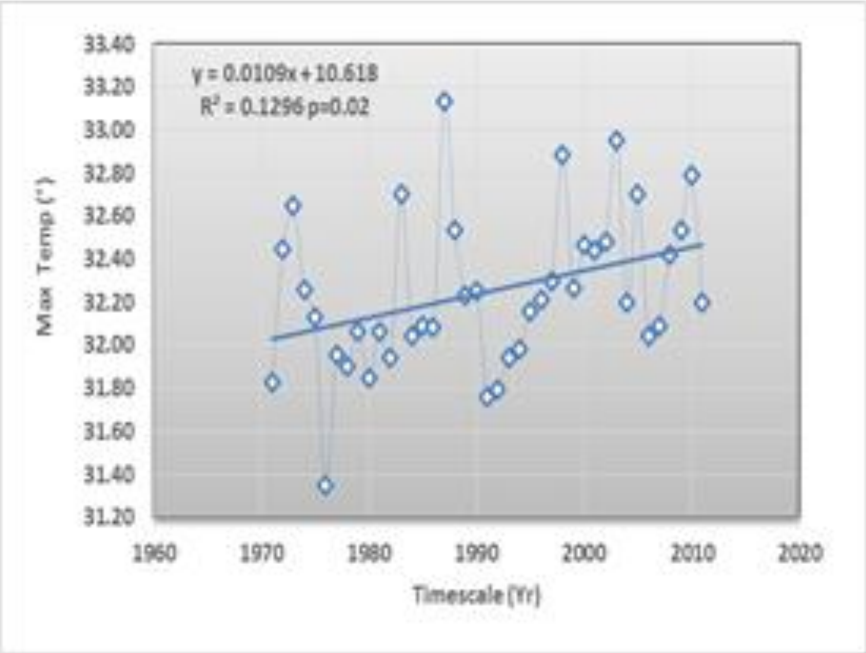
Having selected eight Nigerian States, because they are the major agricultural States which support the economy, each will now be analysed according to crop trends, environmental change and impacts on yields. Parametric testing was used as an effective tool to quantify and assess temporal change, and systematically establish future changes and trends. Consequently, the following detailed analyses separately consider temporal change within each State and for completeness an overall summary is provided at the end of the Chapter. The aim is to improve Nigerian agricultural productivity, as well as climate change mitigation and adaptation.

7.2 Enugu State

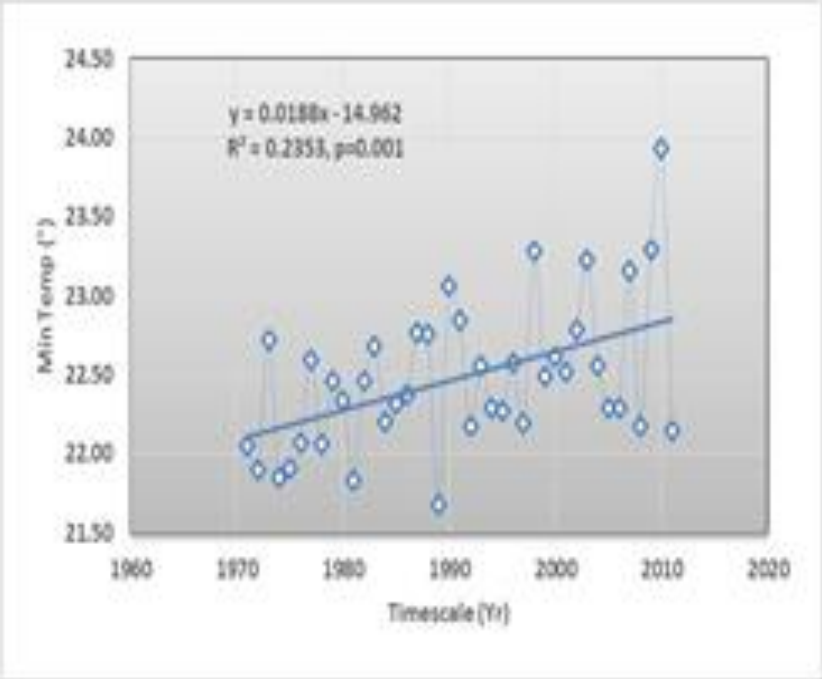
7.2.1 Environmental change (1971-2011)

The first analysis examined whether climate variables i.e. temperature, humidity and precipitation changed appreciably within this time frame. When ***maximum temperature*** change was statistically assessed, a positive low correlation and definite small relationship existed, highlighting a slight increase in temperature over time. The regression model (y = 0.0109x +10.618) R^2 value only explained *circa* 13% of data variation, the temporal trend was statistically significant at >95% confidence p = 0.02 (Figure 7.1a). Similarly, a positive correlation indicated increasing temperature over time when ***minimum temperature*** was assessed. With greater statistical significance, a moderate correlation and a substantial relationship represented by the regression model (y = 0.0188x - 14.962), where R^2 explained *circa* 24% of temporal temperature variation and with 99% confidence a statistically significant rising minimum temperature trend p <0.01 (Figure 7.1b).

A slightly positive and almost negligible relationship existed when ***precipitation*** was considered, with the regression model (y = 0.1764x-204.78) explaining <1% of data variation p = 0.56 (Figure 7.1c). Despite these statistically insignificant results, Figure 7.1c indicates that precipitation patterns have varied cyclically throughout the assessment period. The smaller ***humidity*** dataset between 1981 and 2010, showed a low correlation but definite and small relationship, indicative of a slight increase. The regression equation y = 0.1742x - 273.98, has an R^2 value that explains *circa* 20% of humidity variation over time but importantly, represents a significant increase in humidity p <0.01 (Figure 7.1d). These analyses indicate that environmental factors influence crop yield in Enugu State.

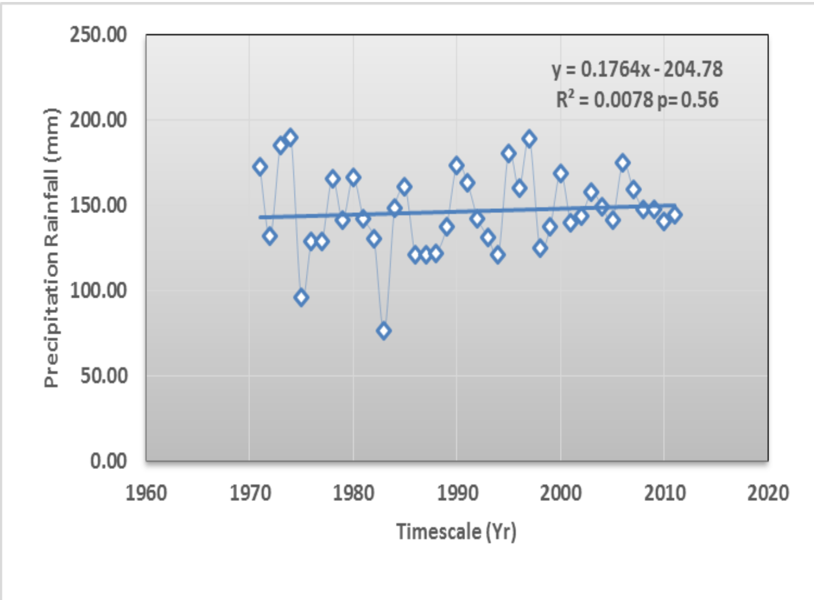


a)



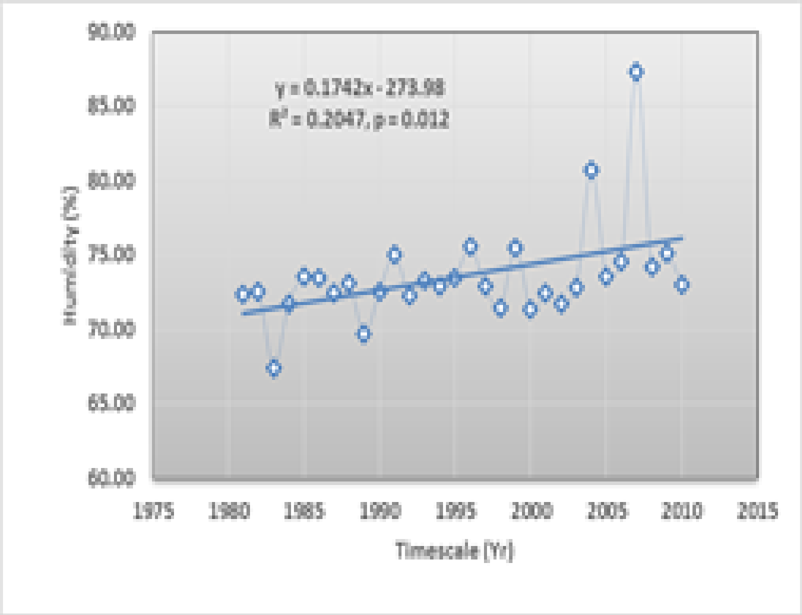
y = 0.0188x - 14.962
R² = 0.2353, p=0.001
Min Temp (°)
Timescale (Yr)

b)



y = 0.1764x - 204.78
R² = 0.0078 p= 0.56
Precipitation Rainfall (mm)
Timescale (Yr)

c)

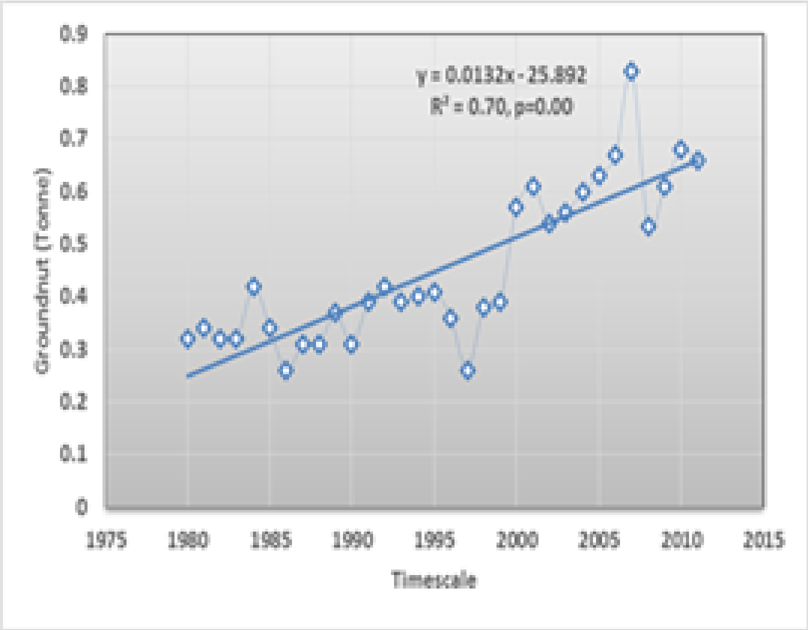


d)

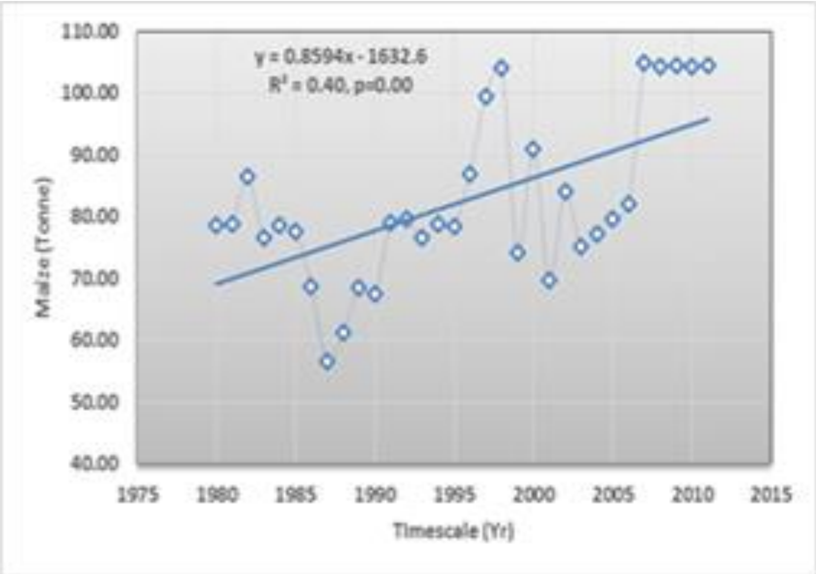
Figure 7.1 Scatter plots showing: a) maximum temperature, b) minimum temperature, c) precipitation and d) Humidity for Enugu State.

7.2.2 Crop Yield (1980-2010)

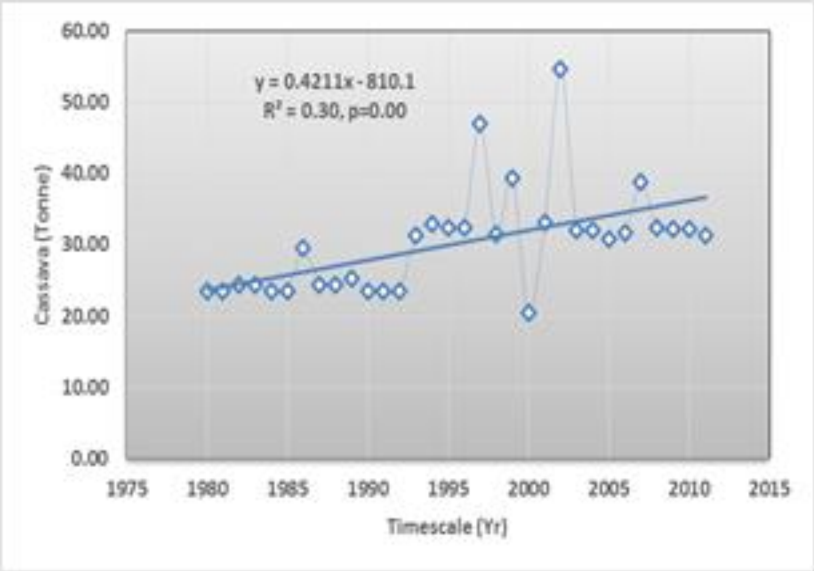
This section details temporal change in crop output, with results tabulated and statistically significant outcomes highlighted in scatter plots. When ***Groundnut*** production was assessed, a high positive correlation and marked relationship was found, indicative of increasing crop yields over time, i.e. illustrated by the regression equation y = 0.01324x - 25.892 and Coefficient of Determination (R^2 = 70%) where the significant trend indicates increased yield ($p < 0.01$; Figure 7.2a). Similarly, the temporal assessment of ***Maize*** also showed a significant trend of increasing yields with $p < 0.01$ (Figure 7.2b). There was also a moderate correlation and substantial relationship indicated by the regression model (y = 0.8594x - 1632.6), with (R^2 = 40%) of data variation. Temporal crop yield data for ***Cassava*** also showed positive correlation, given by the equation y = 0.4211x - 810.1, with (R^2 = 30%) indicative of a moderate correlation and substantial relationship. However, once again Cassava showed a statistically significant temporal increase in crop yield $p < 0.01$ (Figure 7.2c). Therefore, throughout the period between 1980 and 2010, groundnuts, maize and cassava all showed statistically significant increasing crop yields.


y = 0.0132x - 25.892
R² = 0.70, p=0.00
Groundnut (Tonne)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1975
1980
1985
1990
1995
2000
2005
2010
2015
Timescale

a)


y = 0.8594x - 1632.6
R² = 0.40, p=0.00
Maize (Tonne)
110.00
100.00
90.00
80.00
70.00
60.00
50.00
40.00
1975
1980
1985
1990
1995
2000
2005
2010
2015
Timescale (Yr)

b)



c)

Figure 7.2: Temporal crop yields for Enugu State for: a) Groundnut, b) Maize and c) Cassava.

Table 7.1 shows regression results for the remaining staple crops grown in Enugu State. ***Bean*** production showed a low positive correlation and a definite but small relationship existed, indicative of a slight crop yield increases over time. The regression model (y = 0.0056x-10.186), (R^2 = 14%) of data variation (p = 0.03; Table 7.1). In contrast, a slight negative correlation and almost negligible relationship existed when ***Yam*** production was assessed, highlighting a slight decline in crop yield over time. This was given by the regression equation y = -4.911x+ 1220 and an R^2 value that explained just 4% of data variation (p = 0.16; Table 7.1).

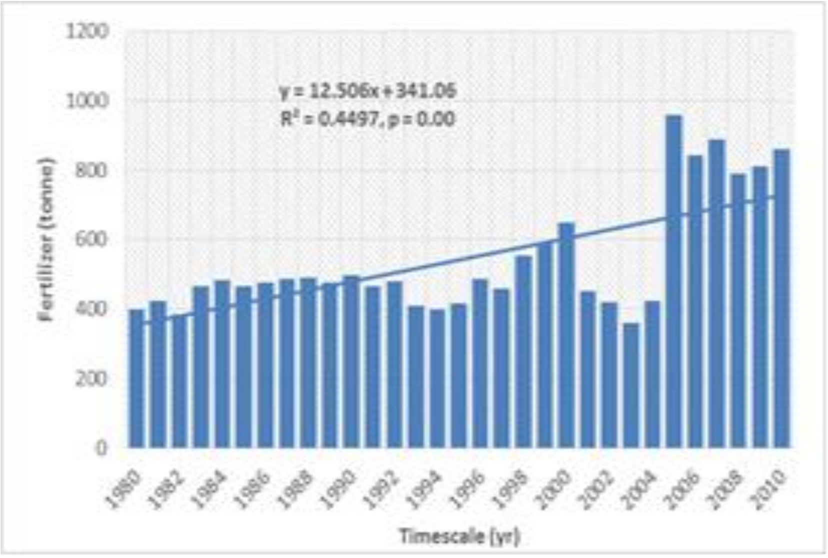
Similar to ***Bean*** production results, ***Rice and Cocoyam*** also highlighted that a low positive correlation and a definite but small relationship existed, indicative of a slight increase in production through time. This was given by the regression equations y = 0.1367x-216.52 and y = 0.1441x-254.04 respectively, and R^2 values that explained 10% of data variation, and in contrast to ***Bean*** production, both results were statistically insignificant (p = 0.10; Table 7.1). In contrast, the assessment of Melon showed a low negative correlation, but definite small relationship existed, given by the regression equation y = -0.0061x =13.012 and similar to ***Rice*** and ***Cocoyam*** results, the R^2 value explained 10% of the data variation (p = 0.10; Table 7.1). The table below shows beans, yam, rice, melon and cocoyam because of their low graphical representation.

Table 7.1: Crop Yield in Enugu State

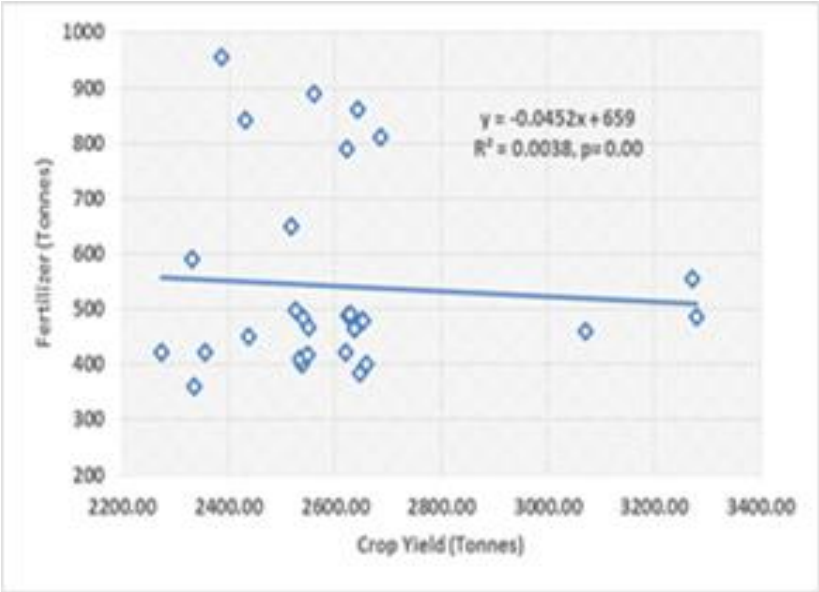
Crop Type	Regression equation	p-value	R^2 value (%)
Beans	y = 0.0056x-10.186	0.03	14%
Yam	y = -4.911+ 12203	0.03	4%
Rice	y = 0.1367x-216.52	0.10	10%
Melon	y = -0.0061x+13.012	0.10	13%
Cocoyam	y = 0.1441x-254.03	0.10	10%

7.2.3 Fertilizer

Chemically synthesised inorganic fertilizers are widely used for both subsistence and commercial farming across most Nigerian States and the Federal and State governments are responsible for its supply (Obidike, 2011). Figure 7.3a, highlights that there has been a significant increase in fertilizer use in Enugu State, confirmed by a moderate positive correlation and substantial relationship existed. This was given by the equation (y = 12.506x + 341.06), and R^2 value that explained almost 50% of data variation, that was statistically significant at 99% confidence. However, Figure 7.3a results are influenced somewhat by a reduction in fertilizer used between 2001 and 2005 and a significant increase thereafter to the end of the assessment period. Consequently, this is because of the changes in governmental policies and political changes during this period. Importantly, when overall fertilizer use and temporal crop yields were assessed there was no statistical evidence to suggest that fertilizer use was beneficial to crop growth in this State. This was given by the regression equation y = -0.0452x + 656 and an R^2 value that explained none of the variation in the data ($p > 0.05$; Figure 7.3b).



a)



b)

Figure 7.3: Temporal trend of: a) Fertilizer used and b) a comparison of overall crop yield and fertilizer use for the period 1980-2011.

7.2.4 Evaluating implications

Groundnut is one of the most important food crops grown in Nigeria, but poor soil quality, lack of nutrients, disease and pest prevalence, flooding and drought stress can severely hinder productivity (Singh *et al*., 2012; Usman *et al*., 2015). Despite fluctuations almost cyclic temporal precipitation (Figure 7.1c) and humidity (Figure 7.1d) trends, ***Groundnut*** production increased.

This was confirmed statistically, by a high correlation and substantial relationship (Figure 7.2a) and reinforced with the increasing in temperature trends (Figures 7.1a and 7.1b respectively) and an increase in fertilizer use (Figure 7.3). Characteristically, groundnut is self-pollinated by producing flowers, above ground (Girei *et al*., 2013). Increased temperature and improved fertilizer application are the key components which foster Groundnut yield (Devasirvatham *et al*., 2015). Table 7.2 produced from temporal crop yield, fertiliser use, and environmental forcing data confirms that increased humidity and fertilizer use, positively influences ***Groundnut*** yield ($r = 0.54$ and 0.68 respectively, $p < 0.01$). Results suggest that provided current climate variation persists, this food crop may be capable of meeting anticipated future demands. The research also highlights the efficacy of derived savannah and humid forest agro-ecological zones (Section 6.2, Table 6.1)in the production of such crops.

Table 7.2: Correlation matrix comparing the stable crop yield and environmental forcing agents. *Note; **bold italic** statistical significance at 99% confidence (p<0.01) and **bold** 95% confidence (p<0.05).*

	Maximum Temp	Minimum Temp	Precipitation	Humidity	Fertilizer
Groundnut	0.15	**0.37**	0.25	***0.54***	***0.68***
Maize	0.04	**0.35**	0.27	**0.31**	**0.54**
Cassava	0.12	0.14	0.20	0.29	0.11
Beans	0.15	0.24	0.17	**0.31**	0.13
Yam	0.05	0.02	-0.04	-0.15	-0.11
Rice	0.04	0.21	0.01	0.23	0.24
Melon	-0.05	-0.10	0.14	-0.09	-0.19
Cocoyam	0.01	0.05	**0.38**	0.06	0.10

Maize is a popular cereal crop used for both human and livestock consumption and is highly sensitive to extreme temperature conditions (CCGS, 2014). Production is influenced by both climatic and socio-economic factors. Climatic or physical factors that impact upon ***Maize*** production include flooding, drought, increase in pest infestation and disease, as well as poor soil quality (CCGS, 2014). Statistically, Figure

7.2b highlighted a moderate correlation and substantial relationship existed in overall output ($p < 0.01$), indicative of a temporal increasing yield. This result is unsurprising as ***Maize*** outputs are generally relative to stable concentrations in precipitation and humidity (Figures 7.1c and 7.1d) and, while showing cyclic fluctuations, both variables remained relatively stable overall. This concurs with Rashid & Rasuel (2015) who argued that precipitation and humidity are crucial to foster suitable growth.

Maize also responds well to a reasonable amount of inorganic fertilizer, particularly those containing, nitrogen (N), phosphorus (P) and potassium (K) and this element has increased through time. Both humidity and fertilizer use were positively correlated with increasing yield ($r = 0.31$, $p<0.05$ and $r = 0.54$, $p<0.01$, respectively; Table 7.2). While, precipitation showed positive correlation with less statistical significance ($r = 0.27$, $p > 0.05$; Table 7.2). However, other factors affecting ***Maize*** yield, are planting period and soil fertility. For instance, if cultivation is conducted after the rainy season low outputs can be expected, this is because the crop is expected to be planted before the rainy days (Snaga *et al.*, 2014). Snaga *et al.*, (2014) also suggested that fertilizer application timing is also crucial and late application, may result in an inability for nutrients to be absorbed by the crop, whereas, early application supports yield. In mitigation, ***Maize*** growth practise has changed within Enugu State and even though precipitation has not significantly increased, additional irrigation alongside increased fertilizer use, during early production stages has improved overall crop yield.

Cassava a tuber crop, highly tolerant to extreme weather but fertilizer application improves soil quality supporting its growth and yield conditions (Okogbenin *et al.*, 2013). However, when excessive amounts are applied there is an impact on overall quality and yield. When ***Cassava*** yields were analysed (Figure 7.2c), a positive correlation existed, indicative of increasing yields. Literally, Cassava is tolerant to higher temperature extremes, therefore, temporal increase in maximum and minimum temperature (Figure 7.1c and 7.1b) would have a very limited effect on output. Similarly, relatively stable precipitation and humidity conditions would also have limited effects.

With less statistical significance, Table 7.2 results show positive correlations between crop yield and all environmental forcing agents with (r) values ranging between 0.12 and 0.29 ($p>0.05$). Surprisingly, fertilizer use also showed statistically insignificant positive correlation suggesting that fertilizer was not being applied at the optimum time or that Cassava food crops do not respond well to the type of fertilizer being applied.

According to Snaga *et al.* (2014), ***Bean*** yield is reliant on suitable temperature extremes and precipitation and climate variation is a potential threat to production. Temporal change analysis (Table 7.1) showed a positive correlation, albeit small, indicative of a very slight increase in yield, corresponding to temperature and precipitation increases during the assessment period. However, except for humidity ($r = 0.31$, $p > 0.05$), Table 7.2 results show, statistically insignificant, positive correlation between crop yield and the remaining environmental forcing agents with (r) values ranging between 0.15 and 0.24 ($p > 0.05$, Table 7.2). Once again, fertilizer use also showed statistically insignificant positive correlation alongside bean yield.

Yam is a climbing tuber-bearing plant which is annual or perinatally produced (Regina *et al.*, 2013). There are over 600 species and varieties and it is one of the major cultivated crops in Nigeria derived from savannah and humid forests. The species is tolerant to extreme weather conditions, fostering high yields. ***Yam*** requires higher temperatures in comparison to other crop types. Therefore, derived savannah and humid forest is particularly well suited to this particular crop production (Regina *et al.*, 2013). However, there was a slight almost insignificant decline in production over time (Table 7.1). Even though this decline is relatively small, the trend is of concern as ***Yam*** constitutes a major staple food stock in Nigeria. According to Amusa *et al.* (2015), pest and diseases are the major issues faced by most ***Yam*** farmers in Nigeria, arising from issues such as mosaic virus, and ultimately contributing to the decline in overall yield. However, Yam farmers have now been applying better adaptation strategies, such as crop rotation and fallowing (Onoh *et al.*, 2014). Table 7.2 results show statistically insignificant ($p>0.05$) variable positive/negative correlations with all environmental forcing that ranged between $r = 0.25$ and $r = -0.15$. There was negative correlation between fertilizer use and crop yield (r = -0.11, p>0.05) suggesting that fertilizer application may not contribute to overall crop production.

Rice is the most widely cultivated crop across agro-ecological zones in Nigeria and requires excessive quantities of water when compared with other crops (Ugwu *et al.*, 2014). Therefore, ***Rice*** growth is highly dependent on increased precipitation and higher temperature than other crops (Ugwu *et al.*, 2014). However, poor soil quality or lack of sufficient fertilizer application could play a role in the overall output (Odjugo, 2010). Statistically, a low positive correlation indicated a slight increase in production throughout the period of assessment (Table 7.1), as a result of a stable increase in precipitation through time (Figure 7.1c). Table 7.2 shows a statistically insignificant, positive correlation between crop yield and all assessed environmental forcing agents with (r) values ranging between 0.01 and 0.23 (p > 0.05), suggesting that there may well be a combination of factors contributing to relative crop yield stability. Once again, fertilizer use also showed statistically insignificant positive correlation (r = 0.24, p>0.05). The results concur with Odjugo, (2010), who argued that ***Rice*** yield is commonly attributed to both climatic and non-climatic factors. Issues such as poor fertilizer quality or late application, poor irrigation practises or soil quality, increased pest and disease prevalence, surface runoff, improper farming techniques, lack of land availability, erosion, leaching and poor agricultural management *inter-alia*.

According to CCPGS (2015), insect infestation and disease are major factors that influence a declining ***Melon*** crop yield. The crop requires a substantial volume of water to provide an effective yield and within Enugu State irrigation is required to maintain production. Statistically, crop yield showed low negative correlation, indicative of a temporal reduction in crop yield, albeit small (Table 7.1). The stability of precipitation throughout the assessment period alongside the increased temperature extremes, may have influenced production, but since irrigation is used it is difficult to assess probable causes.

Except for precipitation (r = 0.14, p >0.05), Table 7.2 results show, statistically insignificant, negative correlation between crop yield and the remaining environmental forcing agents. With (r) values ranging between -0.05 and -0.10 ($p>0.05$), this suggests that there may well be a combination of factors that contribute to relative crop yield stability. Once again, fertilizer use also showed statistically insignificant positive correlation ($r = -0.19$, $p>0.05$).

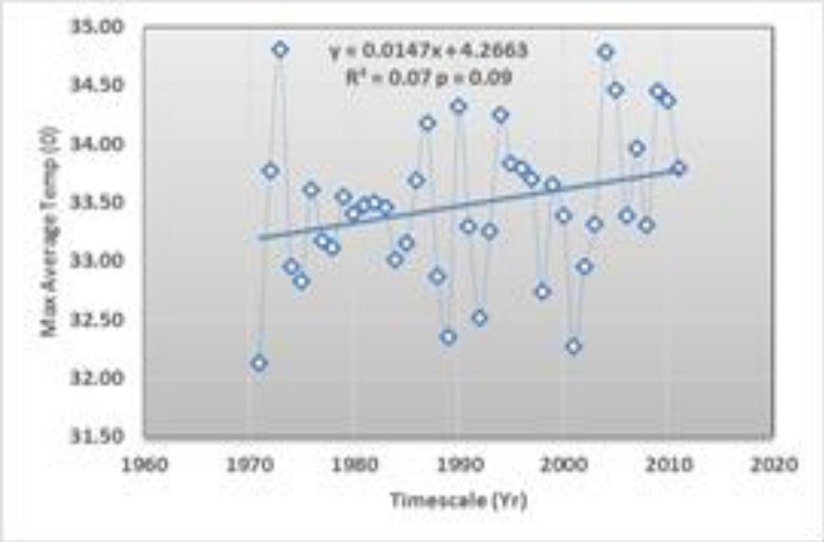
Cocoyam is another widely-cultivated tuber crop, grown mainly in sandy loamy soil and since it is a water retention crop, precipitation is crucial to its eventual yield. According to Ukonze (2012), production is highly influenced by climate variation if exposed to an inadequate water supply, together with increased temperature, erosion and increased pest and diseases, these factors can cause crop decline. However, statistical results demonstrated a positive correlation indicative of a slight increase in crop yield throughout the period of assessment, despite precipitation rates showing very little change. Notwithstanding rainfall correlation, ($r = 0.38$, $p<0.05$) Table 7.2 results show statistically insignificant, positive correlation with remaining environmental forcing agents. The (r) values ranging between 0.01 and 0.23 ($p>0.05$). Once again, this suggested that there may well be a combination of factors that contribute to relative crop yield stability. Similar to previous analyses, fertilizer use also showed statistically insignificant positive correlation ($r = 0.10$, $p>0.05$).

7.3 Kano State

7.3.1 Environmental change (1970-2011)

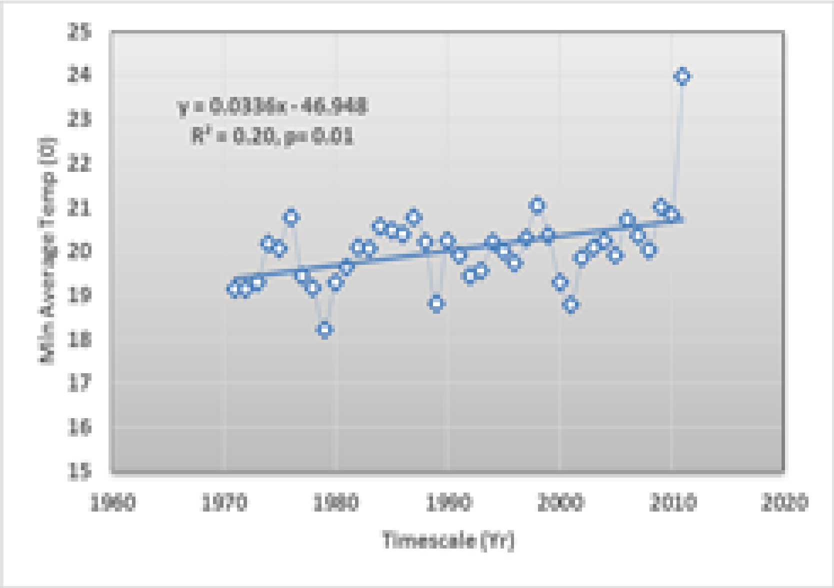
The regression model constructed around ***maximum temperature*** data over time showed a slight positive correlation, and almost negligible relationship existed. The regression model (y = 0.0147x+4.2663), R^2 value explained <1% of data variation and unsurprisingly, the results were statistically insignificant, however, there was a slight increase p = 0.09 (Figure 7.4a). Although, a moderate positive correlation and substantial relationship existed when ***minimum temperature*** was assessed, indicative of an increasing temperature trend. This was given by the regression equation (y = 0.0336x-46.948), and coefficient of determination (R^2) that explained 20% of data variation ($p<0.01$; Figure 7.4b).

The regression model constructed around temporal ***precipitation*** data over time showed a high correlation and marked relationship existed, indicative of an increase in trend. This was given by the equation (y = 1.5701x-3049.4) and (R^2 = 50%), demonstrated by gradient analysis $p <0.001$ (Figure 7.4c). At 95% confidence (p=0.05) the regression model constructed around the temporal ***humidity*** data showed that a low positive correlation and a definite but small relationship existed, indicative of an increasing humidity trend. This was given by with the regression equation y = 0.1342x-217.77 and a coefficient of determination that explained 13%, demonstrated by gradient analysis ($p <0.05$; Figure 7.4d).



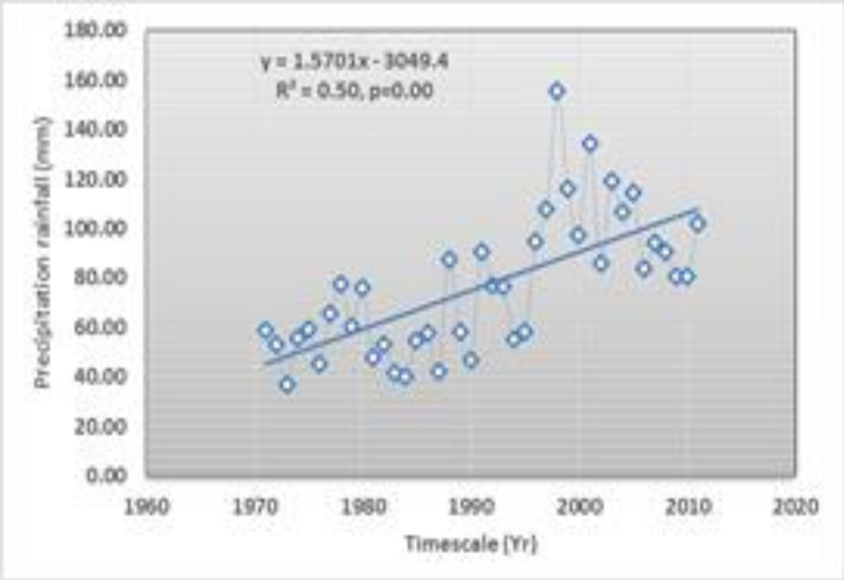
y = 0.0147x + 4.2663
R² = 0.07 p = 0.09
Max Average Temp (0)
Timescale (Yr)

a)

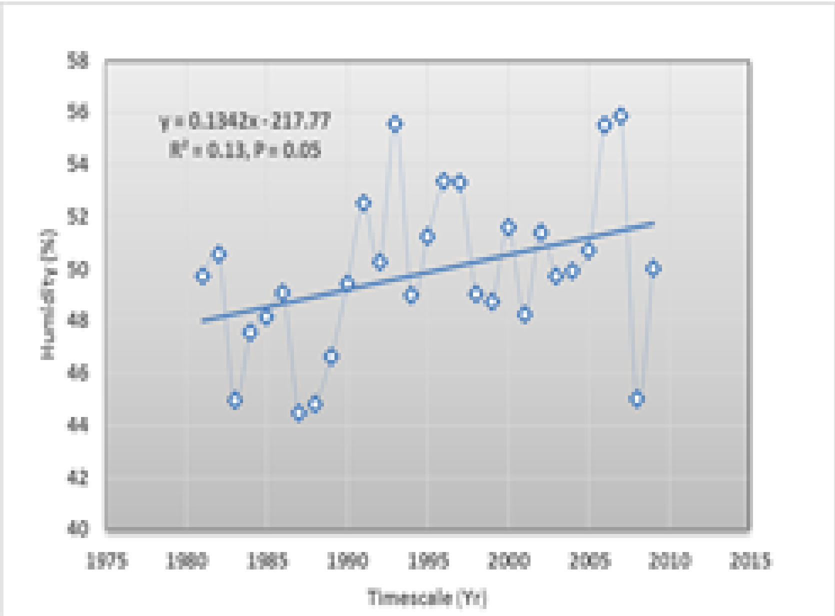


y = 0.0336x - 46.948
R² = 0.20, p= 0.01
Min Average Temp (0)
Timescale (Yr)

b)



c)



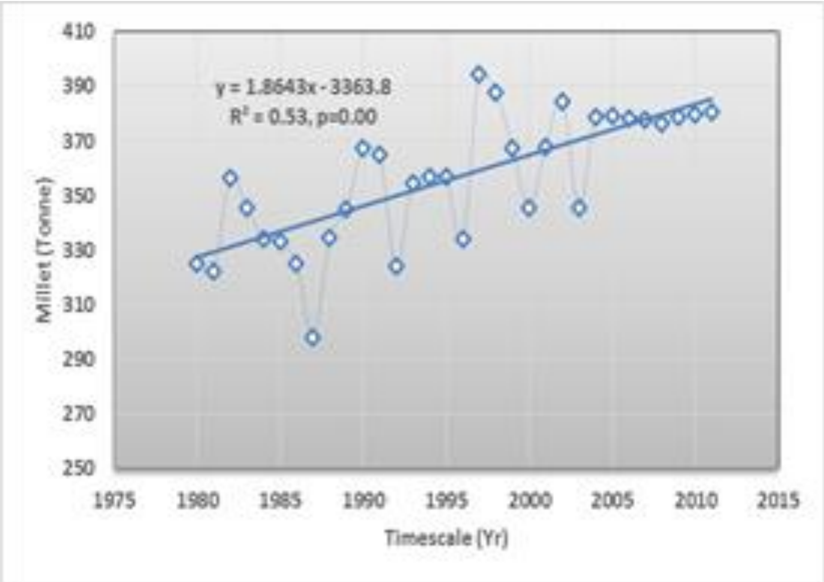
d)

Figure 7.4: Scatter plots showing, a) maximum temperature, b) minimum temperature, c) precipitation and d) Humidity for Kano State.

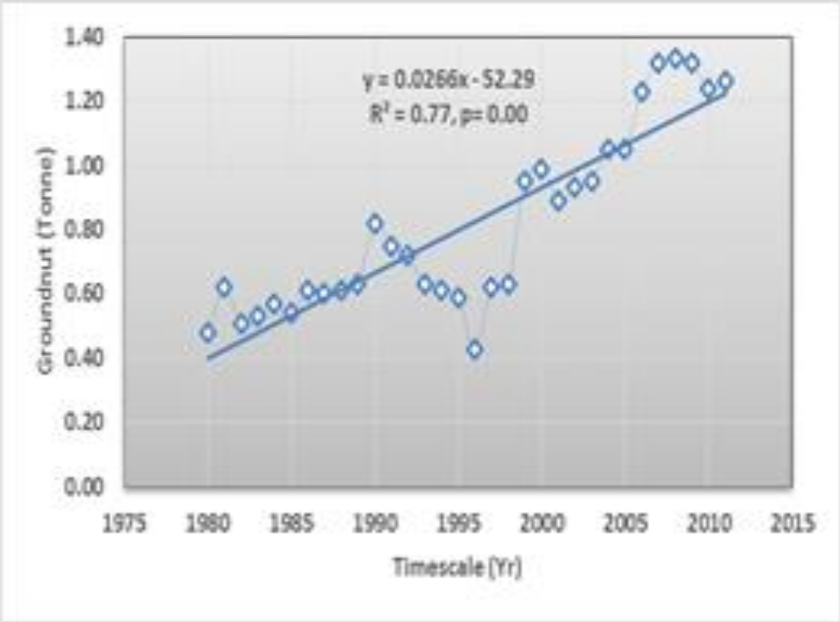
7.3.2 Crop yield (1980-2010)

Figure 7.5 shows the temporal trends of the six staple crops grown in Kano State. The regression model constructed showed a high positive correlation and marked relationship existed for both ***Millet*** and ***Groundnut*** yield indicative of increasing yield for both crops. With the regression equation (y =1.8643x-3363.8 and y = 0.0266x-52.29, respectively), R^2 values explained 53% and 77% of data variation ($p<0.01$; Figure 7.5a, and Figure 7.5b). When ***Guinea corn*** and ***Bean*** yield were assessed, a low positive correlation and definite but small relationship existed, indicative of a slight increasing yield. This was given by the regression equations y = 0.8362x-1325 and y = 0.1457x-154.9 respectively, and (R^2 = 10%) of data variation. Interestingly, even though the regression results were similar the statistical significance varied ***Guinea corn*** yield was statistically significant at 95% confidence ($p<0.05$; Figure 7.5c).

While, ***Bean*** yield results were insignificant (p = 0.29; Figure 7.5d). Contrastingly, high negative correlations and marked relationships existed when both ***Maize*** and ***Rice*** yields were assessed, indicative of a temporal decreasing crop yield trend. This was given by the regression equations y = 1.1499x+2379.1 and y = -1.5559x+3174.4, respectively. Both analyses were statistically significant at 99% confidence level, demonstrated by gradient analysis ($p<0.01$), and the R^2 values explained over half the data variation (Figure 7.5e and Figure 7.5f).

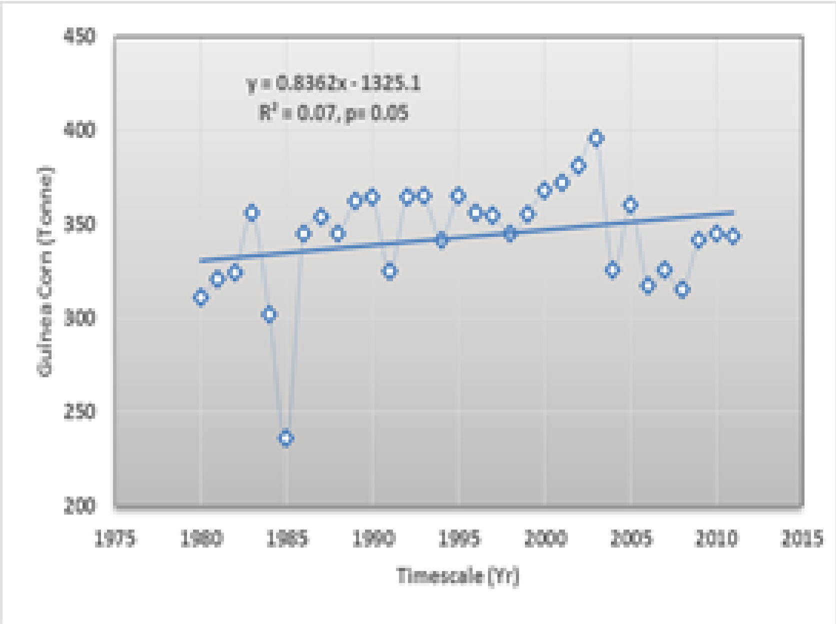


a)



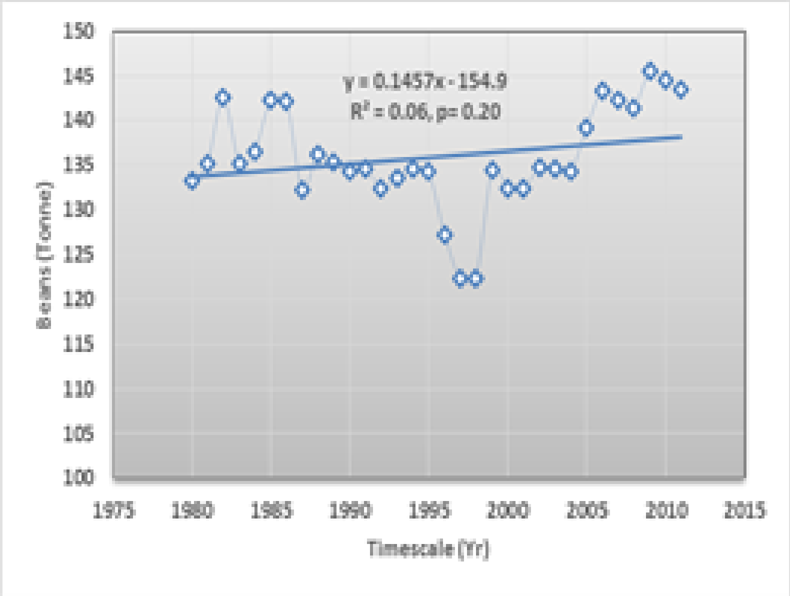
y = 0.0266x - 52.29
R² = 0.77, p= 0.00
Groundnut (Tonne)
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
1975
1980
1985
1990
1995
2000
2005
2010
2015
Timescale (Yr)

b)

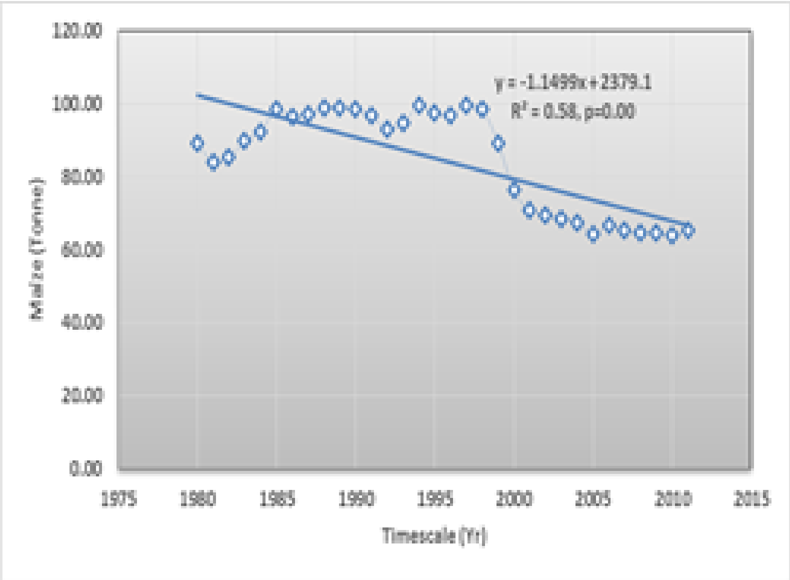


y = 0.8362x - 1325.1
R² = 0.07, p= 0.05
Guinea Corn (Tonne)
450
400
350
300
250
200
1975
1980
1985
1990
1995
2000
2005
2010
2015
Timescale (Yr)

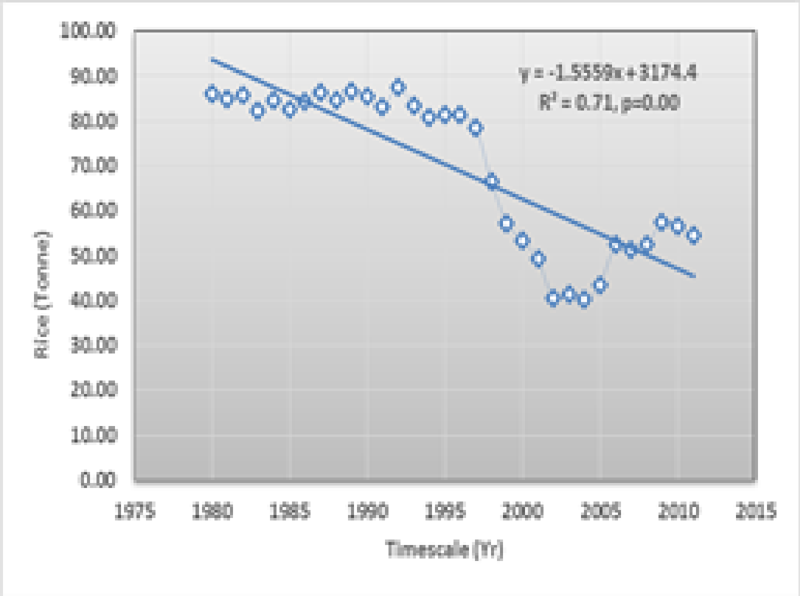
c)


y = 0.1457x - 154.9
R² = 0.06, p= 0.20
Beans (Tonne)
150
145
140
135
130
125
120
115
110
105
100
1975
1980
1985
1990
1995
2000
2005
2010
2015
Timescale (Yr)

d)


y = -1.1499x + 2379.1
R² = 0.58, p=0.00
Maize (Tonne)
120.00
100.00
80.00
60.00
40.00
20.00
0.00
1975
1980
1985
1990
1995
2000
2005
2010
2015
Timescale (Yr)

e)

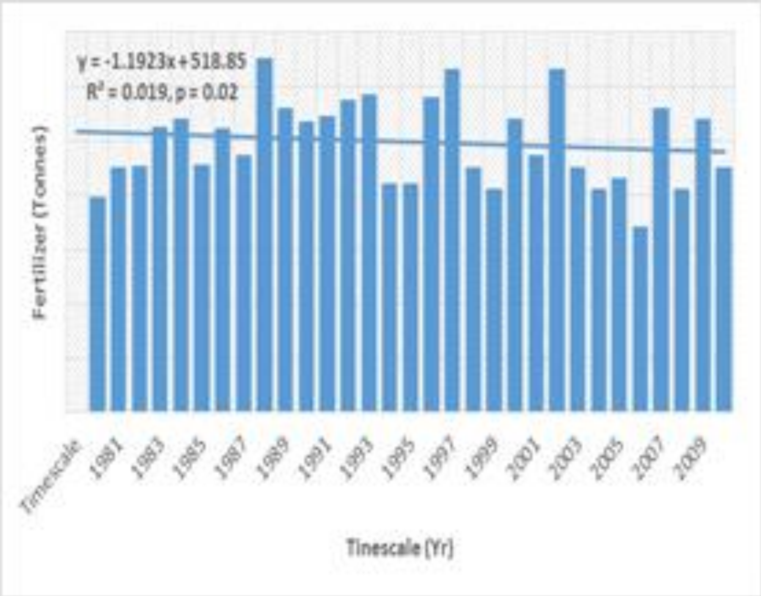


(f)

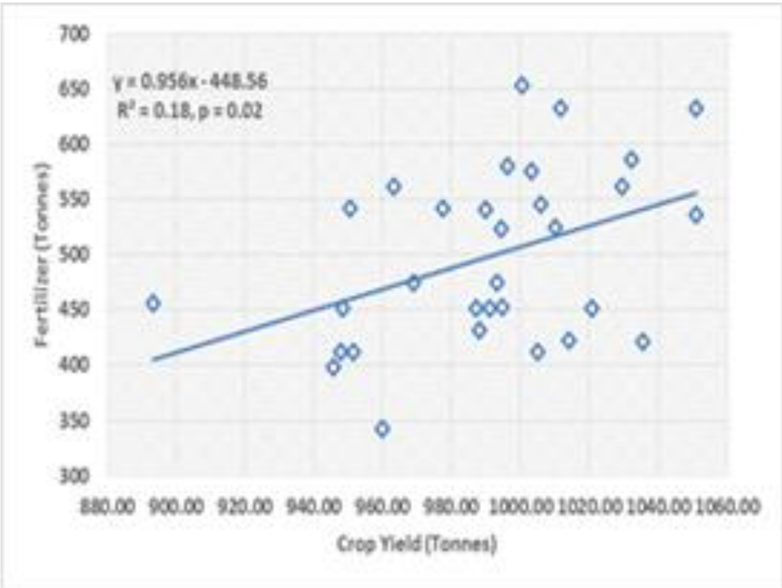
Figure 7.5: Scatter plots showing temporal crop yield for: a) Millet, b) Groundnut, c) Guinea corn, d) Beans, e) Maize and f) Rice for Kano State.

7.3.3 Fertilizer

The regression model constructed around the temporal dataset for fertilizer indicated a negative correlation and a definite small relationship existed. This is given by the regression equation (y = -1.1923x+518.85), and an R^2 that explained almost none of the data variation (p = 0.37; Figure 7.6a). This shows that fertilizer use declined in the State. According to Tasie, (2016) the decline was attributed to government regulations, and the higher cost of fertilizer in the State. Many farmers were unable to cope with rising price of fertilizer caused by inflation, high cost of importation, higher cost of transportation and civic unrest affecting the State. When overall crop output was compared with fertilizer use, a moderate positive correlation and substantial relationship existed indicative of an overall increase in fertilizer use in the State. This was given by the regression equation y = 0.956x – 448.56 and an R^2 value that explained 18% of the data variation (p = 0.25; Figure 7.6b).



a)



b)

Figure 7.6: Temporal trend of: a) Fertilizer used and b) a comparison of overall crop yield and fertilizer use for the period 1980-2011.

7.3.4 Evaluating implications

Kano, the northernmost State, is classified as Sudan and northern Guinea savannah (Section 6.2, Figure 6.1) and temporal increasing trends were observed in all assessed environmental forcing agents (Figure 7.4). There was an increasing temporal trend in ***Millet*** production (Figure 7.5a) and this corresponded to a statistically significant increase in minimum average temperature ($p<0.01$; Figure 7.4b) and precipitation ($p<0.01$; Figure 7.4d) during the assessment period. Alabi, *et al.* (2014) maintains the fact that ***Millet*** germination, development and maturity stages were improved by increasing temperature and increasing precipitation.

Table 7.3 produced from the temporal crop yield, fertiliser use and environmental forcing data (Appendix 1-3) confirms with statistical significance that increased precipitation alongside humidity positively influence ***Millet*** yield increase (r = 0.56 and 0.41, respectively, $p<0.01$). While, temperature extremes show far less positive correlation (r = 0.17 and 0.15 respectively, $p>0.05$). Surprisingly fertilizer use was negatively correlated (r = -0.11, $p>0.05$).

Table 7.3: Correlation matrix comparing the stable crop yield and environmental forcing agents. Note; *bold italic* *statistical significance at 99% confidence (p<0.01) and* **bold** *95% confidence (p<0.05)*

	Maximum Temp	Minimum Temp	Precipitation	Humidity	Fertilizer
Millet	0.17	0.15	***0.56***	***0.41***	-0.11
Groundnut	0.26	0.13	***0.59***	0.23	-0.26
Guinea corn	-0.05	**-0.38**	**0.35**	0.08	0.28
Beans	0.20	0.17	-0.15	-0.03	-0.28
Maize	-0.19	0.02	***-0.54***	-0.21	**0.30**
Rice	-0.16	-0.02	***-0.74***	-0.21	**0.31**

There was a positive correlation indicative of a significant increase in ***Groundnut*** production (Figure 7.5b) and once again Table 7.3 showed statistically significant correlation with precipitation (r = 0.59, $p<0.01$). Results also highlight statistically insignificant, positive correlation between crop yield and the remaining environmental forcing agents with (r) values ranging between 0.13 and 0.26 ($p>0.05$, Table 7.3). Once again, fertilizer use also showed statistically insignificant negative correlation r = -0.26, $p>0.05$). Odjugo (2010) argued that ***Guinea corn*** is one of the major crops cultivated in the State serving as a major source of food and the assessment highlighted low positive correlation ($p<0.05$; Figure 7.5c), indicative of an slight temporal increase in production. Harfield & Prueger (2015) maintain that temperature plays a significant role in the biological and physiological characteristics of these plants.

However, Table 7.3 shows that temperature extremes have negative effects ($r= -0.05$, $p>0.05$ and $r = -0.38$, $p<0.05$). But the opposite was true when precipitation and humidity was assessed against crop yield, a positive correlation existed ($r = 0.35$, $p<0.05$ and $r=0.08$, $p<0.05$). Odjugo (2010) showed that fluctuating fertilizer supplies is one of the major issues faced by ***Guinea corn*** farmers and this concurs with this assessment that showed fertilizer use was positively correlated ($r = 0.28$, $p>0.05$), suggesting that an increase in fertilizer would result in increasing crop yields and Figure 7.5 highlights a reduction in fertilizer use.

There was a significant positive correlation indicative of an increasing ***Bean*** crop yield (Figure 7.5d) and Table 7.3 results showed that increasing temperature extremes resulted in a positive correlation with crop yield ($r = 0.20$ and $r = 0.17$, $p<0.05$). While the opposite was true when precipitation and humidity was assessed against crop yield ($r = -0.15$ and $r = -0.03$, $p>0.05$). Fertilizer was also negatively correlated ($r = -0.28$, $p>0.05$). As previously discussed, ***Bean*** production is mainly affected by pest and disease and increasing precipitation could also result in flooding that could impact ***Bean*** yield. When ***Maize*** yield was assessed, a high negative correlation (Figure 7.5e) indicative of a temporal decrease in crop yield existed.

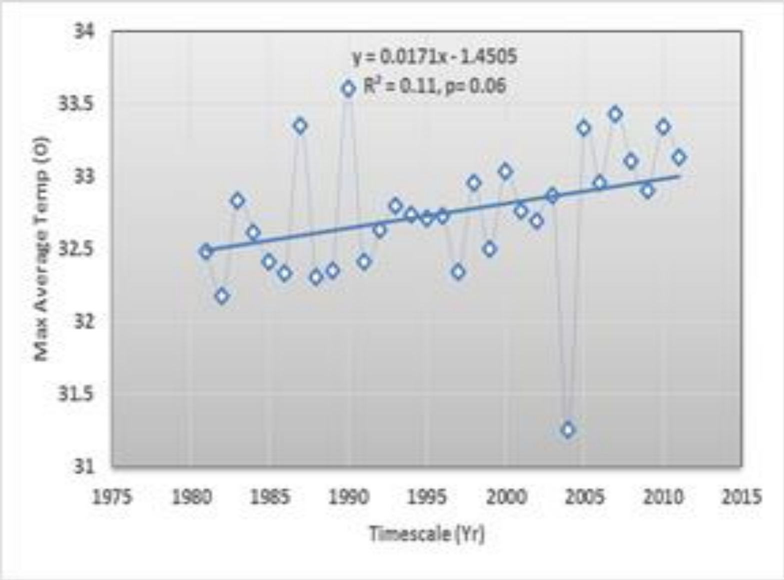
Surprisingly, Table 7.3 results show maximum tempurature extremes, humidity and precipitation were all negatively correlated with crop yield ($r = -0.19$, $r = -0.21$, $p> 0.05$ and $r = -0.30$, $p<0.05$) and even thought minimum extreme tempurature was positively correlated the (r) value was almost zero. What was of most interest was the statistically significant ($p<0.05$) positive correlation between crop yield and fertilizer use, as this suggests that the greater the fertilizer, the higher crop yield, concuring with the falling trend shown in Figure 7.6. The statsitical analysis for ***Rice*** yield (Figure 7.5f), also highlighted a that high negative correlation indicative of a falling trend. Table 7.3 results highlight, with varying statistical significant, negative correlation between crop yield and all environmental forcing agents, with (r) values ranging between -0.02 ($p>0.05$) and -0.74 ($p<0.01$). Interestingly, fertilizer use showed a statistical significant and positive correlation $r = 0.30$, $p < 0.05$).

7.5 Ogun State

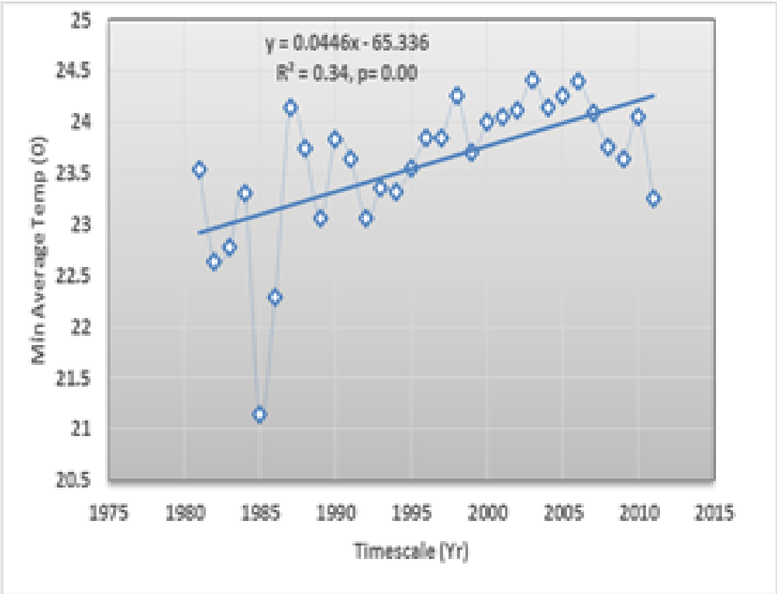
7.5.1 Environmental change (1970-2011)

The regression model constructed around the temporal dataset for ***maximum temperature*** showed a low positive correlation and definite but small relationship indicative of a rising temporal trend existed. This was given by the regression equation of (y = 0.0171x-1.1505) and coefficient of determination (R^2 = 11%), demonstrated by gradient analysis (p = 0.06; Figure 7.7a). Similarly, a moderate positive correlation and substantial relationship existed for ***minimum temperature*** with the regression equation (y = 0.0446x-65.336). The coefficient of determination explained a higher percentage of data variation than previous (R^2 = 34%) and unsurprisingly, the results were statistically significant at 99% confidence, demonstrated by gradient analysis (p = 0.01), this showed an increasing trend for minimum temperature (Figure 7.7b).

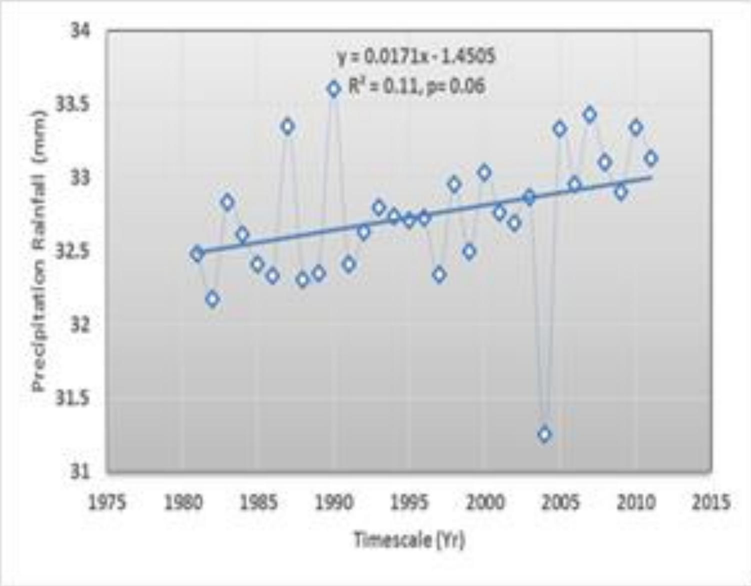
Similar to maximum tempurature results, ***precipatation*** also showed a low positive correlation, and definite but small relationship existed that was indicative of a rising temporal trend. The regession model (y = 0.0171x-1.4505), R^2 value explained 11% of data variation (p = 0.06; Figure 7.7c). The regression model constructed around the temporal dataset for ***humidity*** showed a positive correlation and almost negligible relationship existed, also indicative of a slight rising temporal trend, given by the regression equation y = 0.053x-28.574, and a coefficient of determination (R^2) explained <1% of data variation (p = 0.06; Figure 7.6d).


y = 0.0171x - 1.4505
R² = 0.11, p= 0.06
Max Average Temp (O)
Timescale (Yr)

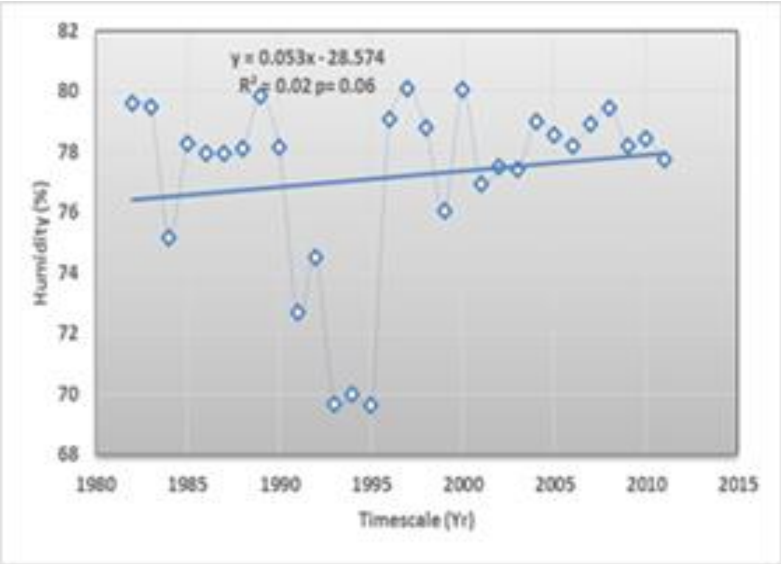
a)


y = 0.0446x - 65.336
R² = 0.34, p= 0.00
Min Average Temp (O)
Timescale (Yr)

b)



c)



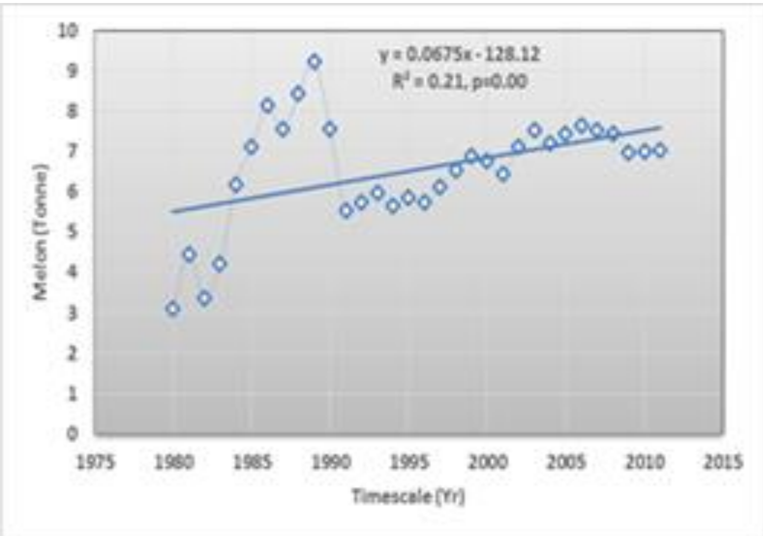
d)

Figure 7.7: Scatter plots showing: a) maximum temperature, b) minimum temperature, c) precipitation and d) Humidity for Ogun State.

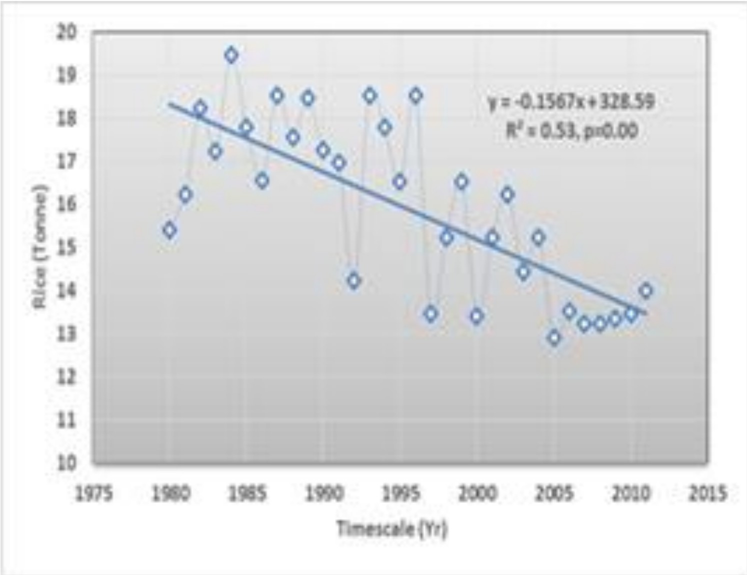
7.5.2 Crop yield (1980-2010)

The regression model constructed for ***Melon*** that shows a moderate positive correlation and substantial relationship existed, once again indicative of a rising temporal trend (Figure 7.8a). This was given by the regression equation y = 0.0675x-128.12 and (R^2 = 21%), demonstrated by gradient analysis ($p<0.01$). In contrast, ***Rice*** showed a negative correlation and marked relationship, indicative of a temporal decrease in crop yield, suggesting ***Rice*** yield declined over time. The regression model (y = -0.1567x+328.59), R^2 value explained over half the data variation p<0.01 (Figure 7.8b). A slight positive correlation and almost negligible relationship existed when ***Cocoyam*** and ***Cassava*** was assessed (Figure 7.8c). This was given by the regression equations (y = 0.1419x - 185.13) and (y = -0.9277x + 3238.7), respectively. Both coefficients of determination explained almost none of the data variation (p>0.05).

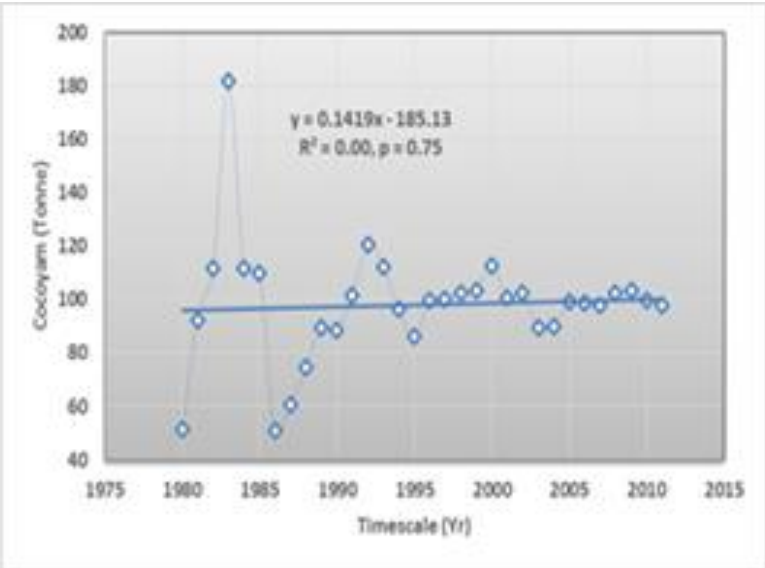
The statistical analysis for ***Yam*** showed a slight negative correlation and almost negligible relationship indicative of a slight decreasing yield. The regression equation (y= 0.0419x+156.03), R^2 value explained none of the data variation (p>0.01; Figure 7.8e). Finally, the statistical representation for ***Maize*** yield was a low positive correlation, but a definite small relationship existed that was indicative of a rising temporal yield, The regression model (y= -0252x+574.32), and (R^2 = 10%) demonstrated by gradient analysis (p>0.05; Figure 7.8f).



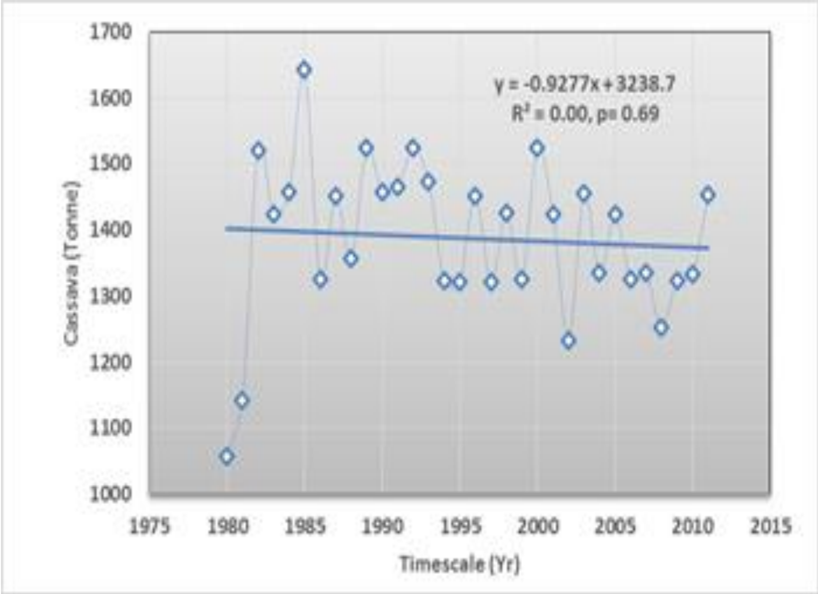
a)


y = -0.1567x + 328.59
R² = 0.53, p=0.00
Rice (Tonne)
Timescale (Yr)

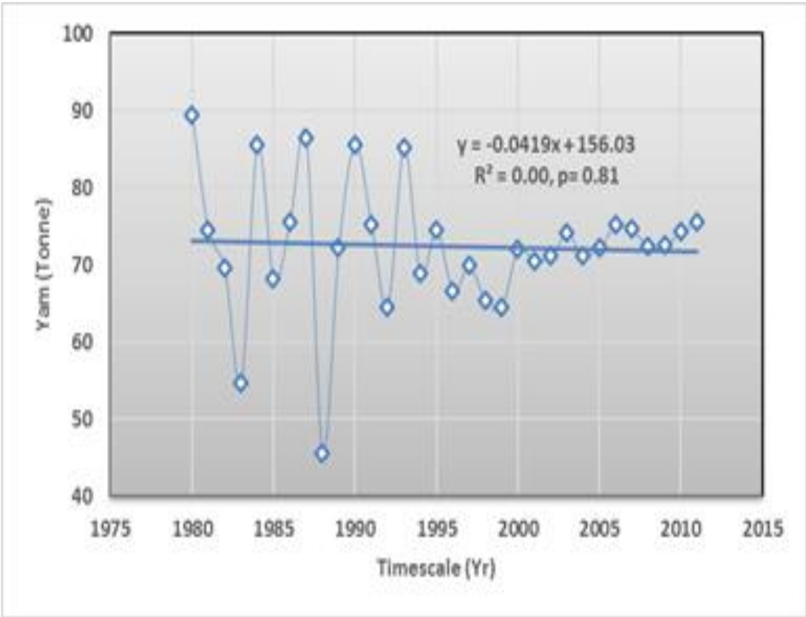
b)


y = 0.1419x - 185.13
R² = 0.00, p = 0.75
Cocoyam (Tonne)
Timescale (Yr)

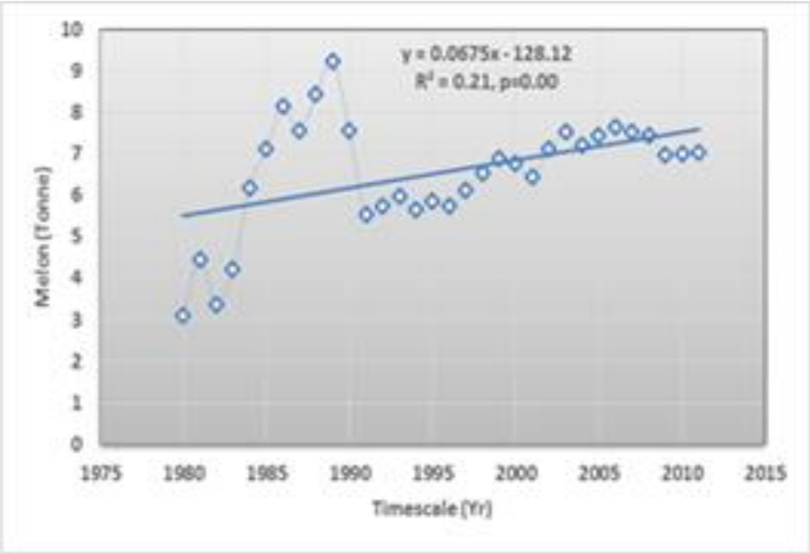
c)


y = -0.9277x + 3238.7
R² = 0.00, p= 0.69
Cassava (Tonne)
Timescale (Yr)

d)


y = -0.0419x + 156.03
R² = 0.00, p= 0.81
Yam (Tonne)
Timescale (Yr)

e)

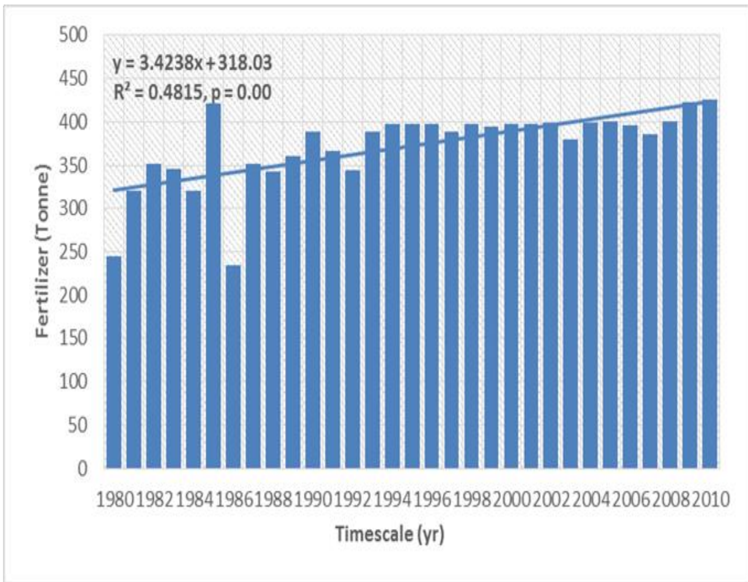


f)

Figure 7.8: Scatter plots showing Temporal crop yield for: a) Melon, b) Rice, c) Cocoyam, d) Cassava, e) Yam and f) Maize for Ogun State.

7.5.3 Fertilizer

A high positive correlation and very dependable relationship existed, when fertilizer was assessed, indicative of a consistent increase in fertilizer use with time. The regression model (y= 3.4238x+318.03), R^2 value explained almost 50% of data variation ($p<0.01$, Figure 7.9a). There was a low positive correlation but definite small relationship with fertilizer use and total crop yield in the State. The regression equation of y=0.1114x + 189 and the R^2 value explained 10% of data variation ($p = 0.07$; Figure 7.9b). The overall fertilizer use in the State increased.



a)

b)

Figure 7.9: Temporal trend of: a) Fertilizer used and b) a comparison of overall crop yield and fertilizer use for the period 1980-2011.

7.5.4 Evaluating implications

Ogun the south-westernmost State is classified as derived savannah and Humid Forest (Figure 6.1) and temporal increasing trends were observed in all assessed environmental forcing agents (Figure 7.7).

The regression model constructed around the temporal dataset for ***Melon*** showed that a postive correlation indicative of a temporal change in environmental forcing agent manily temperature and precipitation. Results showed a positive correlation, indicative of increasing trends of temperature, precipitation and humidity (Figure 7.8). Fertilizer use increased during the period of assessment ($p<0.01$; Figure 7.9a). These statements concur with the results of Table 7.4, where crop yield was positively correlated with all environmental forcing agent and the results ranged between ($r = 0.17$ and $r = 0.28$, $p>0.5$). Furthermore, the result also showed that fertilizer used was also positively correlated, suggesting that an increase in fertilizer has the potential to increase crop yield.

This shows that the adaptation strategies detailed (Oluwasusi & Tijani, 2013) regarding the managing of farms, prevention of water logging, erosion control and the improvement of soil quality through fertilizer application as well as proper timing before cultivation has been successful.

Table 7.4: Correlation matrix comparing the stable crop yield and environmental forcing agents. Note; ***bold italic*** *statistical significance at 99% confidence (p<0.01) and* ***bold*** *95% confidence (p<0.05)*

	Maximum Temp	Minimum Temp	Precipitation	Humidity	Fertilizer
Melon	0.17	0.22	0.23	0.28	0.07
Rice	**-0.31**	***-0.44***	**-0.38**	**-0.33**	**-0.36**
Cocoyam	0.04	-0.19	-0.14	0.04	0.23
Cassava	0.02	***-0.41***	0.05	0.04	0.05
Yam	**0.33**	0.13	-0.08	-0.24	-0.01
Maize	-0.02	-0.16	-0.07	0.01	**-0.34**

The statistical analysis for ***Rice*** showed a negative correlation, indicative of a decrease in crop yield (Figure 7.7b). Table 7.4 results show maximum temperature extremes, humidity and precipitation were all negatively correlated with crop yield, with (r) values that ranged -0.31 and -0.44, that was statistcally siginificant at both 95% and 99% confidence levels. What was of most interest, was the statistically significant ($p<0.05$) negative correlation between crop yield and fertilizer use ($r = -0.36$). However, these results have to be treated with a certain amount of caution as the data supplied by the Ministry of Agriculture and Water Resources applied to total fertilizer use and not to specific crops. Attah (2016) suggested that the current policy where millions of dollars are spent importing ***Rice*** from outside Nigeria has resulted in a lack of investment in ***Rice*** production improvement. This was exacerbated by a lack of government grant aid and loans offered to ***Rice*** farmers.

In contrast to previous analyses, the assessment of ***Cocoyam*** showed a slight positive correlation indicative of a marginal temporal crop yield increase (Figure 7.7c). Table 7.4 results are all statistically insignificant ($p>0.05$) but show that minimum temperature extremes and precipitation were negatively correlated ($r= -0.19$ and -0.14, respectively) and the remaining environmental forcing agents positively correlated, with identical (r) values ($r = 0.04$).

Fertilizer use was positively correlated with crop yield ($r = 0.05$, $p>0.05$). There was a slight decrease in ***Cassava*** yield when assessed (Figure 7.7d). Table 7.4 results showed that decreasing minimum temperature resulted in a negative correlation with ***Cassava*** yield ($r = -0.41$ $p >0.05$). While the opposite was true when maximum temperature, precipitation and humidity was assessed against crop yield ($r = 0.02$ and $r = 0.05$, $r = 0.04$) and fertilizer was also positively correlated with crop yield ($r = 0.05$, $p >0.05$).

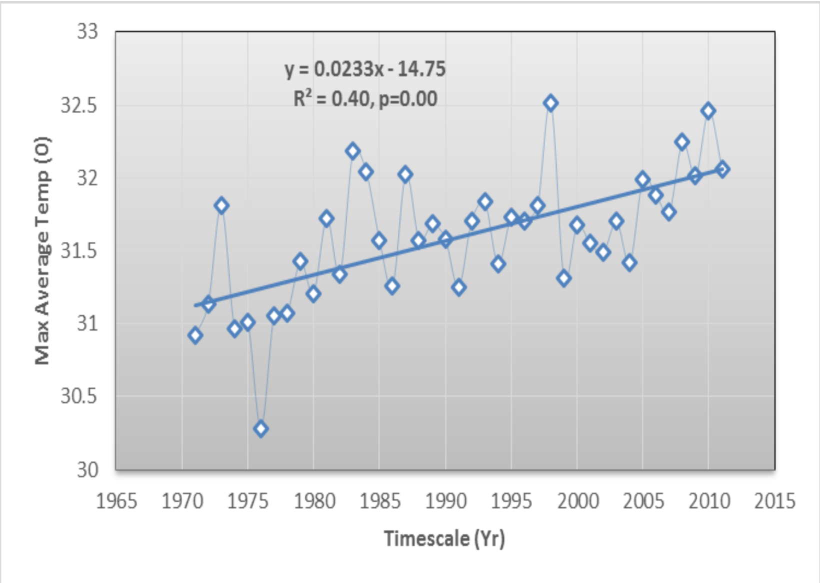
The regression model constructed around the temporal dataset for ***Yam*** showed a slight negative correlation, indicative of a decrease in crop yield (Figure 7.7e). Table 7.4 results show positive correlation with both maximum and minimum tempurature extremes with varying statistical significence ($r = 0.33$; $p<0.05$ and 0.13; $p>0.05$, respectively). In contrast, precipitation, humidity and fertilizer showed statistically insignificant negative correlations ($r = -0.08$, -0.24 and -0.01, respectively; $p>0.05$). Surprisingly, even though there was a significant rise in fertilizer use in this State (Figure 7.9), there was negative correlation with crop yield ($r = -0.11$; $p>0.05$). Amusa *et al.,* (2003) suggested that static or declining ***Yam*** crop yield is commonly caused by diseases, pests, and insect infestations, such as aphid-transmitted poty virus and mosaic virus and pathogens. They also stated that the cost of controlling pests and disease is too expensive, for some farmers to undertake. Yet estimates suggest that >25% of ***Yam*** yield is lost during cultivation, growth, harvesting, and storage (Ezeh, 1998, FAO, 1998). The regression model for ***Maize*** yield showed that a slight positive correlation indicative of a temporal increase existed. Table 7.4 results showed that maximum and minimum tempurature extremes, and precipitation were negatively correlated with ***Maize*** production ($r = -0.02$, $r = -0.16$, $p>0.05$ and $r = -0.7$, $p<0.05$ respectively).

However, humdity showed a positive correlation which should have supported the crop yield.

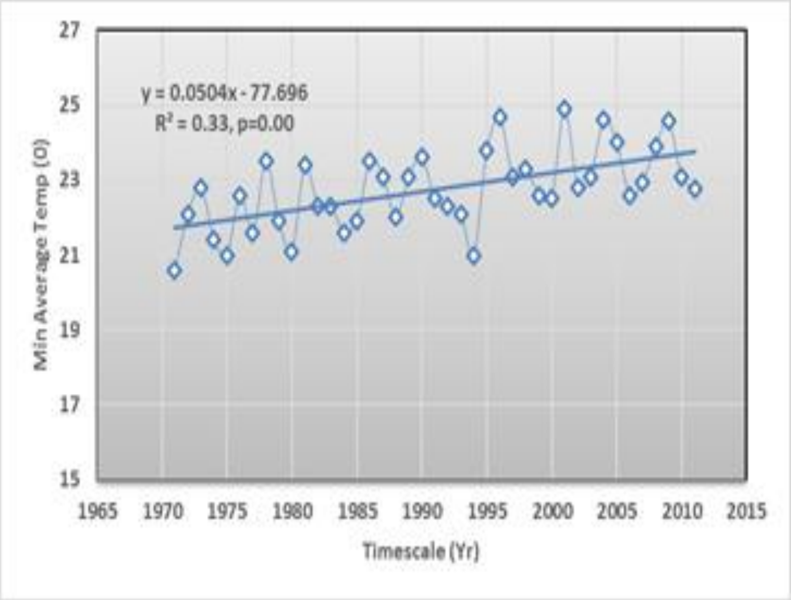
7.6 Edo State

7.6.1 Environmental Change (1971-2011)

The regression model consturcted around ***maximum temperature*** data over time showed a positive correlation and substantial relationship, given by the regression equation y = 0.0233x-14.75, and a coefficient of determination that explained 40% of data variation ($p<0.01$; Figure 7.10a). Similarly, ***minimum temperature*** also showed that a positive correlation and substantial relationship existed. The regression equation (y = 0.0504x-77.696), R^2 value explained 33% of data variation $p<0.01$ (Figure 7.10b). Although, ***precipitation*** showed a low positive correlation and definite small relationship existed, indicative of a slight increase in trend. This was given with the regression model (y = 0.9493x-1711.6), R^2 value explained 12% of data variation p = 0.03 (Figure 7.10c). A weak positive correlation, but a definite small relationship existed for ***humidity*** given by the regression equation y = 0.1217x-160.86, and R^2 value that explained just 5%, of data variation (p = 0.22; Figure 7.10d).

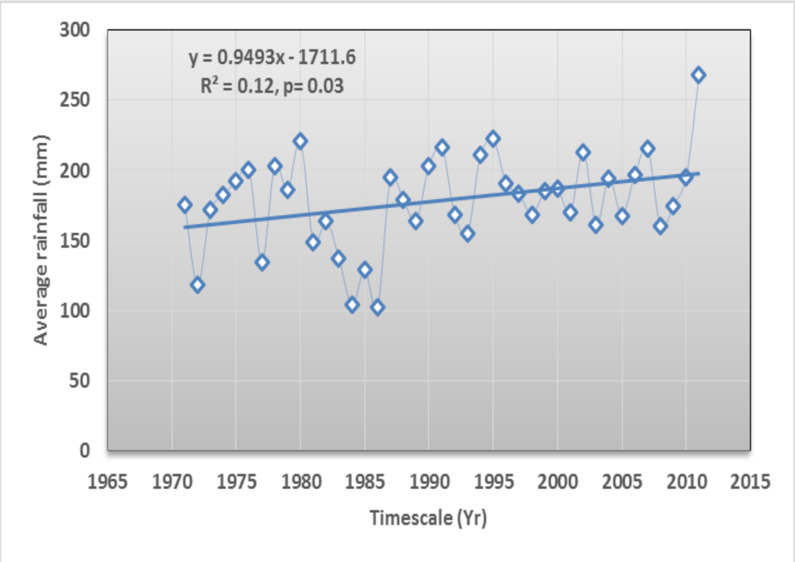


a)



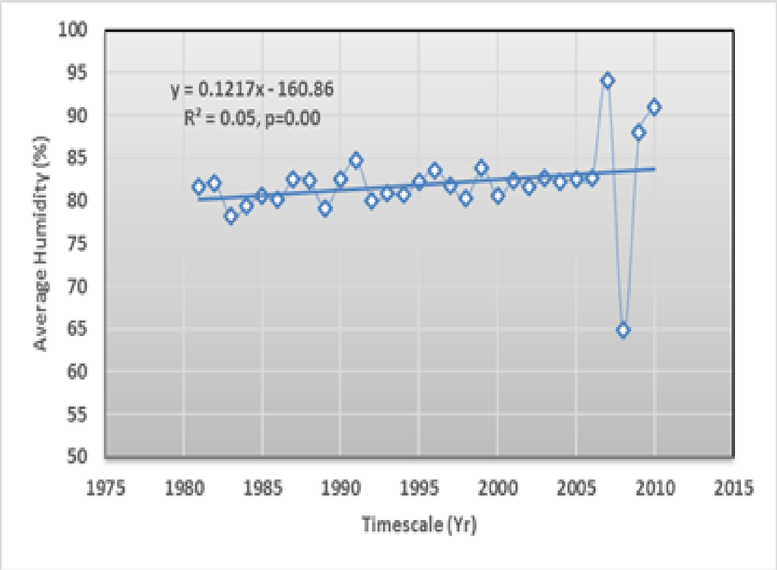
y = 0.0504x - 77.696
R^2 = 0.33, p=0.00
Min Average Temp (0)
27
25
23
21
19
17
15
1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015
Timescale (Yr)

b)



y = 0.9493x - 1711.6
R^2 = 0.12, p= 0.03
Average rainfall (mm)
300
250
200
150
100
50
0
1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015
Timescale (Yr)

c)



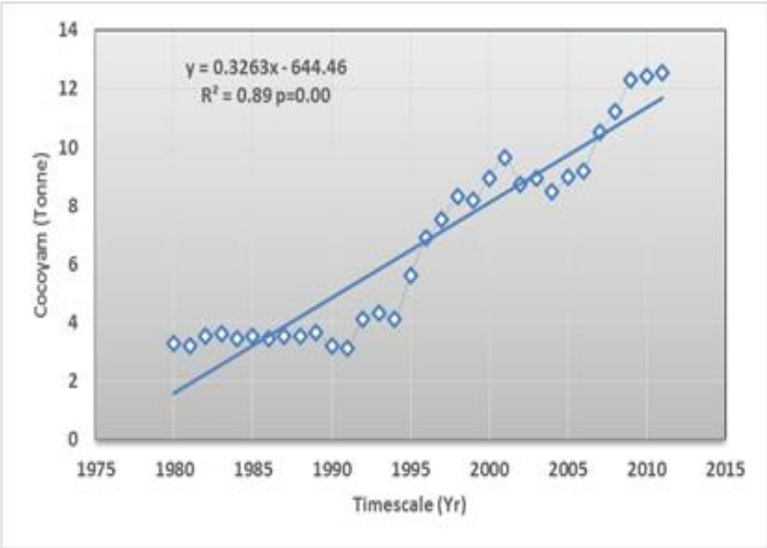
d)

Figure 7.10: Scatter plots showing: a) maximum temperature, b) minimum temperature, c) precipitation and d) Humidity for Edo State.

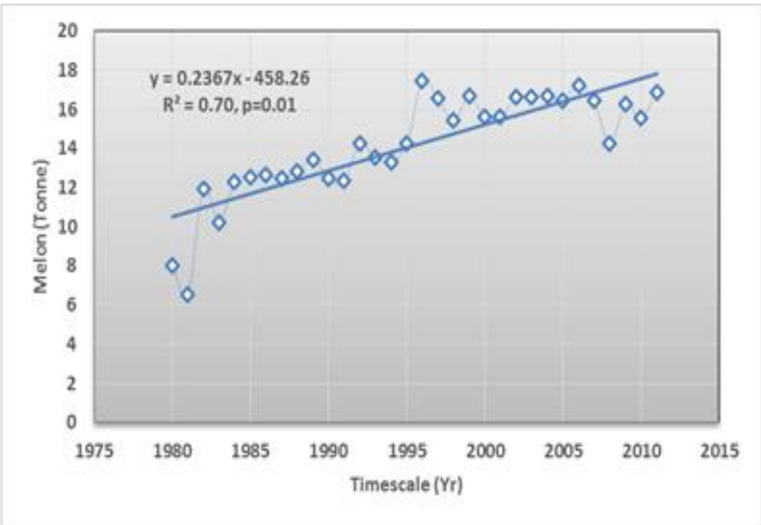
7.6.2 Crop yield (1980-2010)

The regression model for both ***Cocoyam*** and ***Melon*** showed positive correlations existed. Given by regression equations (y = 0.3263x-644.46) and (y = 0.2367x-458.26) and R^2 values that explained 89% and 70% of data variation, indicative of an increasing yield for both crop types ($p<0.01$; Figure 7.11a and Figure 7.11b). Similarly, a positive correlation and marked relationship existed when ***Groundnut*** was assessed, indicative of an increase in yield (Figure 7.11c). This was given by the regression equation (y = 0.0573x-105.47), an R^2 value that explained around half of the data variation ($p<0.01$). In contrast, ***Bean*** production showed a slight negative correlation and almost negligible relationship existed, showing a decrease in yield over time. The regression equation (y = -0.0004 x -1.6062), R^2 value explained almost none of the data variation ($p>0.05$;Figure 7.11d). ***Cassava*** yield showed that a low positive correlation and definite, but small, relationship existed. This shows that cassava yield increased slightly overtime. This was given by the regression equation of (y = 2.7234x-4855.9), and the coefficient of determination explained 14% of data variation (p = 0.03, Figure 7.11e). The regression model for ***Rice*** showed that a negative and almost negligible relationship existed. The regression model (y = - 0.015x + 35.737), R^2 value explained almost none of the data variation and results were statistically insignificant (p = 0.35, Figure 7.11f).

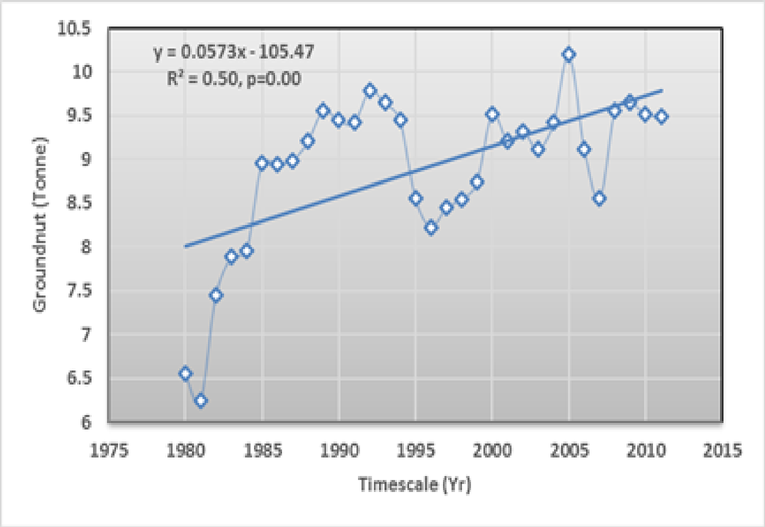
A negative correlation and almost negligible relationship existed when ***Yam*** yield was assessed. This was given by the regression equation y = -0.0537x+488.38 and an R^2 value that explained almost none of the data varation (p = 0.88; Figure7.11g). Finally, when ***Maize*** yield was assessed, a slight positive correlation, and almost negligible relationship existed and once again the regression model (y = 0.0381 x+11.884), R^2 value explained almost none of the data variation (p = 0.43; Figure7.11h).



a)

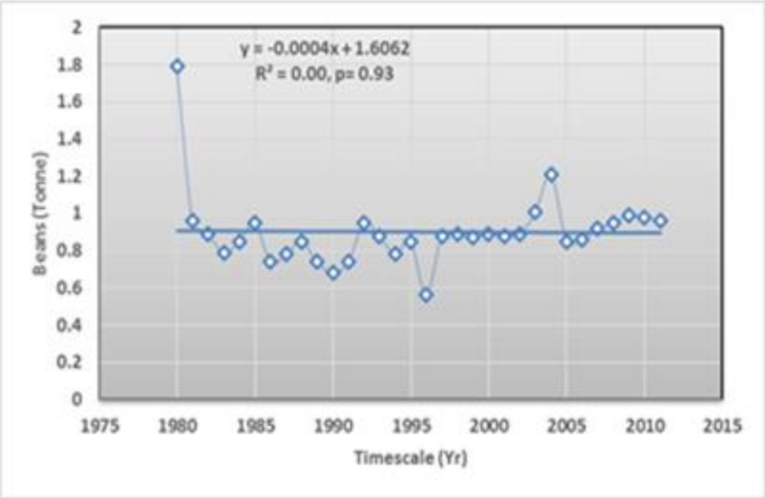


b)



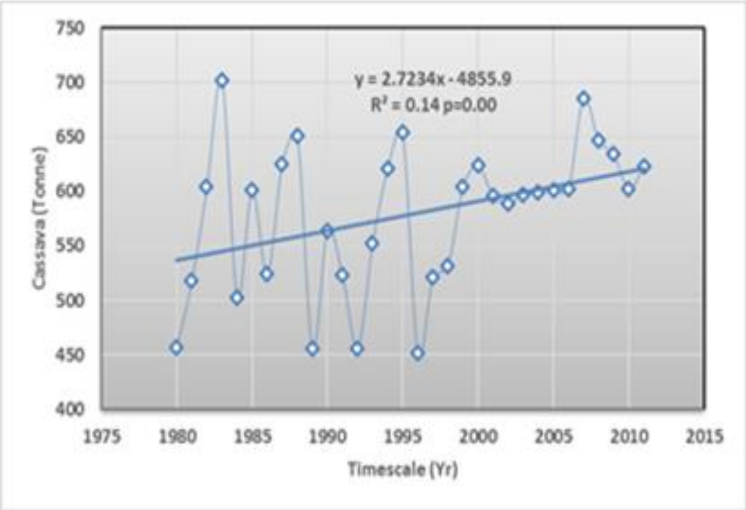
y = 0.0573x - 105.47
R^2 = 0.50, p=0.00
Groundnut (Tonne)
Timescale (Yr)

c)



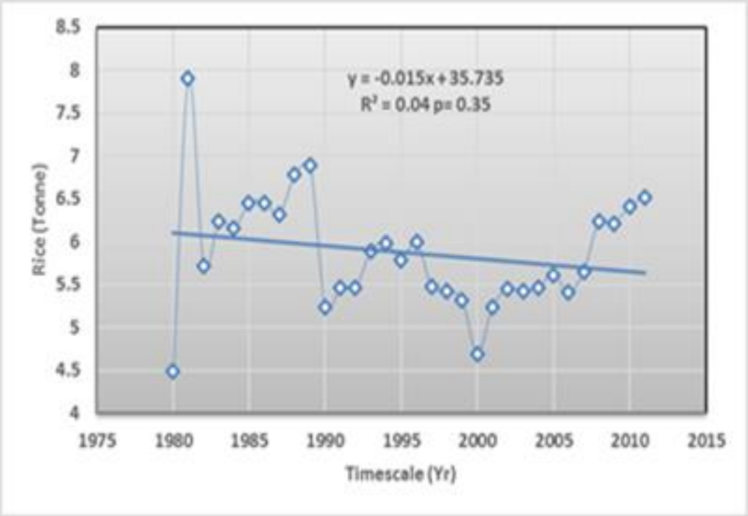
y = -0.0004x + 1.6062
R^2 = 0.00, p= 0.93
Beans (Tonne)
Timescale (Yr)

d)



y = 2.7234x - 4855.9
R^2 = 0.14 p=0.00
Cassava (Tonne)
Timescale (Yr)

e)



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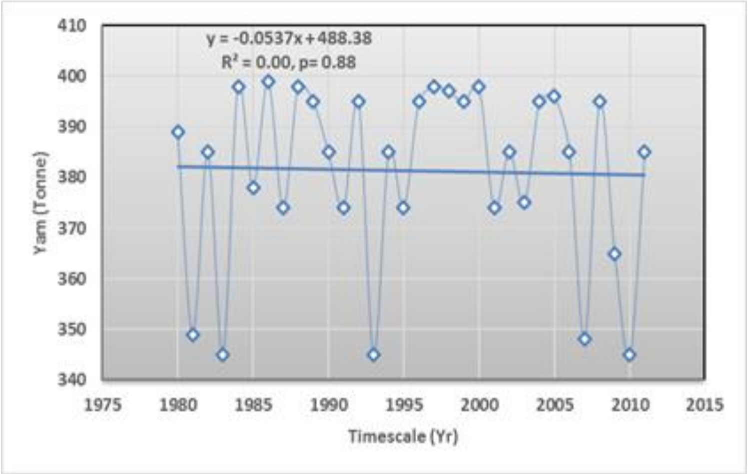

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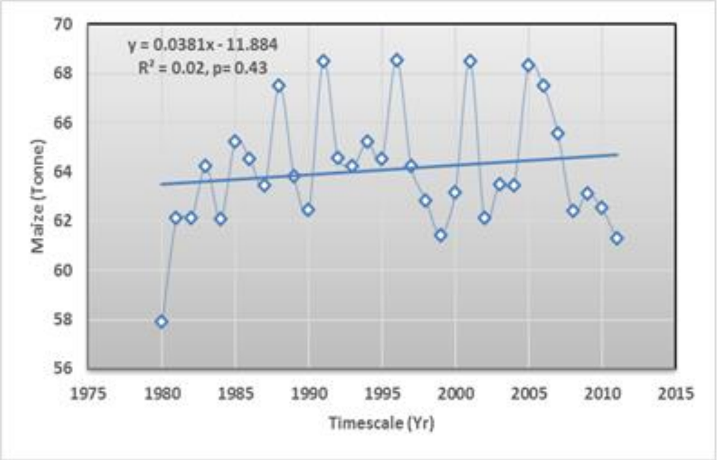
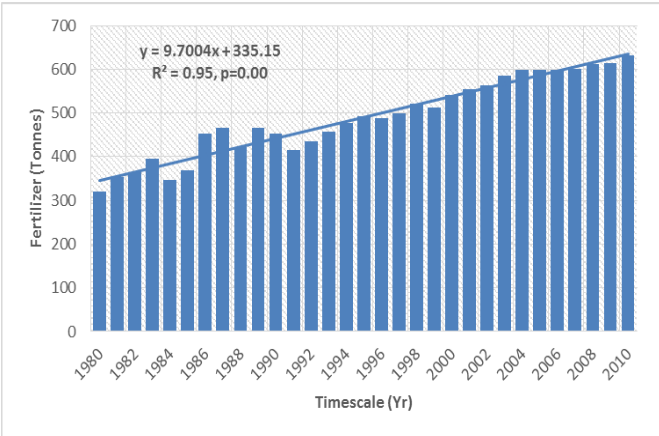


h)

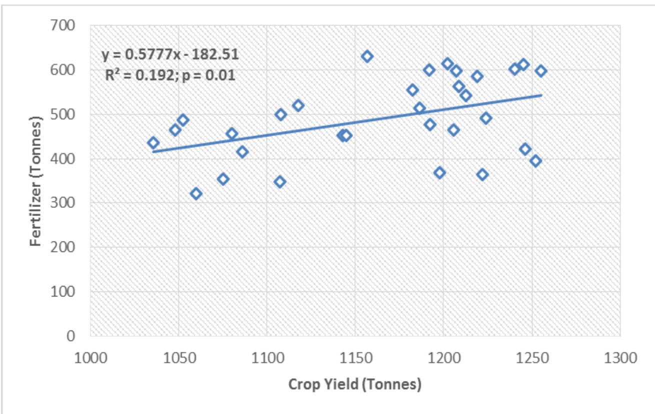
Figure 7.11: Scatter plots showing temporal crop yield for: a) Cocoyam, b) Melon, c) Groundnut, d) Beans, e) Cassava, f) Rice, g) Yam and h) Maize for Edo State.

7.6.3 Fertilizer

Fertilizer use increased significantly during the assessment period and the regression model constructed around the temporal data showed that a very high positive correlation and very dependable relationship existed, indicative of an increasing trend. This was given by a regression equation $y = 9.7004x + 335.15$, and R^2 value that explained almost all the data variation ($R^2 = 95\%$; $p<0.01$, Figure 7.12a). Since there were no data available detailing the fertilizer used for each crop type, a regression model was constructed that compared overall yield and fertilizer usage. The regression model ($y = 0.5777x+182.51$), R^2 value explained almost 19% of the data variation ($p<0.01$; Figure 7.12b). The Federal Government of Nigeria and the United States have invested huge funds improving fertilizer supplies by establishing a fertilizer plant in the State (Ogbomo & Emokaro, 2009; Sotunde, 2015).



a)



b)

Figure 7. 12: Temporal trend of: a) Fertilizer used and b) a comparison of overall crop yield and fertilizer use for the period 1980-2011.

7.6.4 Evaluating implications

Cocoyam is a very important staple crop, generating high income for many households and is consumed by both humans and livestock (Anikwe *et al*., 2007). Temporally, yield increased substantially during the period of assessment and this was confirmed statistically, by a high positive correlation in the humid forest and derived savannah agro-ecological zone (Figure 7.11a). In addition, the results corresponded with the increasing temperature trends (Figure 7.10a and Figure 7.10b, respectively) and a significant increase in overall fertilizer use (Figure 7.12).

Table 7.1 produced from the temporal crop yield, fertiliser use and environmental forcing data concurs with the previous statements, showing positive correlations and (r) values that ranged between 0.22 and 0.91. Temperature extremes, fertilizer ($p<0.01$) and precipitation ($p<0.05$) were statistically significant, while humidity results were insignificant ($p>0.05$). The results support the findings of Enyinnia, (2001) who argued that the climatic condition in this agro-ecological zone supports the biological, ecological, and physiological characteristics of this crop type. Given that, the increase in temperature trend, precipitation, humidity and fertilizer use supported ***Cocoyam*** germination and maturity stages. Farmers, using improved farming, implemented adaptation, and planting techniques, many sowed crops earlier in the year when temperatures were more stable and consistent (Enyinnia, 2001).

Table 7.5: Correlation matrix comparing the stable crop yield and environmental forcing agents. Note; ***bold italic*** *statistical significance at 99% confidence (p <0.01) and* ***bold*** *95% confidence (p<0.05)*

	Maximum Temp	Minimum Temp	Precipitation	Humidity	Fertilizer
Cocoyam	***0.45***	***0.60***	**0.36**	0.22	***0.91***
Melon	0.21	***0.56***	0.31	0.26	***0.82***
Groundnut	0.16	**0.33**	0.15	-0.02	***0.62***
Beans	-0.15	0.01	0.19	0.05	-0.09
Cassava	0.23	0.21	0.18	0.10	***0.41***
Rice	-0.29	-0.06	-0.13	-0.03	-0.15
Yam	-0.26	0.05	-0.03	***-0.42***	-0.04
Maize	-0.05	0.17	-0.07	0.18	0.22

The regression model for ***Melon*** showed that a postive correlation existed, and results also showed an increasing yield (Figure 7.11b). Table 7.5 showed that yield was also positively correlated with all environmental forcing agents. Both minimum temperature and fertilizer were statistically significant ($p<0.01$) and all remaining results were insignificant, with (r) values that ranged between 0.26 and 0.82 ($p<0.05$). Improved farm management, prevention of water logging, erosion control and of soil quality improvement by fertilizer application, has increased overall crop yield (Oluwasusi & Tijani, 2013).

In terms of adaptation, early planting during the rainy season has also increased overall output (Abiola & Daniel, 2013). As previously stated in Section 7.2.4, due to its nutritional components, such as oil and protein, ***Groundnut*** is one of the most important food crops in Nigeria, (Girei *et al.*, 2013) and temporal result showed a considerable increase during the period of assessment. Confirmed statistically, by a high positive correlation (Figure 7.11c) and this corresponded with the increasing temperature trends (Figure 7.10a and Figure 7.10b, respectively) and fertilizer use (Figure 7.12). Table 7.5 shows that, except for humidity, that was negatively correlated ($r = -0.02$; $p>0.05$), all remaining environmental forcing agents were positively correlated with (r) values that ranged between 0.15 and 0.62. Both minimum temperature and fertilizer use were statistically significant ($p<0.05$ and $p < 0.01$, respectively).

The regression model for ***Beans*** showed a slight positive correlation was identified, indicative of a temporal increase (Figure 7.11d). Table 7.5 results showed that minimum temperature extremes, precipitation and humidty were positively correlated with Beans production ($r = 0.01$, 0.19, and 0.05, $p>0.05$, respectively). This was contrasted against negative correlations for maximum temperature and fertilizer use ($r = -0.15$ and -0.09; $p<0.05$). Similarly, ***Cassava*** showed a positive correlation indicative of increasing crop yield (Figure 7.10d).

Table 7.5 results also show positive correlation with all environmental forcing agents and (r) values ranging from (0.10 and 0. 23; $p>0.05$). However, fertilizer was statistically significant at 99% confidence ($r = 0.41$, $p<0.01$). Even though the analysis was based upon overall usage, these results do concur with Emokaro & Erhabor, (2005) who showed that fertilizer application also helped to improve cassava productivity. ***Rice*** was negatively correlated, indicative of a decrease in crop yield over-time (Figure 7.11f). This concurs with Table 7.5 results where all assessed environmental forcing agents were negatively correlated with crop yield, with (r) values ranging between -0.03 and -0.29 ($p>0.05$).

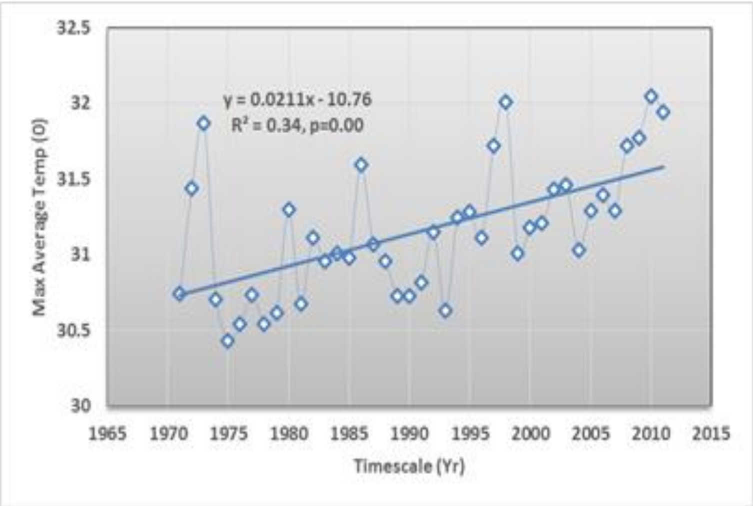
When ***Yam*** was assessed, a small negative correlation was identified indicative of a decreased crop yield (Figure 7.11g). Except for minimum extreme temperature that was positively correlated, Table 7.5 also highlights, with varying statistical significance, negative correlations between crop yield and all remaining environmental forcing agents: (r) values ranging between -0.26 ($p>0.05$) and -0.42 ($p<0.01$). Similarly, fertilizer showed a statistically insignificant and negative correlation ($r = -0.04$, $p<0.05$). In contrast, the assessment of ***Maize*** yield showed a slight positive correlation, indicative of increasing crop yield (Figure 7.11h). Table 7.5 results vary, showing that maximum temperature extremes and precipitation were negative correlated ($r = -0.05$, $p>0.05$ and $r = -0.07$, $p<0.05$). However, the opposite was true when minimum temperature and humidity was assessed ($r = 0.17$, $p>0.05$ and $r = 0.18$, $p>0.05$). Fertilizer was also positively correlated ($r = 0.22$; $p>0.05$).

7.7 Kwara State

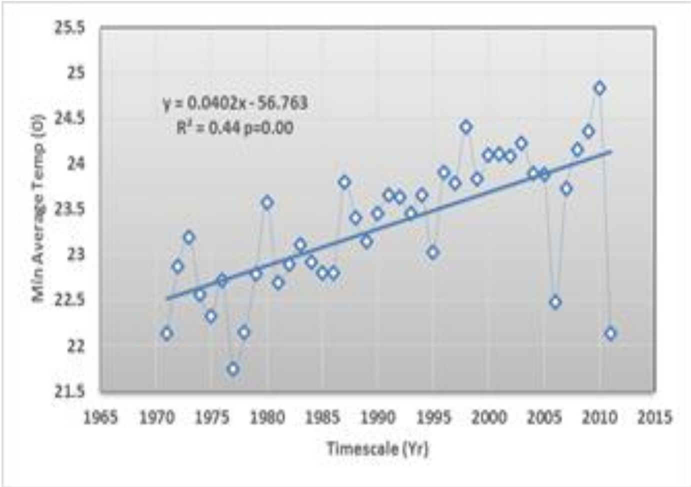
7.7.1 Environmental change (1970-2011)

When ***maximum temperature*** was statistically analysed, a positive, moderate and substantial relationship existed, given by the regression equation y= 0.0211x - 10.76, and a coefficient of determination that explained 34% of data variation. This shows an increase in maximum temperature overtime ($p<0.01$; Figure 7.13a). Similarly, the statistical analysis for ***minimum temperature*** showed a positive moderate and substantial relationship existed, showing an increasing trend over time. The regression model (y = 0.40402x - 56.763), (R^2 = 44%) of data variation ($p<0.01$; Figure 7.13b).

The regression model constructed around ***precipitation*** showed a positive correlation albeit low, and definite but small relationship existed. The regression equation (y = 0.5575x - 988.61), R^2 value explained almost none of the data variation (p = 0.10; Figure 7.13c). The regression model for ***humidity*** highlighted that a positive moderate correlation and a substantial relationship existed, which showed an increasing humidity in the State. This was given by the regression equation (y = 0.1177x-153.55) and an R^2 value that explained around a quarter of data variation ($p<0.01$; Figure 7.13d).



a)



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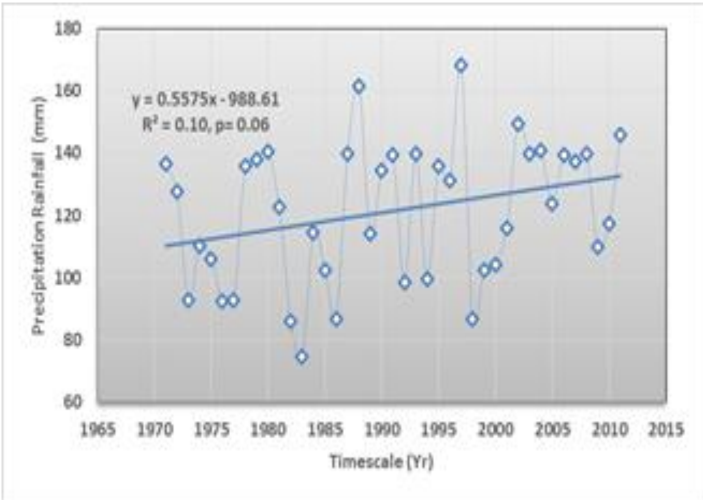

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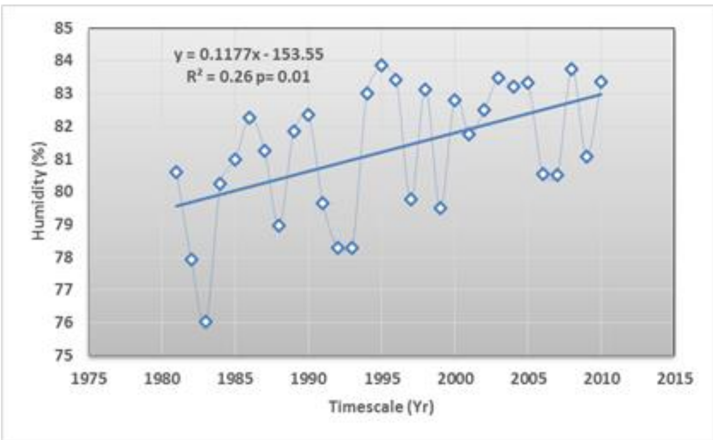


d)

Figure 7.13: Scatter plots showing: a) maximum temperature, b) minimum temperature, c) precipitation and d) humidity for Kwara State.

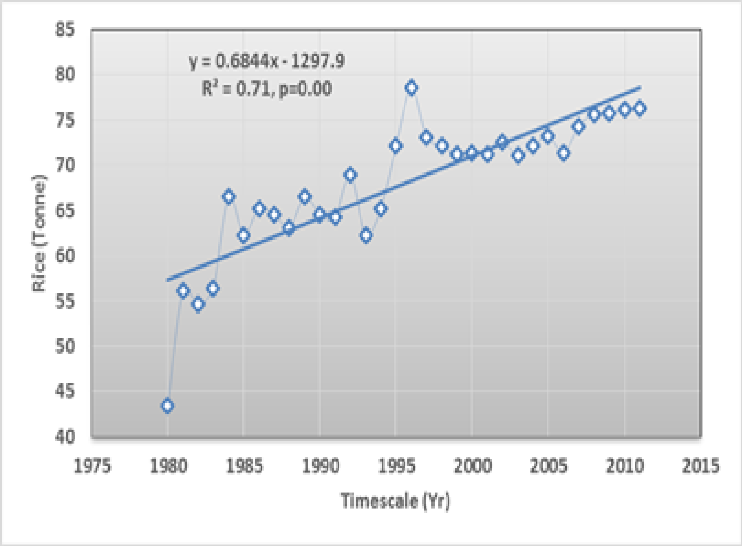
7.7.2 Crop Yield

The regression model constructed around the temporal crop yield data for ***Rice*** showed a strong positive correlation and marked relationship existed, indicative a temporal increase in crop yield with time. This was given by the regression equation (y = 0.6844x-1297.9) and (R^2 =71%) of data variation (p<0.01; Figure 7.14a). In contrast, a strong negative correlation and a marked relationship existed for ***Maize***, indicative of decreasing crop yield overtime. This was given by the regression equation (y= -0.3763x + 843.65) with the coefficient of determination (R^2) explaining 66% of data variation (p<0.01, Figure 7.14b). Similarly, both ***Cassava*** and ***Groundnut*** showed that a weak negative correlations and definite but small relationships existed, indicative of a decreasing temporal trend. The statistical significance varied.

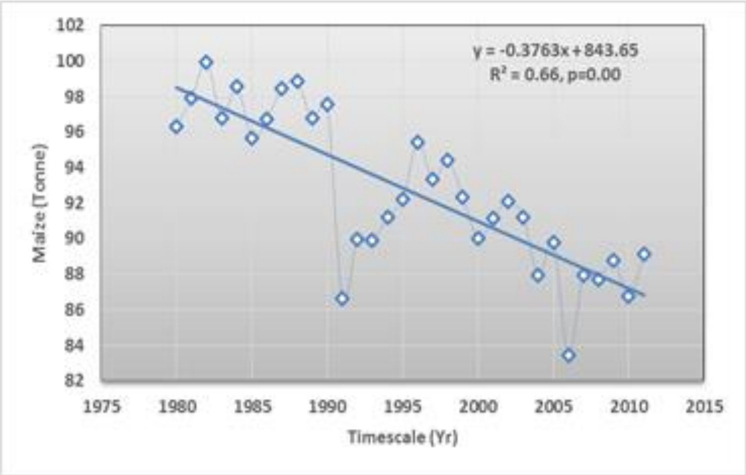
The regression model constructed around the ***Cassava*** data (y = -2.563x +5523.3), highlighted an R^2 value that explained 29% of data variation (p = 0.01; Figure 7.14c). The regression equation for ***Groundnut*** is (y = -0.074x+192.09) and (R^2 = 8%) of data variation (p = 0.12; Figure 7.14d). The scatterplot showed that groundnut yield declined overtime. Furthermore, the regression model constructed around ***Guinea corn*** yield showed a low positive correlation and almost negligible relationship existed, indicative of a slight increase in yield. This was given by the regression equation (y = 0.2392x -327.05) and an R^2 value that explained <10% of data variation (p = 0.13; Figure 7.14e).

The assessment of ***Yam*** showed a low negative correlation and almost negligible relationship existed, given by the regression equation y = -1.711x + 4227.5, and an R^2 value that explained almost none of the data variation (p = 0.20; Figure 7.14f). This implies that yam yield declined during the period of assessment. Similarly, a negative correlation also existed when ***Bean*** was assessed, but with moderate correlation and a substantial relationship. This was given by the regression equation y = -0.0315x + 67.925, and coefficient of determination that explained 29% of data variation (p<0.01; Figure 7.14g).

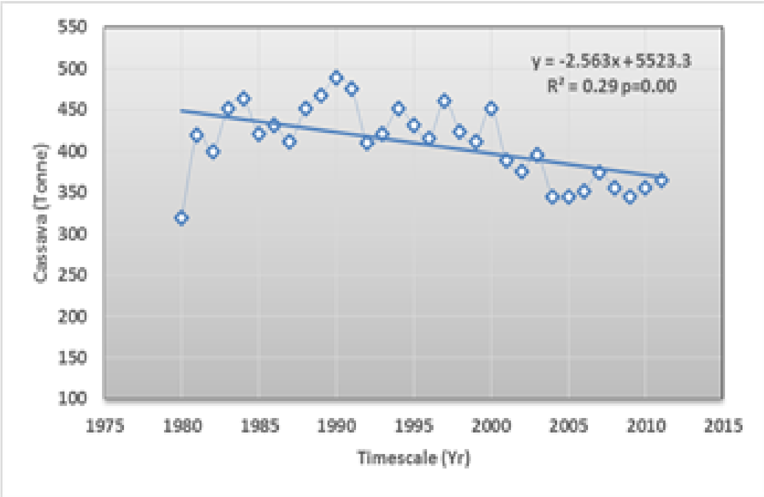
Finally, the regression model constructed around ***Millet*** showed a low positive correlation and definite but small relationship existed and this was given by the regression equation (y = 0.1723x – 309.63), the coefficient of determination that explained 13% of data variation (p = 0.04; Figure 7.14h). However, the scatterplot showed a slight increase in millet yield in the State.



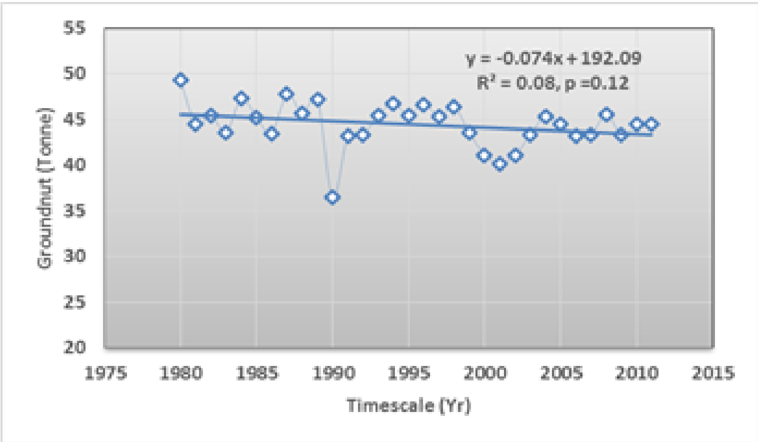
a)



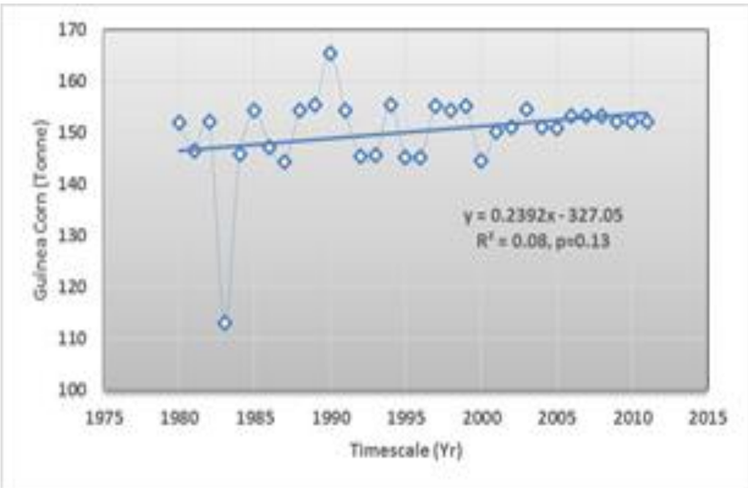
b)


y = -2.563x + 5523.3
R² = 0.29 p=0.00
Cassava (Tonne)
550
500
450
400
350
300
250
200
150
100
1975 1980 1985 1990 1995 2000 2005 2010 2015
Timescale (Yr)

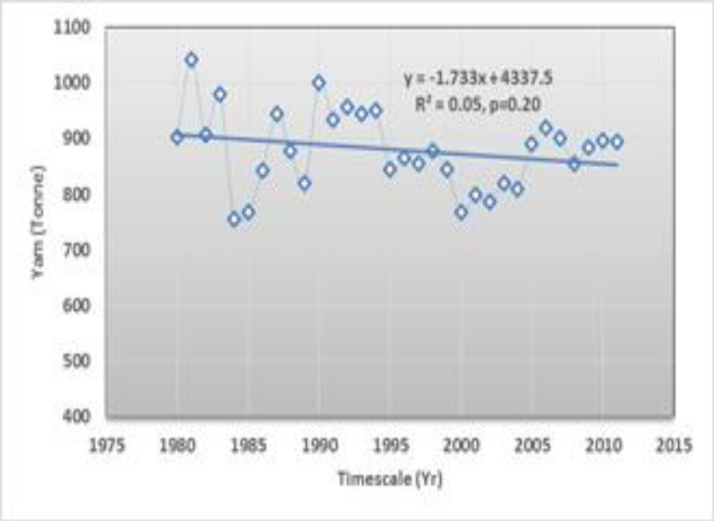
c)


y = -0.074x + 192.09
R² = 0.08, p =0.12
Groundnut (Tonne)
55
50
45
40
35
30
25
20
1975 1980 1985 1990 1995 2000 2005 2010 2015
Timescale (Yr)

d)


y = 0.2392x - 327.05
R² = 0.08, p=0.13
Guinea Corn (Tonne)
170
160
150
140
130
120
110
100
1975 1980 1985 1990 1995 2000 2005 2010 2015
Timescale (Yr)

e)



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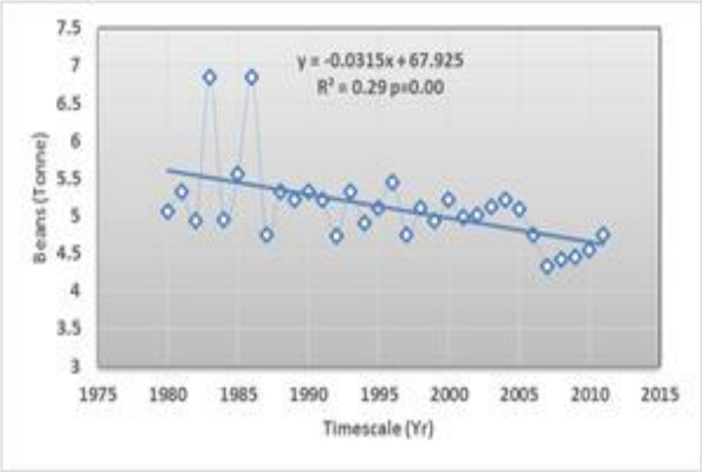
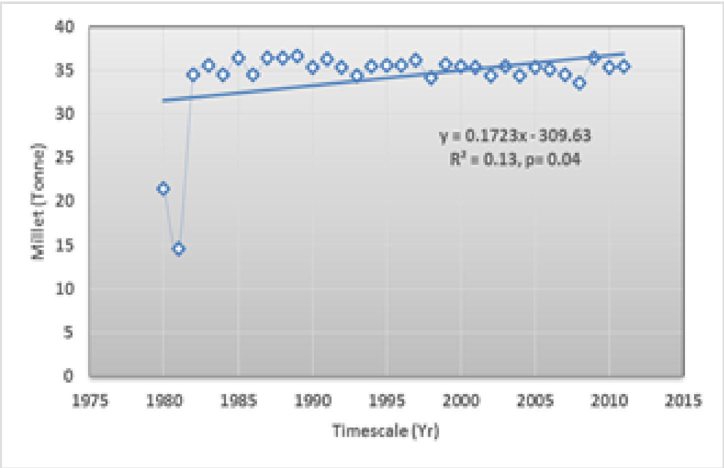


g)

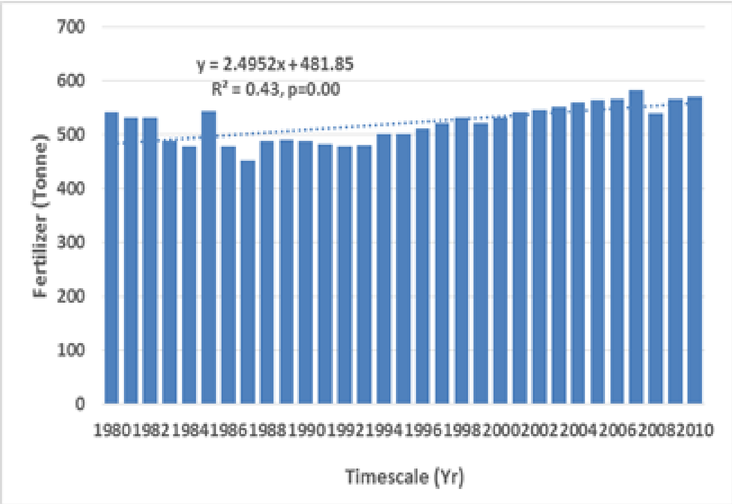


h)

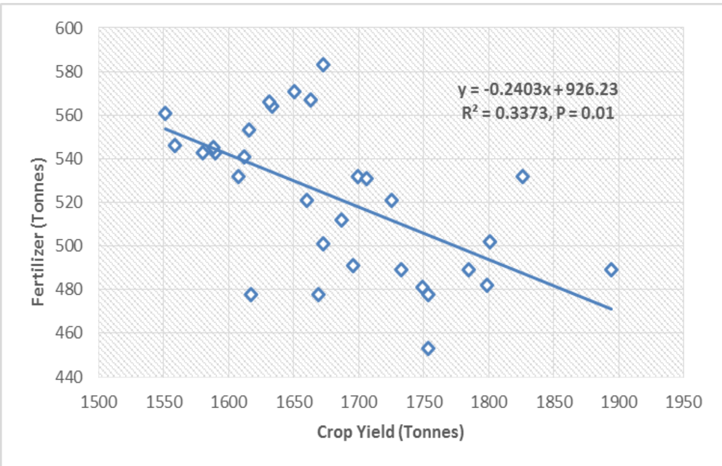
Figure 7.14: Scatter plots showing temporal crop yield for: a) Rice, b) Maize, c) Cassava, d) Groundnut, e) Guinea corn, f) Yam, g) Beans and h) Millet for Kwara State.

7.7.3 Fertilizer

Fertilizer use showed an increasing temporal trend, indicated by a moderate positive correlation and substantial relationship. This was given by the regression equation (y = 2.4952x + 481.85) and an R^2 value that explained almost 50% of data variation ($p<0.01$; Figure 7.15a). Despite the temporal increase, there was moderate negative correlation and a substantial relationship, when fertilizer was compared directly with overall crop yield. This was given by the regression equation (y = -0.2403x + 926.23), and coefficient of determination that explained 34% of data variation ($p<0.01$; Figure 7.15b).



a)



b)

Figure 7.15: Temporal trend of: a) Fertilizer used and b) a comparison of overall crop yield and fertilizer use for the period 1980-2011.

7.7.4 Evaluating implications

Rice was positively correlated, indicative of increasing crop yield overtime (Figure 7.14a), and this concurs with Table 7.6 results. All assessed environmental forcing agents were positively correlated with crop yield, and with the exception of humidity ($r = 0.20$, $p > 0.05$), results were statistically significant with (r) values ranging between 0.39 and 0.51 ($p<0.01$). Similarly, fertilizer use also showed positive correlation ($r = 0.33$, $p < 0.05$). On the contrary, ***Maize*** yield showed a high negative correlation, indicative of a decreasing yield overtime (Figure 7.14b) and Table 7.6 results once again concur. There was negative correlation with all environmental forcing agents, albeit with varying statistical significance, and (r) values that ranged between -0.23 ($p<0.05$) and -0.38 ($p<0.01$). Unsurprisingly, fertilizer use also showed a negative correlation ($r = -0.52$, $p<0.01$).

Table 7.6: Correlation matrix comparing the stable crop yield and environmental forcing agents. Note; ***bold italic*** *statistical significance at 99% confidence (p <0.01) and* **bold** *95% confidence (p<0.05)*

	Maximum Temp	Minimum Temp	Precipitation	Humidity	Fertilizer
Rice	***0.51***	***0.39***	***0.44***	0.20	**0.33**
Maize	**-0.38**	**-0.31**	**-0.38**	-0.23	***-0.52***
Cassava	***-0.48***	-0.22	-0.10	-0.17	***-0.74***
Groundnut	0.06	-0.12	-0.08	0.04	-0.15
Guinea corn	0.15	0.15	0.08	**0.38**	0.27
Yam	-0.22	-0.18	***-0.54***	-0.03	-0.24
Beans	**-0.32**	**-0.34**	-0.10	***-0.42***	***-0.42***
Millet	0.17	0.20	**0.36**	-0.05	-0.15

There was also a high negative correlation, indicative of falling trends, when ***Cassava*** yield was assessed (Figure 7.14c) and once again Table 7.6 results concur. Negative correlation with all environmental forcing agents, albeit with varying statistical significance and (r) values that ranged between -0.10 ($p > 0.05$) and -0.48 ($p <0.01$). Similarly, fertilizer showed a statistically significant and strong negative correlation ($r = -0.74$, $p<0.05$). Previous research has shown that this is attributed to poor farming techniques. Lack of land preparation prior to cultivation plays an overall output to yield (Ezeh, 1998). ***Groundnut*** yield also showed a negative correlation indicative of a decreasing trend (Figure 7.14d).

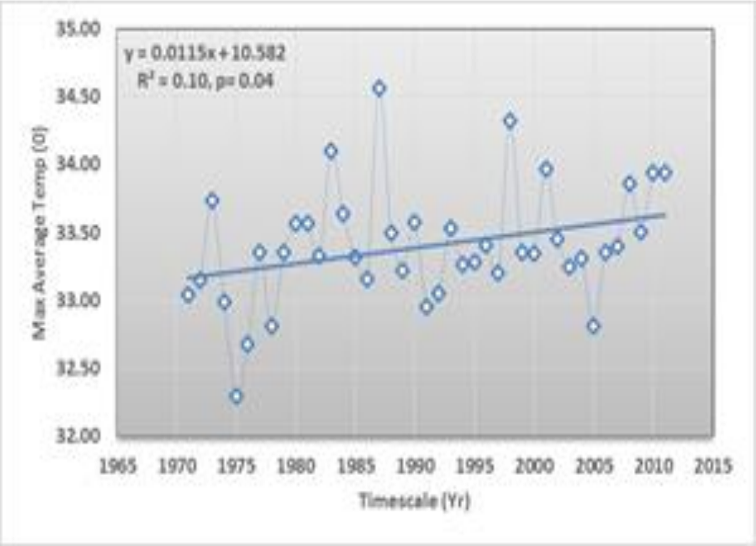
Table 7.6 results show negative correlation with minimum temperature, precipitation and fertilizer used (r = -0.12, -0.08 and -0.15 respectively, p>0.05). However, both maximum temperature and humidity showed a positive correlation (r = 0.06 and 0.04, respectively; p>0.05). There was a positive correlation for ***Guinea corn*** yield indicative of an increasing trend (Figure 7.14e). This concurs with Table 7.6 results, where all environmental forcing agents were positively correlated, and except for humidity (r = 0.38, p<0.05), (r) values ranged between 0.08 and 0.15 (p>0.05). Fertilizer use also showed positive correlation of (r = 0. 27, p>0.05).

The regression model constructed around ***Yam*** showed a negative correlation, and indicative of decreasing crop yield (Figure 7.14f). Table 7.6 results also highlight, with varying statistical significance and negative correlation between crop yield and all environmental forcing agents, with (r) values ranging between -0.03 (p>0.05) and -0.56 (p<0.01). Similarly, fertilizer use showed a negative correlation with crop yield (r= -0.24, p<0.05). Similarly, ***Bean*** yield showed a negative correlation, which implies that yield declined with time (Figure 7.14g). Table 7.6 results show maximum tempurature extremes, humidity and precipitation were all negatively correlated with crop yield and with the exception of precipitation (r = 0.10, p>0.05) the results were statistically significant with (r) values that ranged from r= -0.32 (p<0.05) and r=-0.42 (p<0.01). There was also negative correlation between crop yield and fertilizer use (r = -0.42). The assessment of ***Millet*** showed a slight positive correlation, indicative of a marginal temporal crop yield increase (Figure 7.14h). However, Table 7.6 showed variable correlation, temperature extremes and precipitation were positively correlated with (r) values that ranged between 0.17 (p>0.05) and 0.36 (p<0.05). Humidity and fertilizer use were negatively correlated (r= -0.05 and -0.15 respectively, p>0.05).

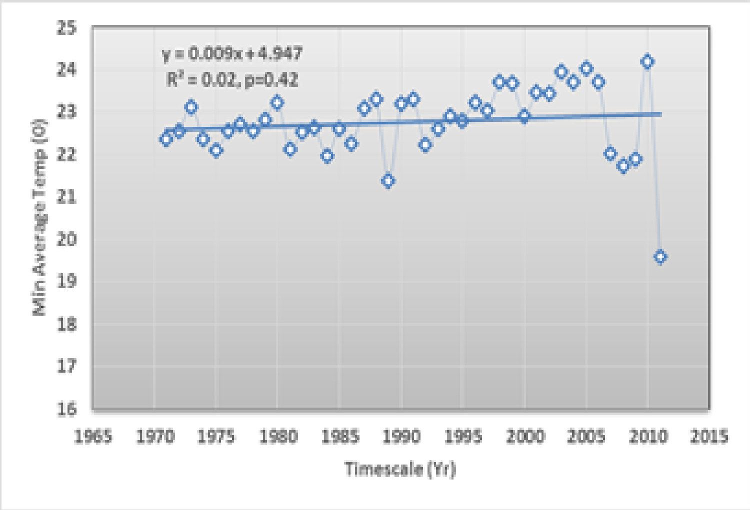
7.8 Kogi State

7.8.1 Environmental Change (1971-2011)

The regression model constructed for both ***maximum and minimum temperature*** showed a slight positive correlations and almost negligible relationships existed. Given by the regression equations (y = 0.0115x-10.582), and (y = 0.009x+4.947), respectively, a coefficient of determination explained <1% of data variation (p = 0.04; Figure 7.16a, and p = 0.42; Figure 7.16b). Similarly, ***precipitation*** explained <1%, of data variation (p = 0.27; Figure 7.16c), (regression equation y = 0.2895x-476.56). By contrast, a slight negative correlation, but almost negligible relationship existed when ***humidity*** was assessed. This was given with the regression equation (y = 0.011x + 45.165) and a coefficient of determination that explained <1% of data variation, (p = 0.94; Figure 7.16d).



a)



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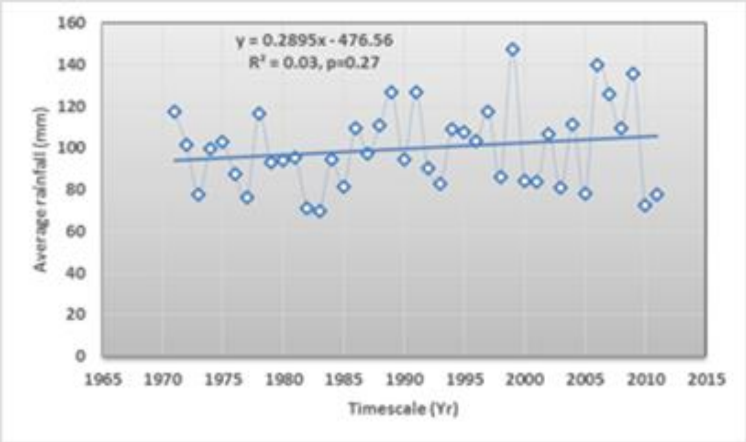

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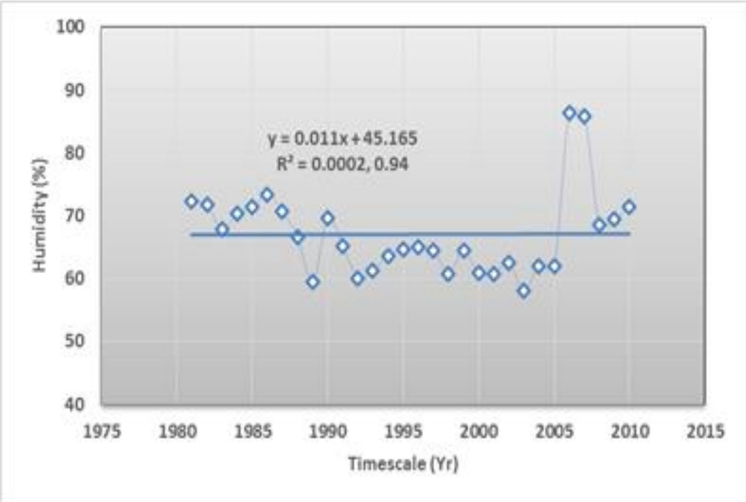


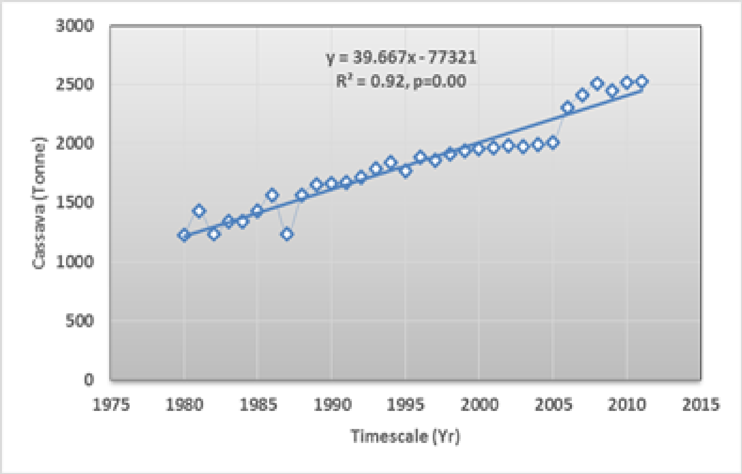
d)

Figure 7.16: Scatter plots showing: a) maximum temperature, b) minimum temperature, c) precipitation and d) Humidity for Kogi State.

7.8.2 Crop yield (1980-2010)

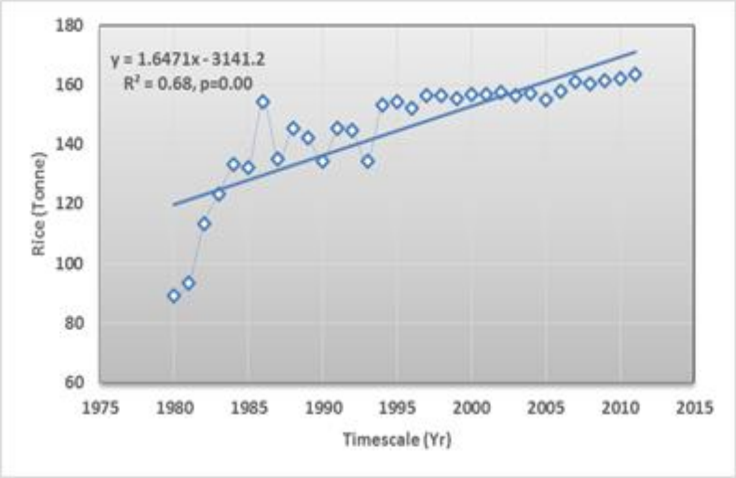
The regression model constructed around ***Cassava*** yield showed that a very high positive correlation and very dependable relationship existed, indicative of an increasing crop yield overtime. This was given by the regression equation ($y = 39.667x-77321$), and the coefficient of determination explained 92% of data variation ($p<0.01$, Figure 7.17a). Similarly, the regression model constructed around ***Rice*** analyses showed a high positive correlation and marked relationship existed also indictative of an increasing crop yield overtime. Given by the regression equation ($y = 1.6471x-3141.2$) and (R^2=68%) of data variation $p<0.01$ (Figure 7.17b). Furthermore, a moderate positive correlation and a substantial relationship existed when ***Groundnut*** yield was assessed, given by the regression equation ($y = 0.3574x – 672.94$). The coefficient of determination R^2 explained 19% of data variation, showing that the crop yield also increased ($p<0.01$, Figure 7.17c). ***Guinea corn*** yield showed a high positive correlation and marked relationship existed, indicative of an increasing yield. This was given by the regression equation of $y = 0.4246x-778.22$, and the coefficient of determination explained 67% of data variation ($p<0.01$, Figure 7.17d).

A moderate positive and substantial relationship existed when ***Millet*** was considered, (regression model $y = 0.0376x-72.324$), R^2 value explained 36% of data variation, showing an increasing yield although the assessment period ($p<0.01$; Figure 7.17e). Similarly, ***Maize*** showed a positive correlation and substantial relationship also existed, indicative of an increasing yield. The regression model ($y = 0.5057x-860.28$), R^2 value explained 31% of data variation ($p<0.01$, Figure 7.17f). When consideration was given to ***Bean*** production, a high positive correlation and a marked relationship existed also indicative of increasing crop yield through time. The regression model ($y = 0.1136x - 212.01$), (R^2 = 61%) of data variation ($p<0.01$; Figure 7.17g). Finally, the analysis of ***Yam*** showed a moderate positive correlation and substantial relationship existed, indicative of an increasing yield overtime. The regression equation ($y = 8.3187x-15321$), and an R^2 value explained 36% ($p<0.01$; Figure 7.17h).



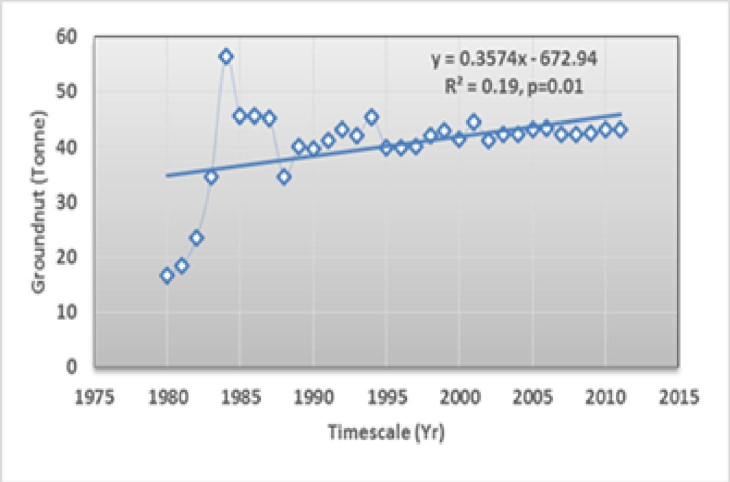
y = 39.667x - 77321
R² = 0.92, p=0.00
Cassava (Tonne)
3000
2500
2000
1500
1000
500
0
1975
1980
1985
1990
1995
2000
2005
2010
2015
Timescale (Yr)

a)



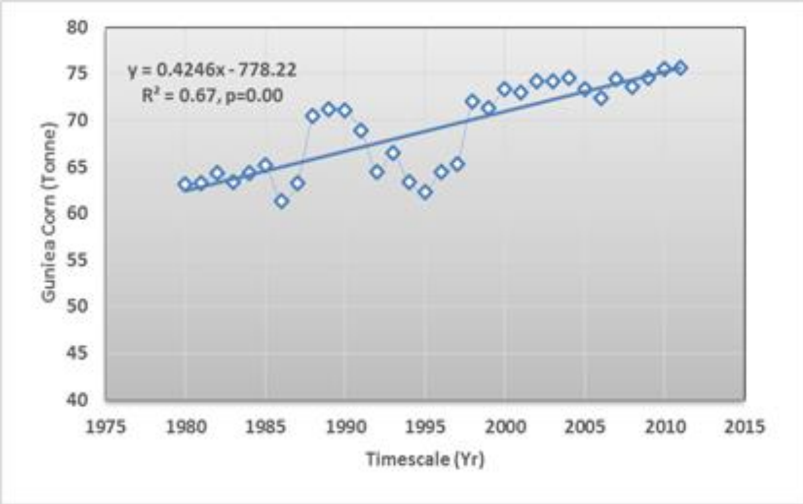
y = 1.6471x - 3141.2
R² = 0.68, p=0.00
Rice (Tonne)
180
160
140
120
100
80
60
1975
1980
1985
1990
1995
2000
2005
2010
2015
Timescale (Yr)

b)

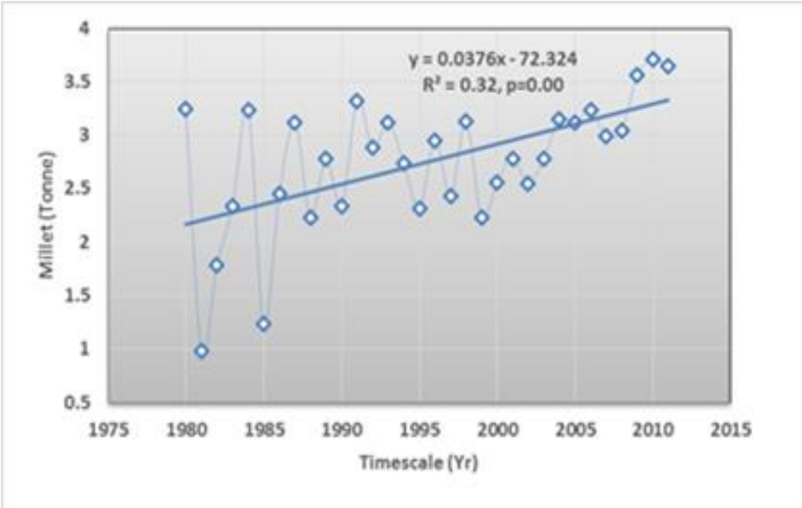


y = 0.3574x - 672.94
R² = 0.19, p=0.01
Groundnut (Tonne)
60
50
40
30
20
10
0
1975
1980
1985
1990
1995
2000
2005
2010
2015
Timescale (Yr)

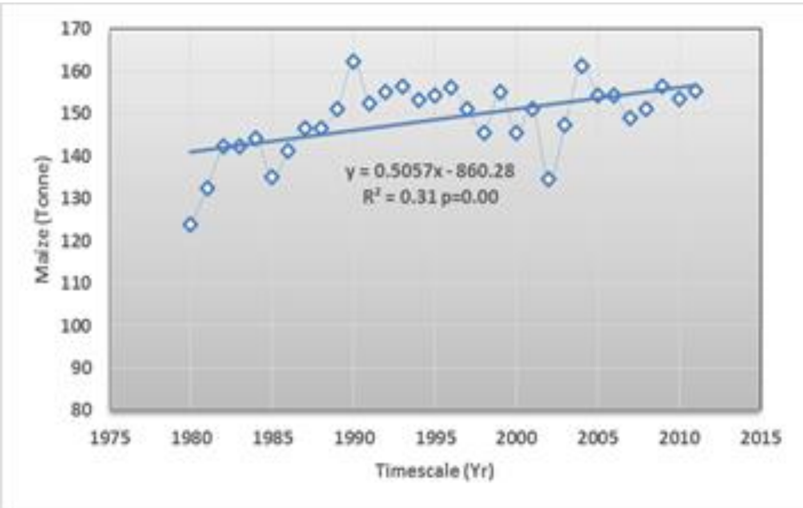
c)


y = 0.4246x - 778.22
R² = 0.67, p=0.00
Guniea Corn (Tonne)
80
75
70
65
60
55
50
45
40
1975
1980
1985
1990
1995
2000
2005
2010
2015
Timescale (Yr)

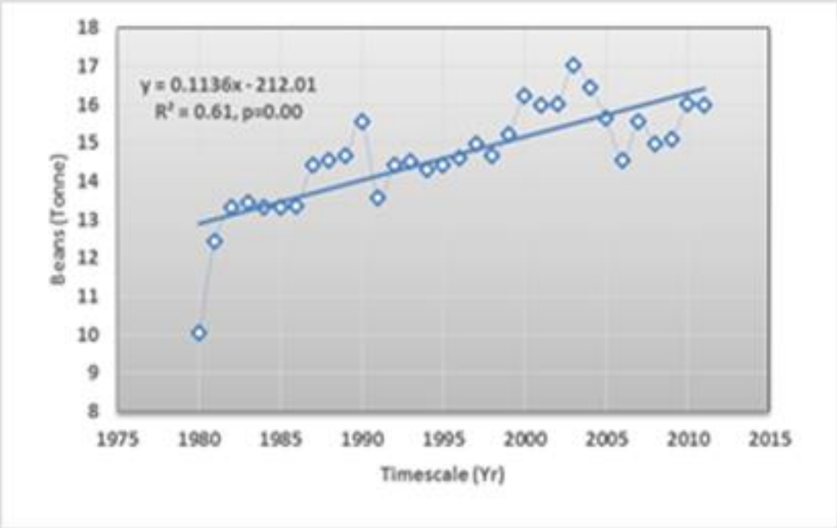
d)


y = 0.0376x - 72.324
R² = 0.32, p=0.00
Millet (Tonne)
4
3.5
3
2.5
2
1.5
1
0.5
1975
1980
1985
1990
1995
2000
2005
2010
2015
Timescale (Yr)

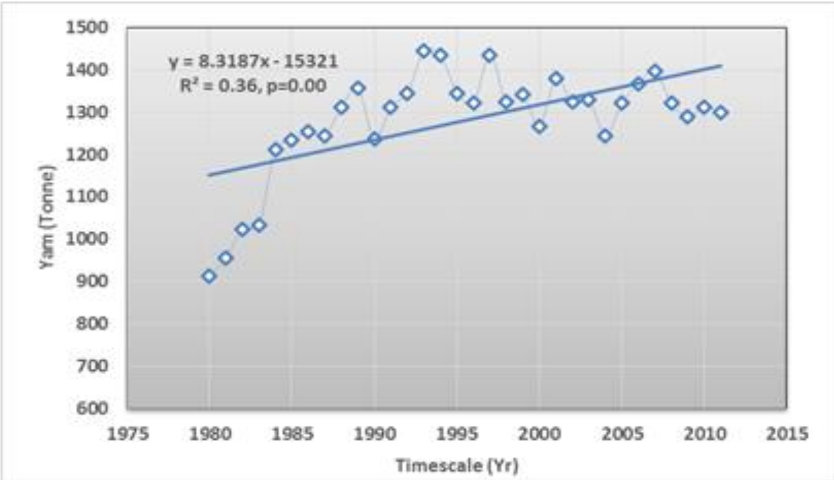
e)


y = 0.5057x - 860.28
R² = 0.31 p=0.00
Maize (Tonne)
170
160
150
140
130
120
110
100
90
80
1975
1980
1985
1990
1995
2000
2005
2010
2015
Timescale (Yr)

f)



g)

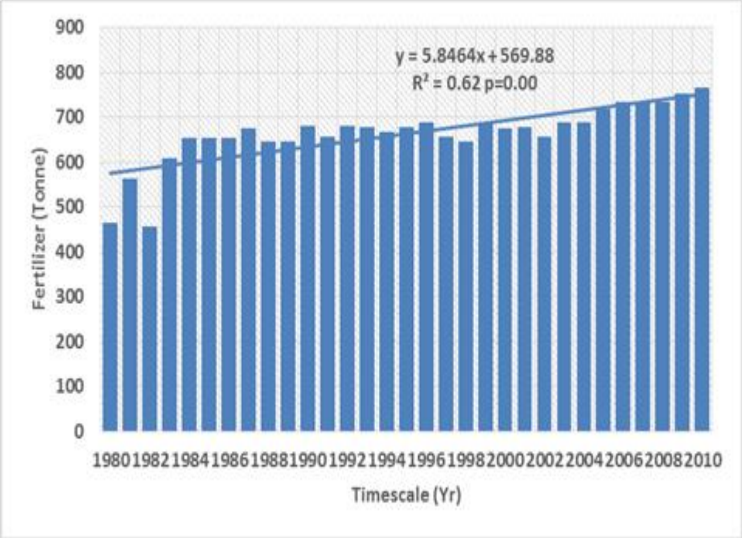


h)

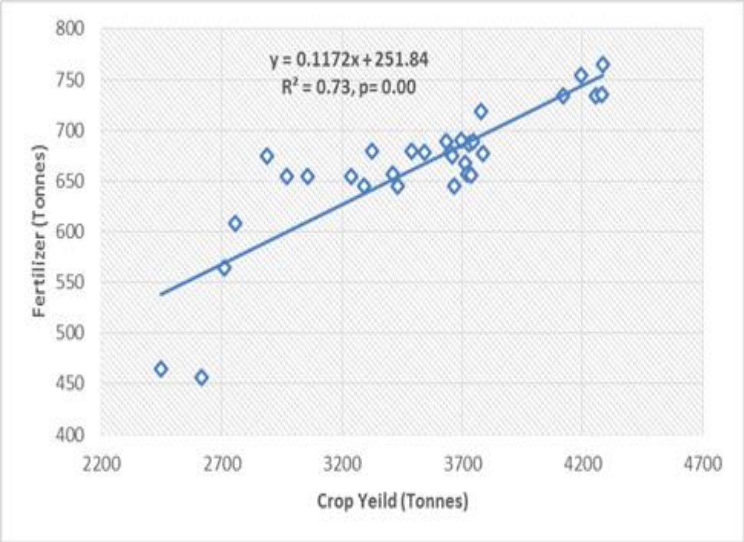
Figure 7.17: Scatter plots showing temporal crop yield for: a) Cassava, b) Rice, c) Groundnut, d) Guinea corn, e) Millet, f) Maize, g) Beans and h) Yam for Kogi State.

7.8.3 Fertilizer

A high positive correlation and very dependable relationship was found when fertilizer was analysed indicative of a consistent increase in fertilizer use with time. The regression model ($y = 5.8464x + 569.88$), and ($R^2 = 62\%$) of data variation ($p<0.01$; Figure 7.18a). When total crop output and fertilizer use was compared, a very strong positive correlation and marked relationship existed indicative of increasing crop yield with increased fertilizer use. This was given by the regression equation $y = 0.1172x + 251.84$ and an R^2 value that explained 73% of data variation ($p<0.01$; Figure 7.18b).



a)



b)

Figure 7.18: Temporal trend of: a) Fertilizer used and b) a comparison of overall crop yield and fertilizer use for the period 1980-2011.

7.8.4 Evaluating implications

Kogi (the Central South State) is classified as derived savannah (Figure 6.1). When Cassava yield was assessed (Figure 7.17a), a postive correlation was identified, indicative of an increasing temporal yield. This concurs with the results of Table 7.7, where crop yield was positively correlated with all environmental forcing agents, albeit with variable correlation, and (r) values that ranged between 0.08 and 0.34 ($p>0.05$-$p<0.05$). Fertilizer use also increased during the period of assessment (Figure 7.18a).

The regression model for ***Rice*** showed a high positive correlation, indicating a steady increase throughout the time of assessment (Figure 7.17b).

Table 7.7 results show with varying statistical significance, positive correlation between crop yield and all assessed environmental forcing agents with (r) values ranging between 0.11 and 0.35 ($p>0.05$- $p<0.05$). This suggests that environmental forcing agents contribute to crop yield increase in this agro-ecological zone. Fertilizer use also showed statistically significant positive correlation ($r = 0.83$, $p<0.01$).

Groundnut also showed a high positive correlation (Figure 7.17c) and Table 7.7 results once again concurred showing with variable statistical significance (r) values that ranged between 0.03 and 0.17 ($p>0.05$). A similar scenario existed for ***Guinea corn*** (Figure 7.17d), i.e. positive correlation that concurred with results of Table 7.7, where crop yield was positively correlated with all environmental forcing agents and (r) values that ranged between 0.02 and 0.34, ($p>0.5$-$p<0.05$). The result also showed that fertilizer used was also positively correlated, suggesting that an increase in fertilizer has the potential to increase ***Guinea corn*** crop yield ($r = 0.56$; $p<0.01$).

Table 7.7: Correlation matrix comparing the stable crop yield and environmental forcing agents. Note; ***bold italic*** *statistical significance at 99% confidence (p<0.01) and* **bold** *95% confidence (p<0.05)*

	Max Temp	Min Temp	Humidity	Precipitation	Fertilizer
Cassava	0.08	0.17	**0.38**	**0.34**	***0.78***
Rice	0.11	0.25	0.26	**0.35**	***0.83***
Groundnut	0.03	0.04	0.00	0.17	***0.75***
Guinea corn	0.21	0.34	0.02	0.19	***0.56***
Millet	-0.04	0.21	0.08	0.17	***0.47***
Maize	-0.32	0.16	0.02	0.29	***0.67***
Beans	0.19	**0.35**	0.14	0.05	***0.71***
Yam	0.05	0.14	0.15	**0.36**	***0.75***

There was also a positive correlation, indicative of a significant increase in ***Millet*** production over time (Figure 7.17e), and except for a negative correlation with maximum temperature ($r = -0.04$, $p>0.05$). Once again, correlation results of Table 7.6 were mostly positive between crop yield and remaining environmental forcing agents with (r) values ranging between 0.08 and 0.21 ($p>0.05$). Once again, fertilizer use showed a statistically significant positive correlation ($r = 0.47$, $p>0.01$).

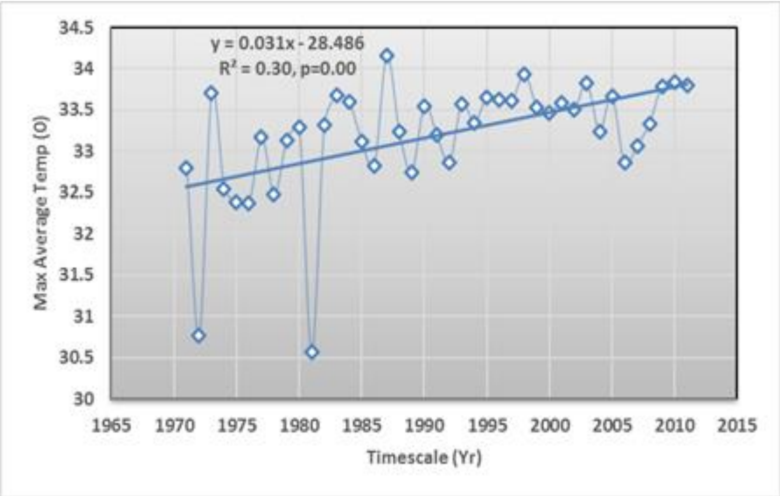
The assessment for ***Maize*** yield showed a positive correlation indicative of increasing crop yield (Figure 7.17f). Table 7.7 results vary showing once again that maximum temperature was negatively correlated ($r = -0.32$, $p>0.05$). However, the opposite was true when minimum temperature, precipitation and humidity was assessed ($r = 0.16$, $p>0.05$, $r = 0.29$, $p>0.05$ and 0.02, $p>0.05$, respectively). Fertilizer was also positively correlated ($r = 0.67$; $p<0.01$). Furthermore, a high positive correlation, indicative of an increasing ***Bean*** crop yield was identified throughout the period of assessment (Figure 7.17g).

Table 7.7 results show statistically significant, positive correlation between crop yield and all assessed environmental forcing agents with (r) values ranging between 0.05 and 0.35 ($p>0.05$ - $p<0.05$). This suggests that climatic variables may contribute to substantial increases in crop yield over-time. In addition to this, fertilizer use showed statistically significant positive correlation ($r = 0.75$, $p > 0.05$). Finally, statistical analysis of ***Yam*** showed a postive correlation, indicative of increasing crop yield throughout the assessment period (Figure 7.17h). Table 7.7 results highlight the statistical significance and positive correlation between crop yield and all remaining environmental forcing agents, with (r) values ranging between 0.05 and 0.36 ($p>0.05$-$p<0.05$). Similarly, fertilizer showed a statistical significant and positive correlation ($r = 0.75$, $p>0.05$).

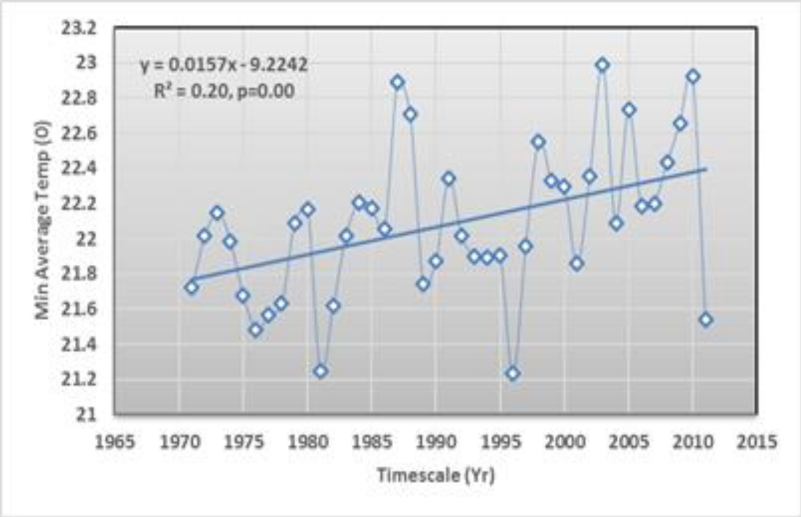
7.9 Benue State

7.9.1 Environmental Change (1971-2011)

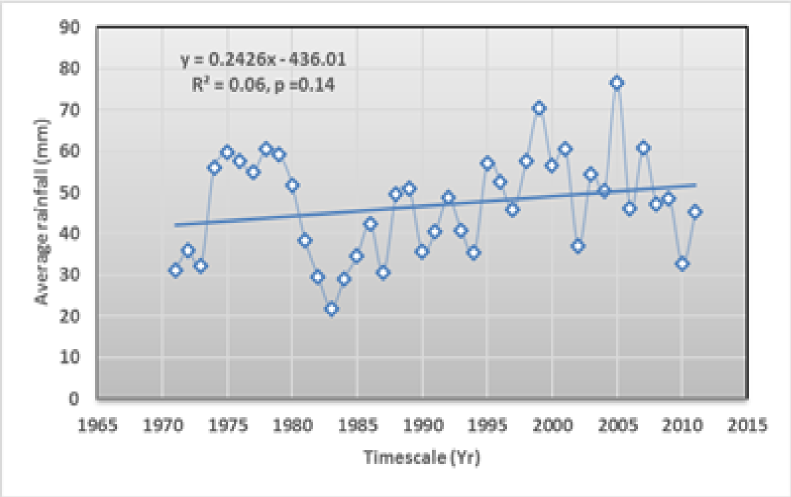
A moderate positive correlation and a substantial relationship existed when ***maximum temperature*** was assessed. This was given with the regression equation ($y = 0.031x - 28.486$) and a coefficient of determination that explained 30% of data variation ($p<0.01$; Figure 7.19a). Similarly, ***minimum temperature*** showed a moderate positive correlation and substantial relationship also existed when analysed indicative of an increasing trend, given by the regression equations ($y = 0.0157x - 9.2242$) and ($R^2 = 20\%$) of data variation ($p<0.01$; Figure 7.19b). The regression model constructed around temporal ***precipitation*** data showed a weak positive correlation and definite small relationship existed. This was given by the equation $y = 0.2426x - 436.01$ and an R^2 value that explained just 6% of data variation ($p = 0.14$; Figure 7.19c). A moderate positive correlation and substantial relationship also existed when ***Humidity*** was assessed, with a slight increasing trend. This was given by the regression equation is $y = 0.1942x - 345.1$. The coefficient of determination explained almost a quarter of data variation ($R^2 = 24\%$ and $p<0.01$; Figure 7.19d).



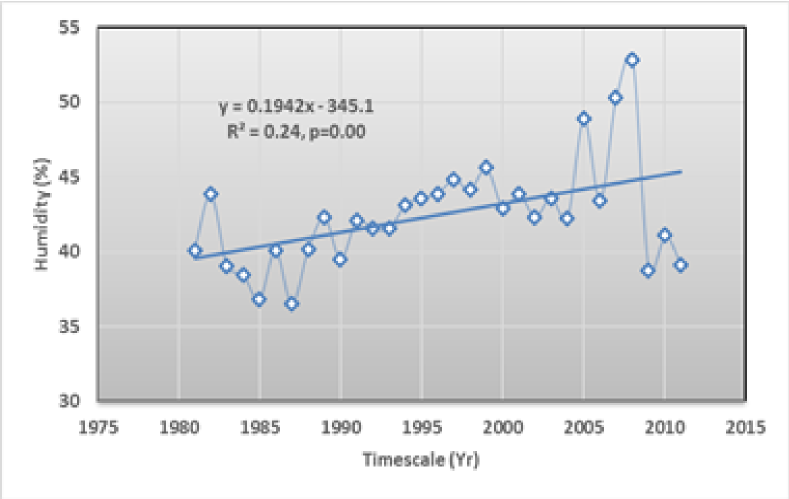
a)



b)



c)



d)

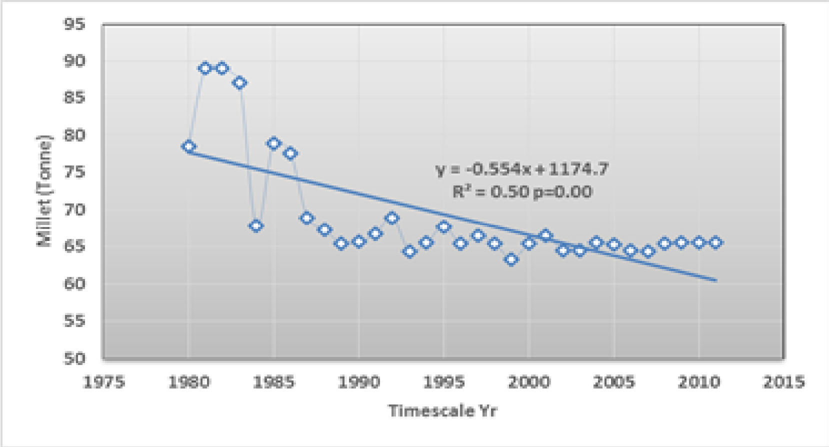
Figure 7.19: Scatter plots showing: a) maximum temperature, b) minimum temperature, c) precipitation and d) Humidity for Benue State.

7.9.2 Crop Yield

A high negative correlation and marked relationship existed when ***Millet*** was assessed, indicative of decreasing crop yield over time. This was given by the regression equation ($y = -0.554x+1174.7$) and an R^2 value that explained half of the variation in the data ($p<0.01$; Figure 7.20a). In contrast, the regression model constructed around the temporal crop yield data for ***Guinea corn*** was indicative of a moderate correlation and, substantial relationship that highlighted an increase in crop yield with time. Given by the equation ($y = 1.3564x - 2523.4$), this showed a positive correlation and an R^2 value that explained 40% of data variation ($p<0.01$; Figure 7.20b). A similar scenario existed, when consideration was given to ***Groundnut***. A moderate positive correlation and substantial relationship existed. The regression model ($y = 0.4549x - 563.57$), R^2 value explained 19% of data variation ($p< 0.01$; Figure 7.20c). The assessment of ***Rice*** showed that a low negative correlation and definite but small relationship existed, indicative of a decreasing trend with time. This was given by the regression equation ($y = -0.8557x + 1970.2$), the R^2 value explained only 9% ($p = 0.06$; Figure 7.20d).

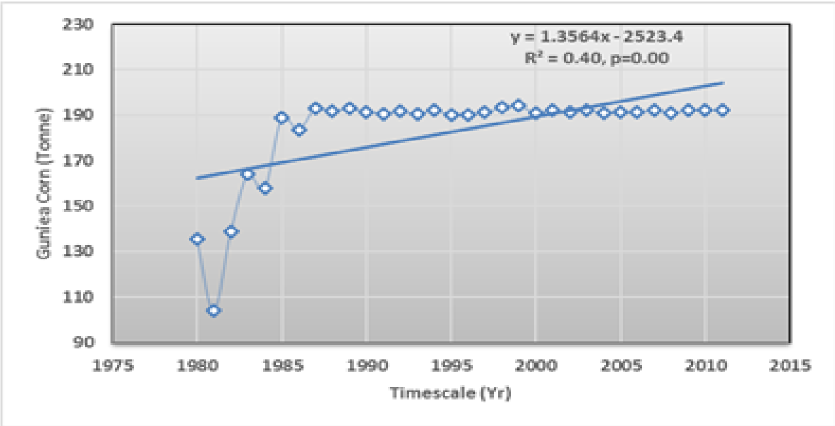
A slight positive correlation and negligible relationship existed when ***Cassava*** was assessed, indicative of an increase in yield. This was given by the regression equation ($y = 4.1435x - 5130.5$), the coefficient of determination that explained 2% of data variation ($p = 0.63$; Figure 7.20e). A low positive correlation and definite but small relationship existed, indicative of slight increase in crop yield with time when ***Yam*** was assessed. This was given by the regression equation $y = 5.1683x - 7589.0$ The coefficient of determination (R^2) explained 6% of data variation ($p = 0.30$; Figure 7.20f).

The regression model constructed for ***Maize*** showed a negative and almost negligible relationship existed. The regression equation ($y = - 0.3394x + 816.84$) and ($R^2 = 7\%$) of the data variation ($p = 0.08$; Figure 7.20g). Similarly, a negative and almost negligible relationship existed for ***Bean***. The regression model ($y= -0.0068x + 34.873$), R^2 value explained almost none of the data variation ($p= 0.56$; Figure 7.20h).



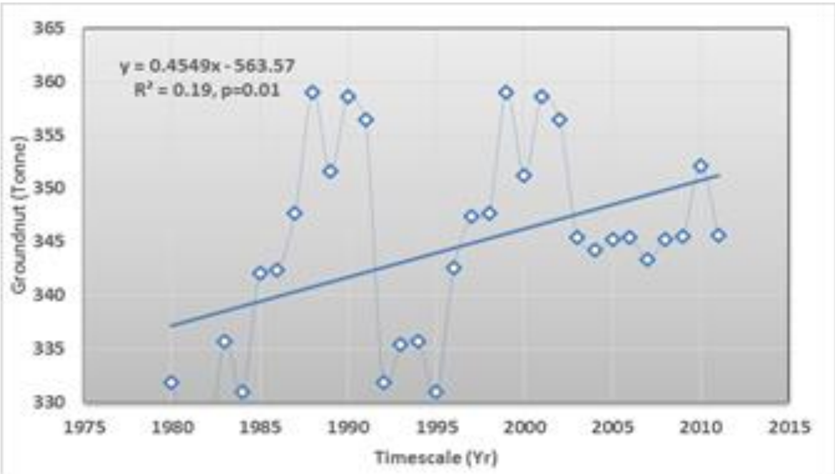
y = -0.554x + 1174.7
R^2 = 0.50 p=0.00
Millet (Tonne)
Timescale Yr

a)



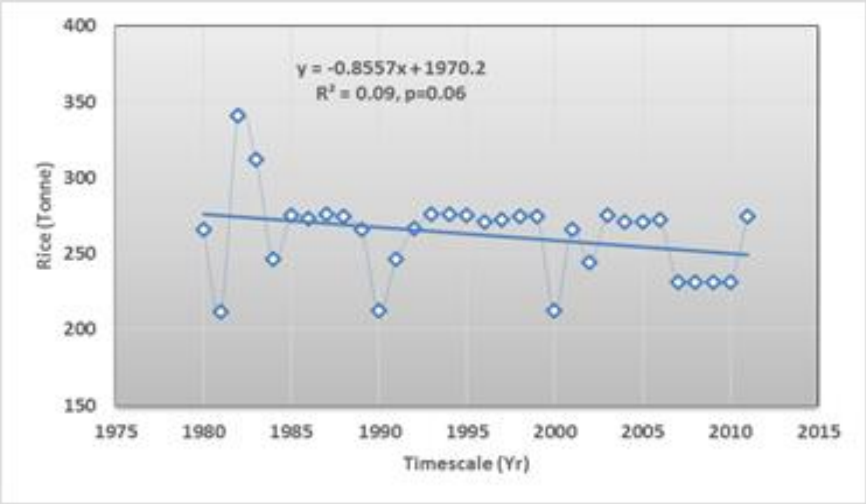
y = 1.3564x - 2523.4
R^2 = 0.40, p=0.00
Guniea Corn (Tonne)
Timescale (Yr)

b)



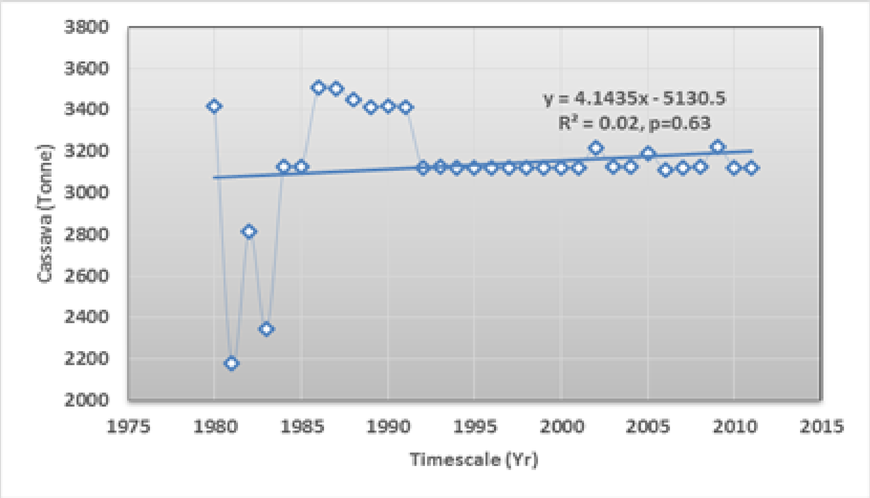
y = 0.4549x - 563.57
R^2 = 0.19, p=0.01
Groundnut (Tonne)
Timescale (Yr)

c)



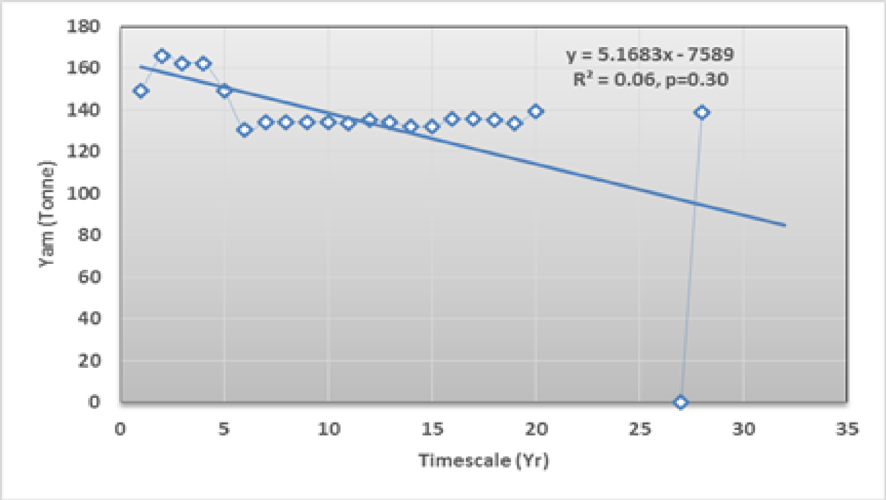
y = -0.8557x + 1970.2
R² = 0.09, p=0.06
Rice (Tonne)
400
350
300
250
200
150
1975
1980
1985
1990
1995
2000
2005
2010
2015
Timescale (Yr)

d)



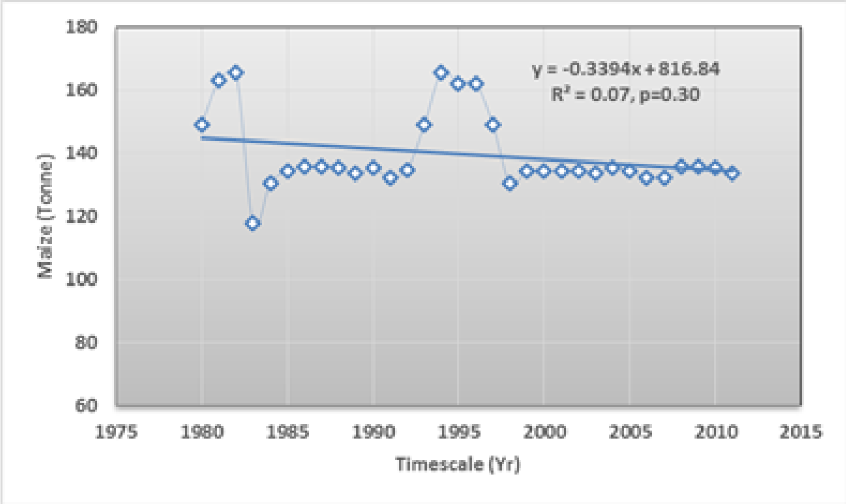
y = 4.1435x - 5130.5
R² = 0.02, p=0.63
Cassava (Tonne)
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
1975
1980
1985
1990
1995
2000
2005
2010
2015
Timescale (Yr)

e)

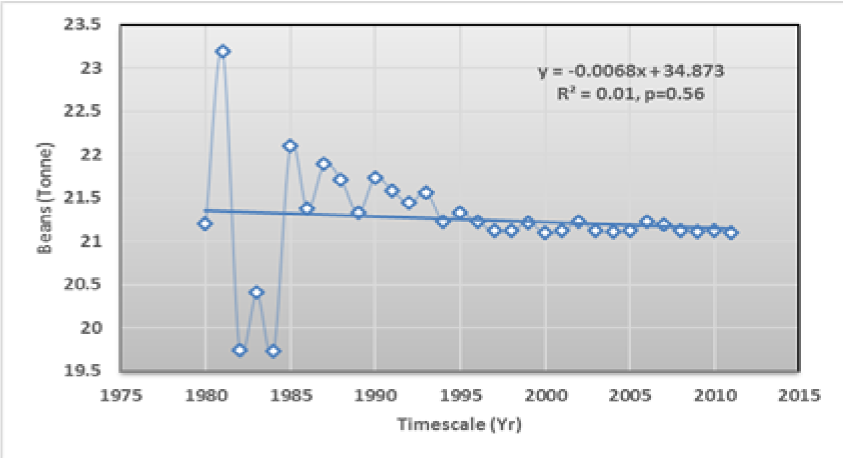


y = 5.1683x - 7589
R² = 0.06, p=0.30
Yam (Tonne)
180
160
140
120
100
80
60
40
20
0
0
5
10
15
20
25
30
35
Timescale (Yr)

f)



g)

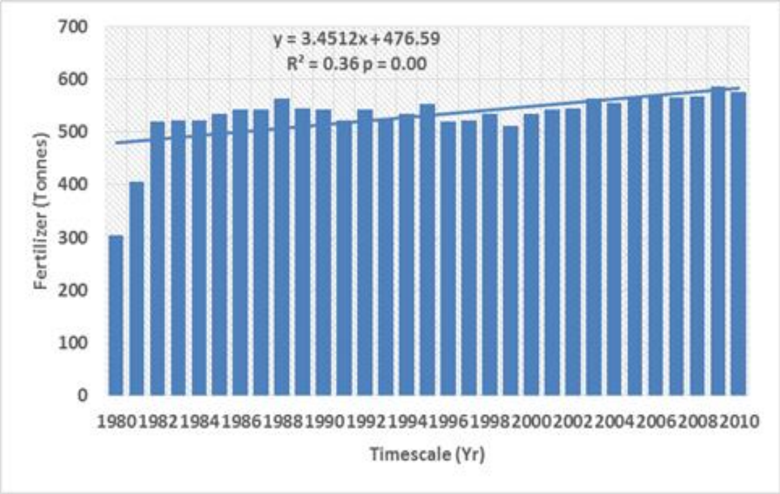


h)

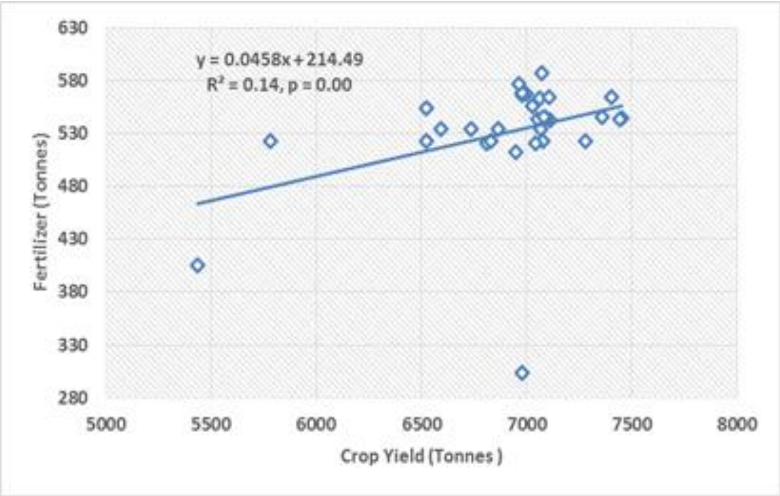
Figure 7.20: Scatter plots showing temporal crop yield for: a) Millet, b) Guinea corn, c) Groundnut, d) Rice, e) Cassava, f) Yam, g) Maize and h) Bean for Benue State.

7.9.3 Fertilizer

A moderate positive correlation and substantial relationship existed, when fertilizer was assessed, indicative of a consistent increase in fertilizer use with time. The regression model (y = 3.4512x+476.59), R^2 value explained 30% of data variation ($p<0.01$, Figure 7.21a). There was a weak positive correlation but definite small relationship with fertilizer use and total crop yield in the State. The regression equation (y = 0.0458x + 214.49), R^2 value explained 14% of data variation ($p<0.05$, Figure 7.21b).



a)



b)

Figure 7.21: Temporal trend of: a) Fertilizer used and b) a comparison of overall crop yield and fertilizer use for the period 1980-2011.

7.9.4 Evaluation implication

Millet was negatively correlated with time, indicative of a decrease in crop yield over the time assessed (Figure 7.20a). This concurs with Table 7.7 results where all assessed environmental forcing agents were negatively correlated with crop yield, with (r) values ranging between r= -0.32 and r= -0.48. Similarly, fertilizer use was negatively correlated (r = -0.52). This indicates that ***Millet*** yield decreased, possibly because of variations in environmental conditions. Fertilizer use may not be supportive to the germination and maturity of ***Millet*** in this agro-ecological zone. Temporal change analysis (Figure 7.20b) showed a positive correlation, indicative of increase in ***Guinea corn*** production.

Table 7.7 concurs with these (r) values ranging between r= 0.19 and r= 0.61. Additionally, fertilizer use indicates a positive correlation of (r = 0.75) suggesting that fertilizer supports crop germination and maturity stages. Figure 7.20c shows ***Groundnut*** yield was positively correlated between environmental forcing agents with (r) values ranging from r= 0.08 and r= 0.41. Fertilizer use showed a statistically significant positive correlation (r = 0.41), with groundnut production in this State.

Table 7.8: Correlation matrix comparing the stable crop yield and environmental forcing agents. Note; ***bold italic*** *statistical significance at 99% confidence (p<0.01) and* **bold** *95% confidence (p<0.05)*

	Max Temp	Min Temp	Precipitation	Humidity	fertilizer
Millet	***-0.48***	**-0.37**	***-0.48***	**-0.32**	***-0.52***
Guinea corn	***0.61***	***0.40***	**0.33**	0.19	***0.75***
Groundnut	**0.34**	***0.41***	**0.30**	0.08	***0.41***
Rice	0.27	-0.12	-0.11	-0.07	0.00
Cassava	***0.45***	***0.40***	0.24	-0.02	0.21
Yam	0.19	0.25	0.05	-0.02	***0.43***
Maize	**-0.29**	***-0.54***	-0.06	0.10	**-0.36**
Beans	***-0.55***	-0.09	0.09	-0.18	-0.21

There was a significant negative correlation, indicative of a decreasing ***Rice*** crop yield with time (Figure 7.20d) and Table 7.8 results showed that there was negative correlation of minimum temperature, precipitation and humidity with crop yield (r = -0.12, r = -0.11, and r = -0.07, respectively). However, the opposite was true when the maximum was assessed against crop yield (r = 0.27). Fertilizer use showed no correlation with crop yield.

When ***Cassava*** yield was assessed, a slight positive correlation, indicative of a temporal crop yield, increases (Figure 7.20e). Surprisingly, Table 7.8 results shows maximum and minimum extreme temperature and precipitation, were all positively correlated with crop yield (r = 0.45, r = 0.40, r = 0.24, respectively). There was a negative correlation humidity and crop yield (r = -0.02). However, a positive correlation existed between crop yield and fertilizer use.

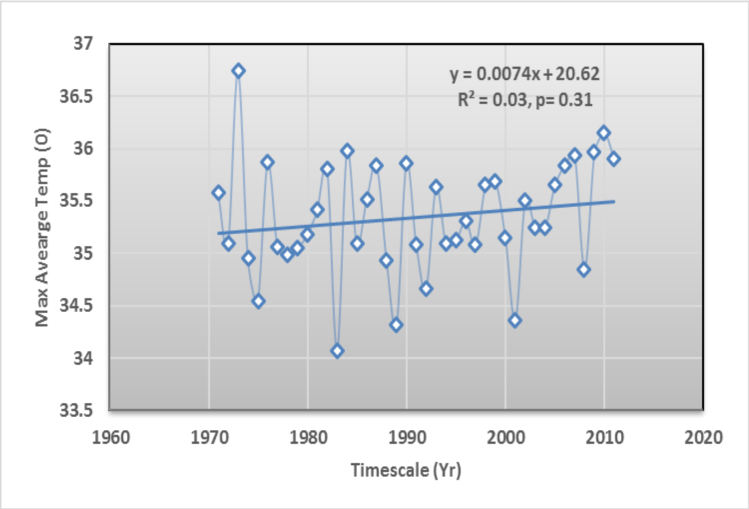
There was an increasing temporal trend in ***Yam*** production (Figure 7.20f) and this corresponded to a statistically significant increase in maximum and minimum temperature and precipitation (r = 0.19 and r = 0.25, respectively) and precipitation (r = 0.05; Table 7.8). Also, fertilizer use was positively correlated. However, humidity showed a negative correlation (r = -0.02).

The statsitical analysis for ***Maize*** yield (Figure 7.20g) also highlighted a negative correlation indicative of decreasing yield. Table 7.8 results highlight, with varying statistical significance, negative correlations between crop yield and almost all environmental forcing agents, with (r) values ranging between r= -0.06 and r= -0.29. However, humidity was positively correlated with crop yield with r = 0.10. Fertilizer use showed a statistical insignificant and negative correlation (r = -0.36). There was a positive correlation indicative of a significant increase in ***Bean*** production (Figure 7.20h) and, once again, Table 7.8 showed a significant correlation with precipitation (r = 0.59). Results also highlight, negative correlation between crop yield and the remaining environmental forcing agents with (r) values ranging between -0.09 and -0.55 (Table 7.8). Once again, fertilizer use also showed negative correlation (r = -0.21).

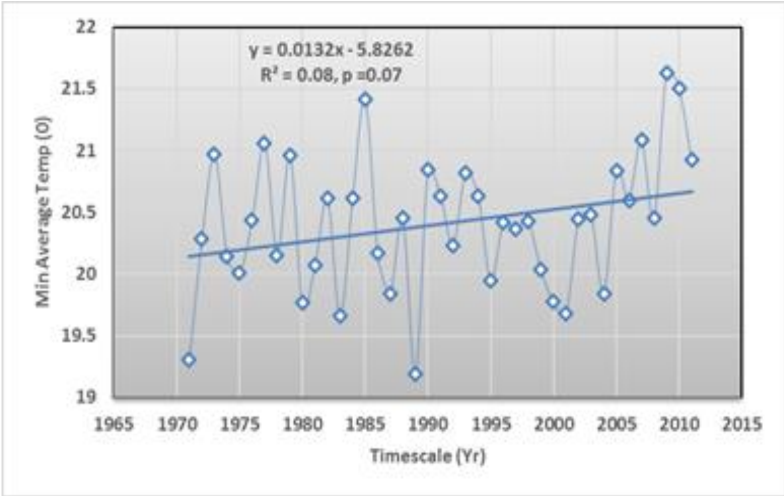
7.10 Niger State

7.10.1 Environmental Change (1971-2011)

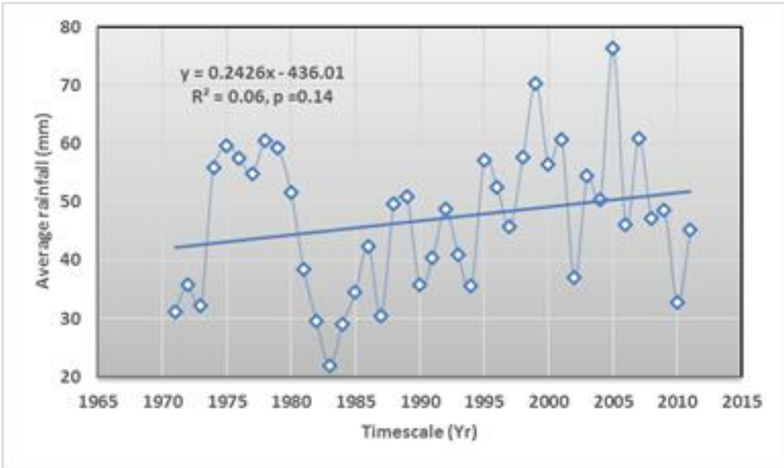
The regression model constructed around ***maximum temperature*** data over time showed a slight positive correlation and negligible relationship, given by the equation $y = 0.0074x + 20.62$ and $R^2 = 3\%$ and statistically insignificant gradient ($p = 0.31$; Figure 7.22a). Although ***minimum temperature*** showed a moderate positive correlation and substantial relationship existed, given by the regression equation $y = 0.0132x - 5.8262$ and $R^2 = 8\%$ with a gradient significance of $p = 0.07$ (Figure 7.22b). ***Precipitation*** showed that a low positive correlation and definite, but small, relationship existed, indicative of a slight increase in trend. The regression model ($y = 0.2426x – 436.01$), R^2 value explained 6% of the data variation $p = 0.14$ (Figure 7.22c). A moderate postive correlation and substantial relationship existed when ***humidity*** was assessed, indicative of a temporal increasing trend. This was given by the regression equations $y = 0.168x – 274.7$ and an R^2 value that explained 21% of data variation ($p<0.01$, Figure 7.22d).



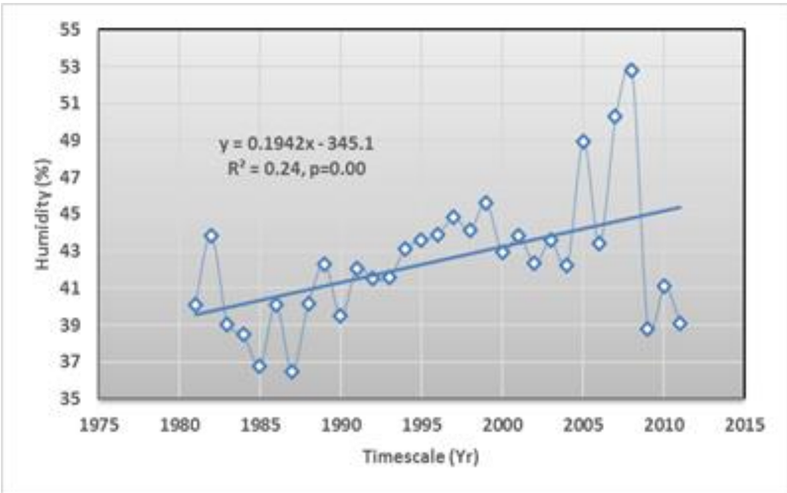
a)



b)



c)



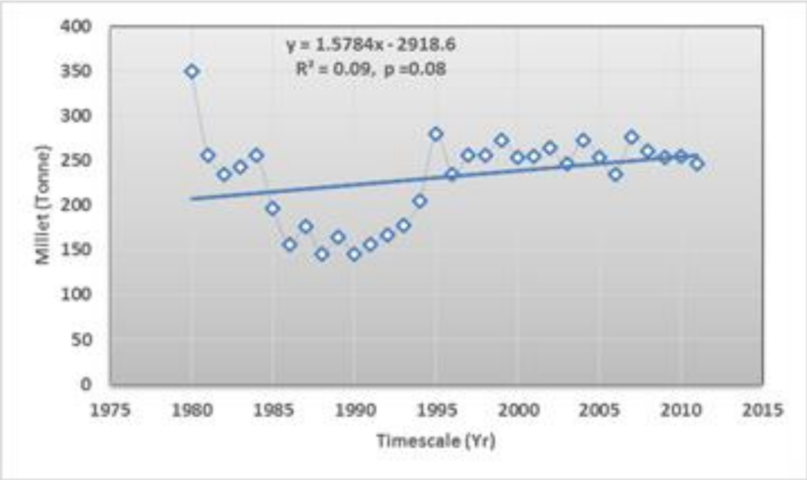
d)

Figure 7.22: Scatter plots showing: a) maximum temperature, b) minimum temperature, c) precipitation and d) Humidity for Niger State.

7.10.2 Crop Yield

The regression model for ***Millet*** showed a low positive correlation and definite, but small, relationship existed. This is shown by the regression model y = 1.5784x – 2918.6 (R^2 = 9%), with the gradient identified as important (p = 0.08; Figure 7.23a). However, there was a moderate negative correlation and substantial relationship when ***Guinea corn*** was assessed. The regression equation (y = -1.8537x + 4462.6) had a coefficient of determination (R^2 = 40%), but importantly, Guinea corn suffered statistically significant reductions in yield, evidenced by gradient significance $p<0.01$ (Figure 7.23b). Similarly, ***Groundnut*** showed a very high negative correlation and dependable relationship, that indicated a temporal decrease in crop yield. The regression model y = -3.6327x + 7754.6 and (R^2 = 73%) also had a significant downward gradient given by $p<0.01$ (Figure 7.23c). Conversely, ***Beans*** showed an increase in temporal yield evidenced by a high positive correlation and marked relationship indicative of an increase in production. The regression equation y = 0.7948x – 1326 and (R^2 = 47%) showed a statistically significant rise in production ($p<0.01$; Figure 7.23d).

Yam production also had significantly increased yields at the 99% confidence level, demonstrated by gradient analysis ($p<0.01$; Figure 7.23e). Here, a moderate correlation and substantial relationship exists, as shown by the regression model y = 15.622x - 27435 (R^2 = 20%), that was once again indicative of an increase in crop yield. When consideration was given to ***Maize*** production, a low positive correlation and a definite, but small, relationship existed, indicative of slight increasing crop yield through time. The regression model y = 0.0446x + 335.52 explained none of the data variation ($R^2 < 0.01$) nor gradient significance (p = 0.83; Figure 7.23f). A high positive correlation and very dependable relationship existed when ***Cassava*** was assessed. This was given with the regression equation y = 4.6835x - 89731 and a coefficient of determination that explained 70% of data variation ($p<0.05$; Figure 7.23g). By contrast, ***Rice*** yield showed a negative correlation and almost negligible temporal relationship, given by the regression equation y= -0.1732x + 804.55. Consequently, the coefficient of determination explained none of the data variation (p = 0.60; Figure 7.23h). ***Melon*** yields show a slight positive correlation and almost negligible relationship with the regression model y = 1.014x – 1804.7 (R^2 = 10%) of the data variation (p = 0.08; Figure 7.23).



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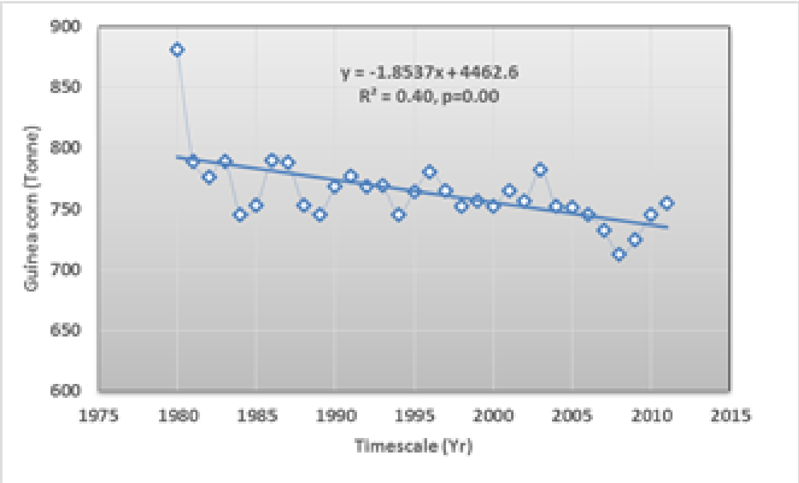

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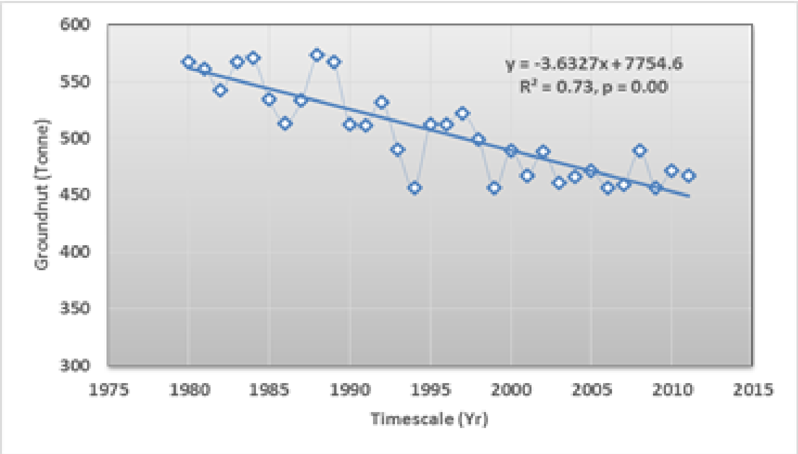
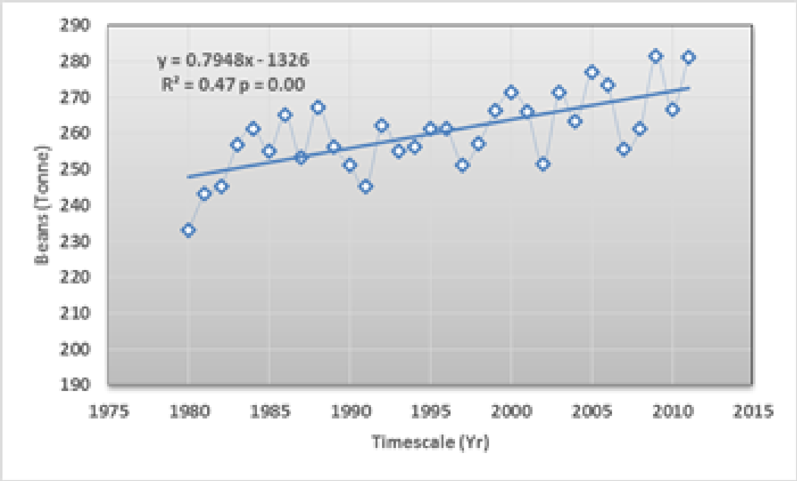
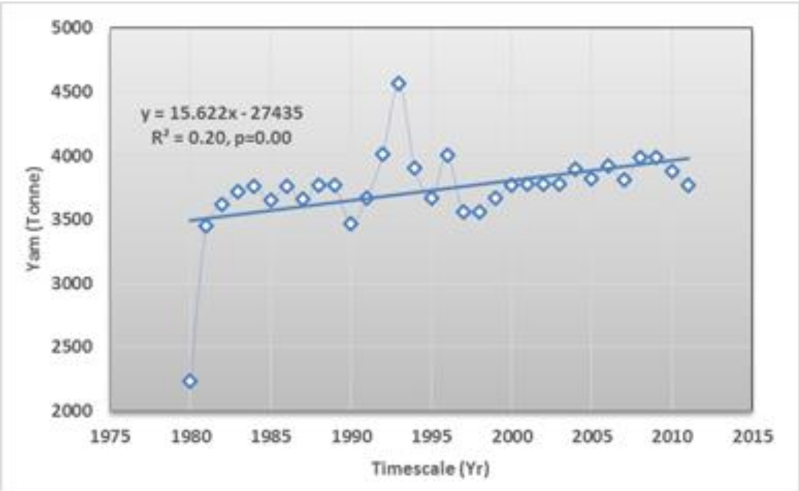


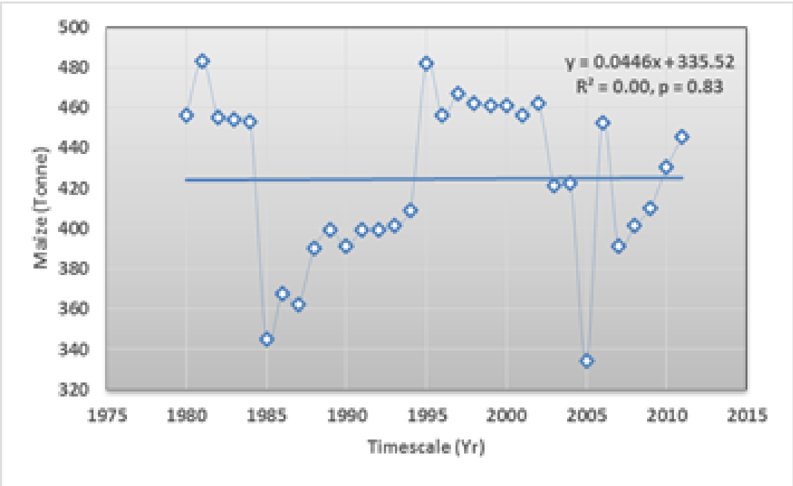
c)


y = 0.7948x - 1326
R² = 0.47 p = 0.00
Beans (Tonne)
Timescale (Yr)

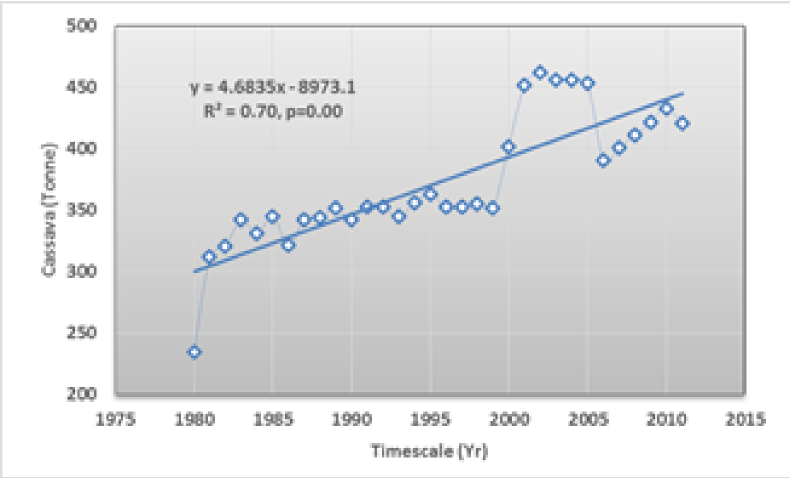
d)


y = 15.622x - 27435
R² = 0.20, p=0.00
Yam (Tonne)
Timescale (Yr)

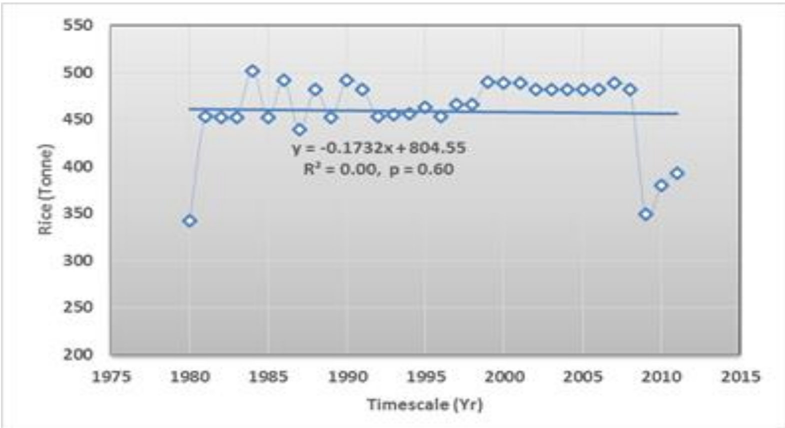
e)


y = 0.0446x + 335.52
R² = 0.00, p = 0.83
Maize (Tonne)
Timescale (Yr)

f)



g)



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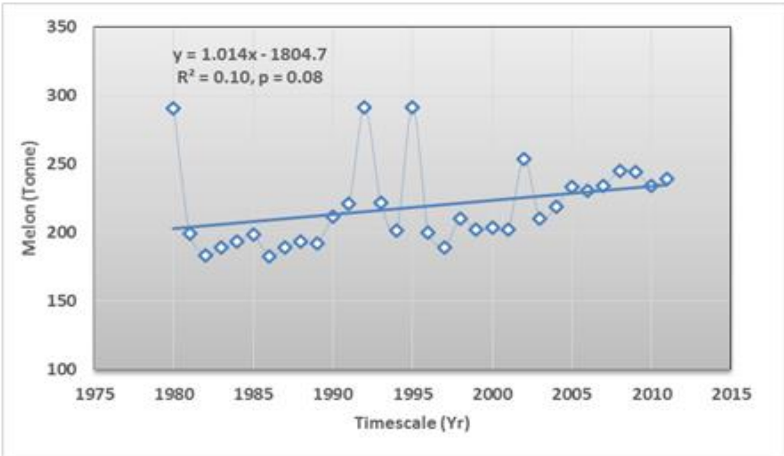
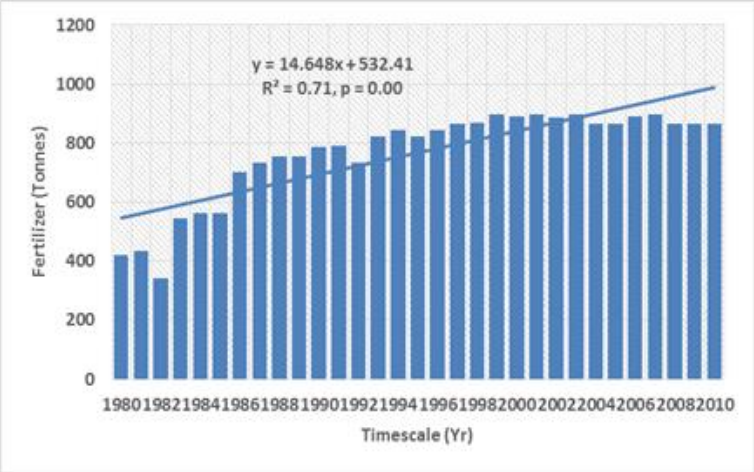


i)

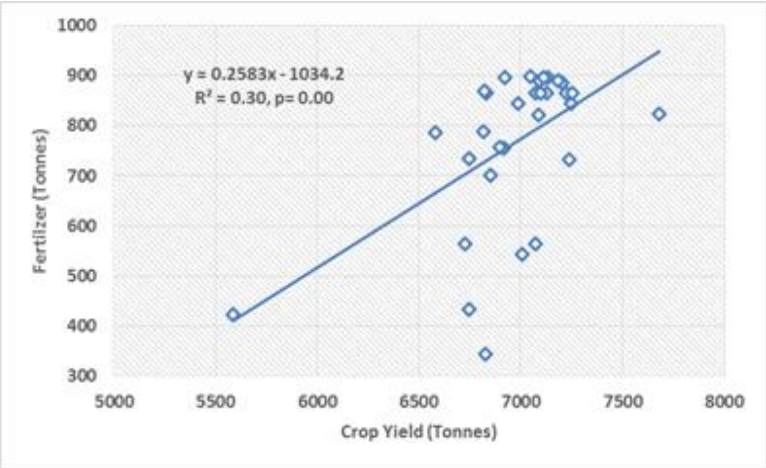
Figure 7.23: Scatter plots showing Temporal crop yield for: a) Millet, b) Guinea corn, c) Groundnut, d) Beans, e) Yam, f) Maize, g) Cassava, h) Rice, and i) Melon for Niger State.

7.10.3 Fertilizer

The regression model constructed around the temporal dataset for fertilizer indicated a very strong positive correlation and a very dependable relationship existed. The regression equation y = 14.648x + 532.41, R^2 value of 71% and the results was statistically significant at 99% confidence (p<0.01; Figure 7.24a). A moderate positive correlation and substantial relationship existed, when fertilizer was compared with overall crop yield. The regression model (y = 3.4238x+318.03), R^2 value explained 30% of data variation (p <0.01, Figure 7.24b).



a)



b)

Figure 7.24: Temporal trend of: a) Fertilizer used and b) a comparison of overall crop yield and fertilizer use for the period 1980-2011.

7.10.4 Evaluating implications

There was slight increasing temporal trend in ***Millet*** production (Figure 7.23a), and this corresponded to a statistically significant increase in maximum average temperature (p= 0.09; Figure 7.22a) and precipitation (p = 0.40; Figure 7.22c) during the assessment period. Alabi *et al.*, (2014) showed that ***Millet*** germination, development and maturity stages were improved by increasing temperature and increasing precipitation. Table 7.8 produced from the temporal crop yield, fertilizer use and environmental forcing data. Maximum temperature alongside precipitation positively influence ***Millet*** yield with r = 0.13 and 0.04, respectively. While, minimum temperature and humidity shows a negative correlation of r= -0.07 and -0.04, respectively. Fertilizer use was also negatively correlated (r = -0.01). Similarly, there was a negative correlation indicative of a significant decrease in ***Guinea corn*** production (Figure 7.23b). Table 7.8 results also highlight, statistically insignificant, negative correlations between crop yield and environmental forcing agents with (r) values ranging between r= -0.15 and -0.40. Once again, fertilizer use showed a statistically significant negative correlation (r = -0.56). This signifies that the decline in ***Guinea corn*** production is attributed to climatic factors and fertilizer use had no influence on production rates.

The statistical analysis of ***Groundnut*** showed a negative correlation, and indicative of decreasing crop yield (Figure 7.23c). Table 7.9 results highlight statistically significant, negative correlation between crop yield and all remaining environmental forcing agents, with (r) values ranging between r = -0.36 and -0.51. Similarly, fertilizer use showed a statistically significant and negative correlation (r = -0.77). The assessment of ***Beans*** yield showed a positive correlation indicative of increasing crop yield (Figure 7.23d). Table 7.9 results shows that all environmental forcing agents were positively correlated with crop yield (r) values ranging between r= 0.15 and r= 0.44. Fertilizer use also showed a positive correlation with crop yield (r = 0.61).

Table 7.9: Correlation matrix comparing the stable crop yield and environmental forcing agents. Note; *bold italic* statistical significance at 99% confidence ($p<0.01$) and **bold** 95% confidence ($p<0.05$)

	Max Temp	Min Temp	Precipitation	Humidity	Fertilizer
Millet	0.13	-0.07	0.04	-0.04	-0.01
Guinea corn	-0.15	***-0.40***	**-0.32**	-0.28	***-0.56***
Groundnut	**-0.36**	**-0.38**	***-0.49***	***-0.51***	***-0.77***
Beans	0.17	0.27	0.15	***0.44***	***0.61***
Yam	0.05	0.29	0.13	**0.36**	***0.51***
Maize	-0.05	**-0.32**	0.09	-0.07	-0.10
Cassava	0.08	0.24	0.19	0.22	***0.71***
Rice	-0.17	-0.25	0.08	-0.43	0.29
Melon	0.04	0.12	0.21	0.34	0.14

When ***Yam*** yield was assessed (Figure 7.23e), a postive correlation indicative of a temporal change in environmental forcing agent was assessed, results also showed positive correlation indicative of increasing trends. Fertilizer use increased during the period of assessment ($p<0.01$; Figure 7.24a). These results concur with the results of

Table 7.9, where crop yield was positively correlated with all environmental forcing agent and the results ranged between r = 0.05 and 0.36. The assessment of ***Maize*** showed a slight positive correlation indicative of a marginal temporal crop yield increase (Figure 7.23f).

Table 7.9 results show that minimum temperature extremes and precipitation were negatively correlated r = -0.05 and -0.32. However, precipitation was positively correlated (r = 0.09). Fertilizer use was also negatively correlated with crop yield (r = -0.10).

When ***Cassava*** was assessed (Figure 7.23g), a strong positive correlation was identified, indicative of a temporal increase over time.

Table 7.9 results showed that all environmental forcing agents were positively correlated with ***Cassava*** production with (r) values ranging from r = 0.08 and 0.24, respectively. Fertilizer use also showed a positive correlation of (r = 0.71). In contract, ***Rice*** showed a negative correlation, indicative of decreasing crop yield trend (Figure 7.23h).

Table 7.9 result also show negative correlation with all environmental forcing agents and (r) values that ranging from r= -0.17 to r= -0.43. However, precipitation and fertilizer use showed positive correlations but, there was no increase in crop yield. This signifies that ***Rice*** requires improved climatic factors to support yield. There was also a positive correlation indicative of an increasing trends, when ***Melon*** yield was assessed (Figure 7.23i) and, once again,

Table 7.9 results concur. There were positive correlations with all environmental forcing agents, albeit with varying statistical significance, and (r) values that ranged between r= 0.04 and r= 0.34. Similarly, fertilizer showed a statistical significant and positive correlation (r = 0.14).

7.11 Environmental forcing

Temporal resolution of data enabled analysis of both environmental change and crop outputs to be exposed. Lack of data related to fertilizer used on each crop type, the geographical location of crop planting within each agro-ecological zone, and within those States with multiple zones, makes detailed analysis more difficult. However, these limitations notwithstanding, constructed regression models and correlation matrices did reveal distinct temporal variations in the assessed environmental forcing agents and crop yield. Consequential to this and with differing levels of statistical significance, variations in crop yield were related to environmental forcing, alongside interesting variations between fertiliser used and crop yield.

The R^2 values and p-values derived from the environmental forcing data were tabulated and displayed in Appendix B. Results showed that ***Maximum Average Temperature*** between 1971 and 2011 rose in all assessed states and agro-ecological zones. The central (orientated from south towards north) States of Edo, Kwara and Benue all showed statistically strong positive correlation with R^2 values that ranged between 30% and 40% ($p < 0.01$) and while, variable agro-ecological zones are present, all contained derived savannah (Section 6.2; section 6.1). Positive correlation and statistical significance (at 95% confidence) was also shown in two further central states (Enugu and Kogi) with R^2 values of 12% and 10%, respectively. Once again, these States contained derived savannah. Even though the statistical results for the remaining states were insignificant with R^2 values that ranged between 3% and 11% ($p>0.05$), importantly, they also showed positive correlations.

Statistical analysis also showed that ***Minimum Average Temperature*** between 1970 and 2011 rose in all assessed States and agro-ecological zones. Statistically, the central northern State of Kwara classified under the derived and southern guinea savannah showed the strongest positive correlation (R^2 = 44%; Figure 7.22b). In addition to this, four other states showed a positive significant correlation at 99% confidence. Namely, Enugu State, Ogun State Edo State and Benue State classified as derived savannah and humid forest, the R^2 values ranged from 20-33% respectively. Kogi State minimum average temperature varied showing the weakest correlation of all assessed States (R^2 = 2%). Analysis also showed that ***Precipitation*** increased between 1970 and 2011 in all assessed States and agro-ecological zones. Statistically, Kano State showed the highest temporal correlation with an R^2 value that explained 50% of data variation (Figure 7.4c). The remaining zones displayed lower positive correlation and R^2 values ranging from 0% and 12%. The derived Savannah and Humid Forest in Enugu State, displayed almost no statistical correlation. Results show that Kano State within Sudan savannah and Northern Guinea Savannah ecological zones shows the strongest statistical correlation.

A similar scenario existed when ***Humidity*** was assessed with all states displaying a positive correlation indicative of increasing temporal trends. Statistically, Kwara State displayed the strongest correlation (Figure 7.13d). With less statistical significance, the remaining States exhibited R^2 values ranging between 0-24% respectively. The derived savannah of Kogi State showed the weakest correlation with the R^2 values explaining none of the data variation, as a result crop yield will be influenced across the State and agro-ecological zone.

7.12 Crop Yield

The R^2 values and p-values derived from the crop yield data were tabulated and displayed in Appendix C. There were 10 major crop types assessed (Chapter 6) within the eight identified States and agro-ecological zones given in Chapter 6, Table 6.1. The temporal dataset extended from 1980-2010 and statistical analysis showed varying results throughout.

Beans were produced in seven States. Geographically, Kogi State classified as derived savannah had the strongest positive correlation, indicative of an increasing crop yield trend and an R^2 value explaining 61% of data variation (Figure 7.17g). Niger State also showed strong positive correlation (R^2 = 47%) and with less statistical significance. Edo, Kano and Enugu States were also positively correlated with R^2 ranging from 0-14%. Kwara and Benue States displayed decreasing crop yield trends, highlighted by negative correlation (R^2 = 0.01 and 29%, respectively). This implies that Kogi State (derived savannah) and to a lesser extent Niger (northern and southern Guinea savannah) are most suitable for the cultivation of Beans under current environmental conditions.

Yam was also cultivated in seven States and similar to previous results, Kogi State exhibited the highest positive correlation indicative of increasing crop yield trends and an R^2 value explaining 36% of data variation (Figure 7.17h). Niger State also displayed statistically high ($p < 0.01$) positive correlation (R^2 = 20%) and with less statistical significance, Enugu and Benue States were also positively correlated (R^2 = 4% and 6%, respectively (Table 7.1 and Figure 7.20f).
Similarly, Ogun State and Edo State, which are classified as derived savannah, also exhibited positive correlations but the R^2 values explained none of the data variation. Kwara State was negatively correlated indicative of a decreasing crop yield trend (R^2 = 5%). These are similar to previous results, which suggest that Kogi (derived savannah) and to a lesser extent Niger States (northern and southern Guinea savannah) are most suitable for the cultivation of Yam under current environmental conditions.

Rice was cultivated in all eight States and statistically, both Kwara and Kogi States exhibited the strongest positive correlation, indicative of increasing crop yield trends (R^2 = 71% and 68%, respectively, Figure 7.14a and Figure 7.17b). Enugu State also showed positive correlation, albeit with less statistical significance (R^2 =10%). Kano and Ogun States showed high negative correlation indicative of decreasing crop yield trends (R^2 = 53% and 71%, respectively). Niger, Edo and Benue States were also negatively correlated, albeit with statistically insignificant results and the R^2 values ranging from 0-9%. Results suggest that both Kwara State and Kogi State (derived savannah and southern Guinea savannah) are most suitable and Kano and Ogun States (derived savannah and Humid Forest and Sudan savannah and Northern Guinea savannah, respectively) are the least favourable to produce ***Rice***.

Melon was cultivated in four States and statistically all showed positive correlation indicative of increasing crop yield trends. Edo State showed the highest correlation with an R^2 value explained 70% of the data variation (Figure 7.11b). The remaining States of Ogun, Enugu and Niger States exhibited less statistical significance and R^2 values ranging from 10-21%. Results suggests that Edo State (Derived savannah and Humid Forest) is suitable for the cultivation of Melon. ***Cocoyam*** was cultivated in three States and similar to previous States, Edo State exhibited the strongest positive correlation and an R^2 value explaining 89% of data variation (Figure 7.11a). Enugu State also showed a positive correlation, with less statistical significance (R^2 = 10%), both results indicative of increasing crop yield trends. In contrast, Ogun State exhibited negative correlation, indicative of a decrease in yield but with no statistical significance (R^2 = 0%). Similar to previous findings, results suggest that Edo State (Derived savannah and Humid Forest) is most suitable for the cultivation of **Cocoyam**.

Groundnut was cultivated in seven States and statistically, Kano State showed the highest positive correlation and an R^2 value explaining 77% of data variation (Figure 7.5b). In addition to this, Enugu and Edo States showed high positive correlation (R^2 = 50% and 70%, respectively, Figure 7.2a and Figure 7.11c). With less statistical significance derived savannah States, Kogi and Benue also exhibited positive correlation, with both R^2 values explaining 19% of data variation and all results indicative of an increasing trend. Niger State exhibited strong negative correlation, indicative of a decreasing trend (R^2 = 71%) and similarly, but with less statistical significance Kwara State was also negatively correlated (R^2 = 8%). Results suggest that Kano State (Sudan savannah and Northern Guinea savannah) is most suitable for the cultivation of Groundnut and based on these results Niger State is the least suitable.

Maize was cultivated in all States and statistically Enugu State showed the strongest positive correlation, and an R^2 value explaining 40% of data variation (Figure 7.2b). Kogi State also showed high positive correlation (R^2 = 36%). In addition to this, Edo and Ogun States were also positively correlated (R^2 = 2% and 10%, respectively). Kwara and Kano States exhibited the highest negative correlation (R^2 = 66% and 58%, respectively, Figure 7.14b and Figure 7.5e). With almost no statistical significance, Benue and Niger States were also negatively correlated (R^2 = 7% and 0%, respectively, Figure 7.20g and Figure 7.23f). Results suggest that Enugu and Kogi States (derived savannah and Humid Forest), are most suitable for the cultivation of ***Maize*** and based on these results. Kwara and Kano States is the least suitable. This, however, implies that the States are unsuitable for maize production, as they have lower crop output.

Cassava is cultivated in seven States and statistically, Kogi State showed the highest positive correlation, indicative of an increasing trend and an R^2 value explaining 92% of data variation (Figure 7.17a).

Niger State also exhibited a high positive correlation (R^2 = 70%) and, with less statistical significance, Enugu, Edo and Benue States were also positively correlated, with R^2 values ranging from 2-30%. Kwara State and Ogun State were negatively correlated (R^2 = 0-29%, respectively). Results suggests that Kogi State and Niger State (Derived savannah and Northern and southern Guinea savannah) are both suitable for the cultivation of Cassava.

Millet is cultivated in five States and statistically, Kano State showed the highest positive significant correlation, indicative of an increasing crop yield trend and an R^2 value explaining 53% of data variation (Figure 7.5a). Kogi State showed high positive correlation (R^2 = 32%) and with less statistical significance, Kwara and Niger States were also positively correlated with (R^2 = 9% and 13%, respectively). Benue State exhibited high negative correlation indicative of a decreasing crop yield trend (R^2 = 50%). Results suggest that Kano and Kogi States (Sudan savannah and Northern Guinea savannah and Derived savannah) are both suitable for the cultivation of ***Millet*** and based on these results Niger State is the least suitable.

Guinea corn is cultivated in five States and statistically, Kano State showed the highest positive significant correlation indicative of increasing crop yield trends and an R^2 value explaining 77% of data variation (Figure 7.5c). Edo and Enugu States also exhibited strong significant positive correlations (R^2 = 40% and 67%, respectively) and with less statistical significance Kwara State also exhibited positively correlated with guinea corn (R^2 = 8%). Niger State is classified under the Northern and southern Guinea savannah and showed a strong negative correlation indicative of a decreasing crop yield (R^2 = 40%). Once again, results suggest that Kano State (Sudan savannah and Northern Guinea savannah) is suitable for the cultivation of ***Millet*** whereas Niger State is unsuitable due to climate change related issues such as drought and desertification.

In Enugu State, both Groundnut and ***Maize*** were positively correlated with minimum average temperature and humidity. ***Beans*** were only positively correlated with humidity. In addition, **Cocoyam** was positively correlated with precipitation only. In Kano State, ***Millet*** yield showed high positive correlated with precipitation and humidity. ***Groundnut*** yield was positively correlated with precipitation. Beans were negatively correlated with precipitation and humidity. ***Guinea corn*** was negatively correlated with maximum and minimum average temperature. ***Maize*** was negatively correlated with maximum temperature, precipitation, and humidity. ***Rice*** was negatively correlated with all environmental forcing agents in Kano State.

In Ogun State, ***Yam*** alone was positively correlated with maximum average temperature. ***Rice*** yield was highly negatively correlated to all environmental forcing agent in the State. In addition, ***Cassava*** was negatively correlated to minimum average temperature. In Edo State, Cassava, Cocoyam and Melon were all positively correlated with all environmental forcing agents. Groundnut was highly correlated with minimum temperature, but negatively correlated with humidity. Beans were negatively correlated with maximum average temperature, but was positively correlated with other environmental forcing agents. ***Rice*** was negatively correlated with all environmental forcing agents. Furthermore, Yam was positively correlated to only minimum average temperature. ***Maize*** was negatively correlated with maximum average temperature and precipitation, but was positively correlated with minimum average temperature and humidity.

In Kwara State, ***Rice*** was positively correlated with all environmental forcing agents. While, ***Maize*** and ***Cassava*** were both negatively correlated with all environmental forcing agents. ***Groundnut*** was positively correlated with maximum average temperature and humidity, and was negatively correlated with minimum average temperature and precipitation. ***Guinea corn*** was positively correlated with all environmental forcing agents. ***Yam*** and ***Bean*** were both negatively correlated with all environmental forcing agents. While ***Millet*** was negatively correlated with humidity, but was positively correlated with maximum average temperature, minimum average temperature and precipitation. In Kogi State, ***Millet*** and ***Maize*** were negatively correlated with maximum average temperatures. All other crops, namely, ***Cassava***, ***Rice***, ***Groundnut***, ***Guinea corn***, ***Bean*** and ***Yam*** were positively correlated with all other environment forcing agents.

In Benue State, ***Millet*** was negatively correlated with all environmental forcing agents. ***Guinea corn*** and ***Groundnut*** were both positively correlated with all environmental agents. ***Rice*** was negatively correlated with minimum average temperature, precipitation and humidity, but was positively correlated with maximum average temperature. ***Cassava*** and ***Yam*** were both positively correlated with all environmental forcing agent except for humidity. ***Maize*** was only positively correlated with humidity, while ***Beans*** was only positively correlated with precipitation. In Niger State, ***Millet*** was positively correlated with maximum average temperature but negatively correlated with other environmental forcing agents. ***Guinea corn*** and ***Groundnut*** was negatively correlated with all environmental forcing agents. ***Beans*** and ***Yam*** were both positively correlated with all environmental forcing agents. ***Maize*** was positively correlated with precipitation. ***Cassava*** and ***Melon*** were both positively correlated with all environmental forcing agents. Finally, ***Rice*** was positively correlated with only precipitation.

The analysis for fertilizer use with overall crop yield in six States increased and statistically, Kogi State showed the highest positive correlation with fertilizer use and overall crop yield with R^2 value explaining 73% of data variation (Figure 7.18b). This was followed by Niger State with a positive significant correlation of (R^2 =30%) of the data variation (Figure 7.24b). Other States, namely Ogun State, Benue State, Kano State and Edo State, showed a slight positive significant correlation with fertilizer use and overall crop yield, with R^2 ranging from 10-19%. Kwara State showed a high negative correlation with fertilizer use and overall crop yield with R^2 value explaining 33% of data variation (Figure 7.15b). As well as Enugu State, which exhibited a slight negative correlation of R^2 value of none.

7.13 Summary

The main objectives of Chapter 7 were to analyse crop yield and environmental forcing trends applied to eight Nigerian States, satisfying two of the main aims of this research project as detailed in Chapter 1 (Section 1.3). Consequently, Chapter 8 assesses the responses to questionnaires aimed at the farming community and their perception of climate change in Nigeria. This draws an end to this chapter, environmental forcing agents influenced crop yield in each State assessed. As a result, the next chapter analyses farmers' perception concerning climate change.

Chapter 8: Farmers perception of climate change

8.1 Introduction

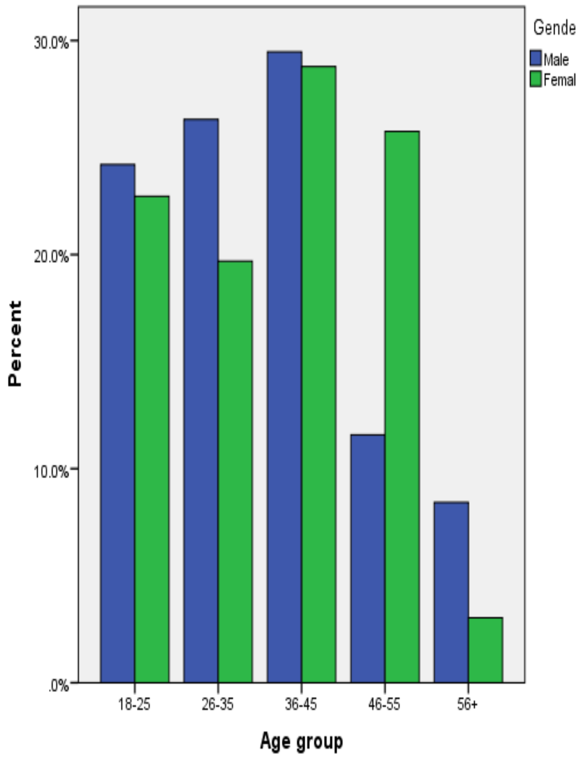
Chapter 7 presented the analysis of temporal environmental forcing mainly temperature, precipitation and humidity compared with temporal crop yields. All related to the eight identified agricultural States responsible for the greatest staple food production (Section 6.4), with varying agro-ecological characteristics (Section 6.1). This chapter will focus upon the questionnaire results designed to extrapolate knowledge, concerns, awareness and perception of climate change and other related environment issues among Nigerian farmers. Similar questionnaire approaches are used by other researchers as a way of identifying and proposing mitigation and adaptation policies to climate change (Whitmarsh, 2005). Results will provide vital information detailing how farmers have been coping, mitigating and independently adapting to climate change (Egbe, 2014).

8.2 Socio-demographic characteristics (Q1)

Fifty-eight percent of the respondents were female, and most questionnaire responses were received from age groups ranging between 36 and 45 (Figure 8.1a). However, there were a higher proportion of males when compared to females within this age group. The sample size of the farmers was 227. While the total number of questionnaires distributed was 300, only 227 of the farmers responded. Of those that complted the questions, forty-five percent of respondents had no formal education and just 23% attended high school. Of those educated, 21% gained a first degree and 11% a master's degree (Figure 8.1b). The results concur with Whitmarsh, (2005) who also showed that education played a vital role, raising awareness, concerns and perception to climate change and other related environmental issues. Whitmarsh, (2005) also suggested that those with structured education tend to be more informed, concerned and aware of climate change and other environmental issues when compared to those with no or less formal education.

In terms of employment status, 38% of respondents were employed by either Government or an organisation, 48% were self-employed, and the remainder were classed as unemployed (Figure 8.1c). It is important to consider employment status as it provides knowledge of climate change and other environmental related issues. In recent times, most industries and companies are now raising awareness of such challenges as cutting carbon emissions, reducing waste, pollution and environmental conservation (Aderinwale & Amosun, 2012).

Thirty-nine percent had been employed for <5 years, 19% between 6-10 years, and 28% between 11-15 years. Unsurprisingly, those that had been employed 16-20 years and over significantly reduced (9% and 4% respectively; Figure 8.1d). When asked how far they travelled to work, most either travelled <5km or between 6-10 km (28% and 21%, respectively) or between 11-15 km (25%). The percentage of those travelling greater distances to 14% between 16 and 20 km and 12% travelled distanced greater than 20 km (Figure 8.1e). Ownership of land is important in order to know who controls the land management and licencing of planting. When tenure status was examined, 37% were owner operators, 42% were tenants and 18% were hired labour. Three percent of respondent answered ‘other’ but it is unclear what type of tenure agreement was in place (Figure 8.1f). Twenty-four percent were listed as having no dependents, 50% had between 1-3, 21% between 4-6 persons, and finally, 5% of respondents stated they had >7 dependents (Figure 8.1g).


Gende
Male
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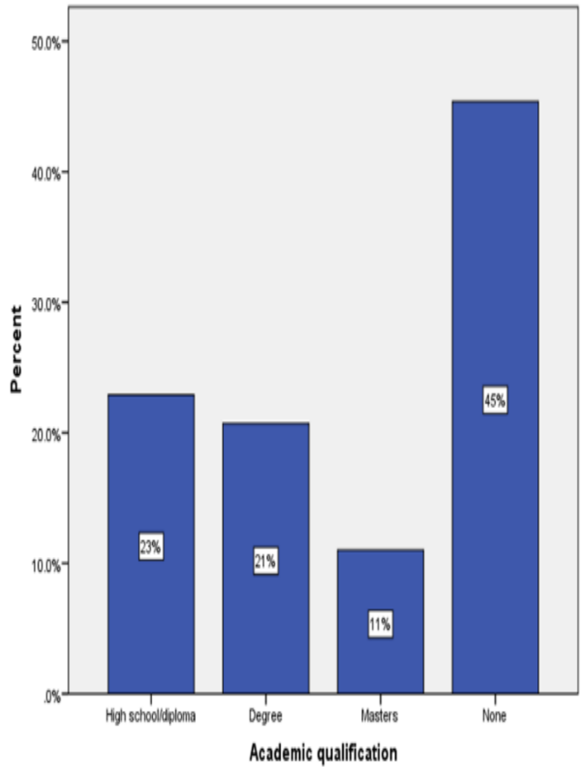
Age group

a)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Percent
23%
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Masters
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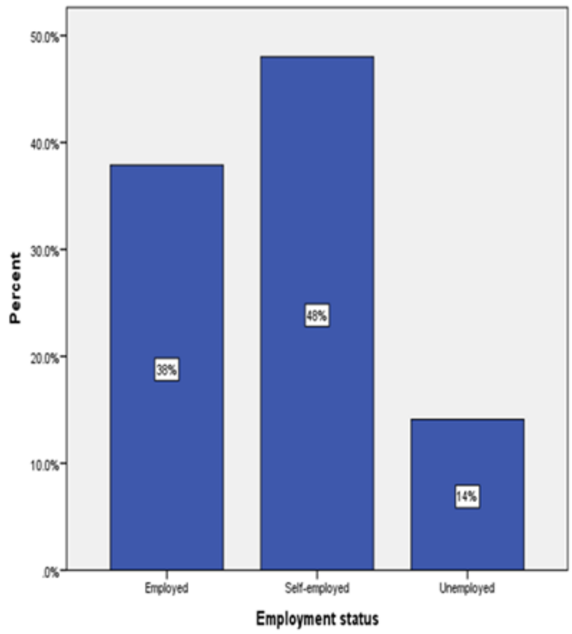
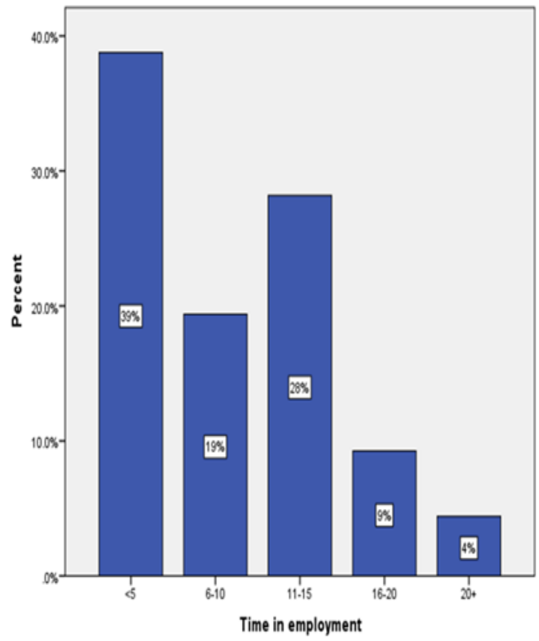
Academic qualification

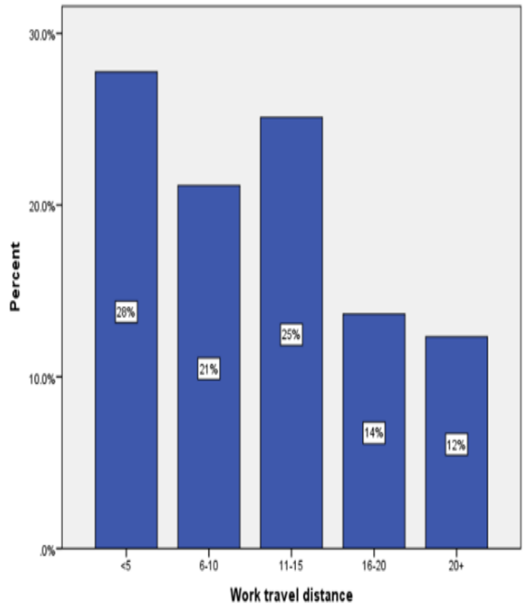
b)


50.0%
40.0%
30.0%
20.0%
10.0%
.0%
Percent
38%
48%
14%
Employed
Self-employed
Unemployed
Employment status

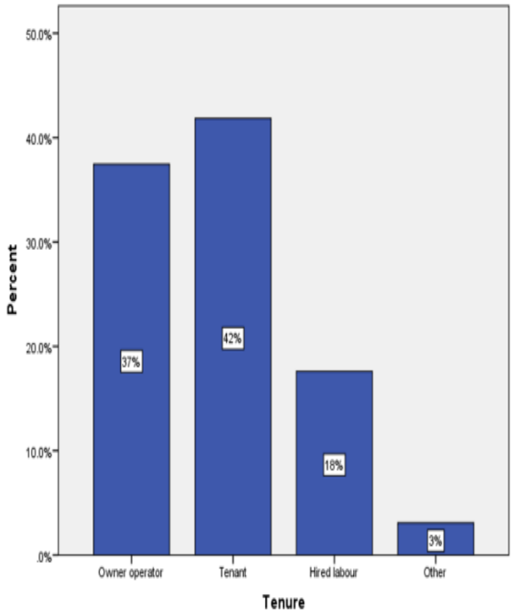
c)


40.0%
30.0%
20.0%
10.0%
.0%
Percent
39%
19%
28%
9%
4%
<5
6-10
11-15
16-20
20+
Time in employment

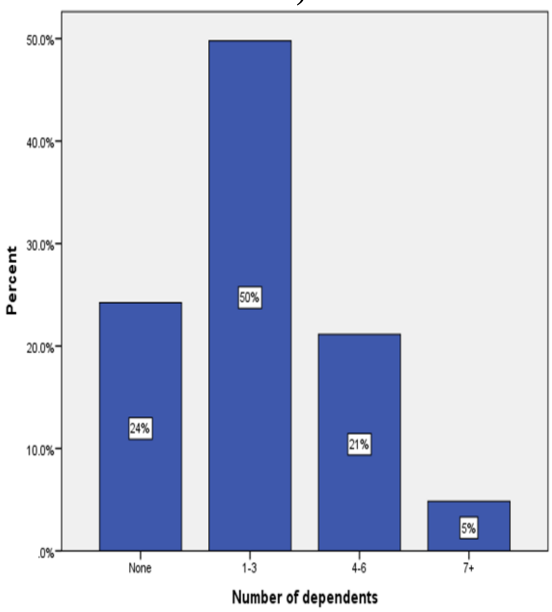
d)



e)



f)



g)

Figure 8.1 : a) Farmers age group, b) Farmers Academic qualifications, c) Employment Status, d) Time of Employment, e) Work Travel distance, f) Tenure and g) Number of Dependents.

8.3 Agricultural Programmes and Schemes

8.3.1 Membership of organisations (Q9)

Seventy-eight percent of farmers did not belong to any organisations. This contrasted with the findings of Gbetibouo (2009) who showed that in several parts of the world, farmers belong to one or more organisations. Q10, was aimed at understanding which organisation the farmers are members of. In Nigeria, Federal and State government oversee the management of farming organisations. This includes audits and recording of financial investments made by the agricultural sector (Schlenker & Lobell, 2010). Organisations also foster improvements in agricultural policy, monitoring and evaluate rural farming activity and development, examples of these groups are as follows: Organisations such as the Nigeria Investment Co-operative Agency (NICA), Nigerian Agricultural Insurance Corporation (NAIC), Fertilizer Producers and Suppliers' Association (FEPSAN), International Institute of Tropical Agriculture, Network of African Rural Women Associations (NARWA), Nigerian Association of Women in Agriculture and Development (NAWAD) and Nigeria Network of Non-Governmental Organisations (NNNGO) among others (Gbetibouo, 2009; Tenge *et al*., 2004).

Apata (2009) suggested that belonging to an organisation strengthened social, economic and environmental awareness, a strong community group can influence policy making among both farming communities and government organisations. According to Ishaya & Abaje (2008), there are several organisations providing agricultural funding in Nigeria, mostly in the form of grants and loans (Federal Government, State governments and the private sector or agri-businesses). The funds provide for the purchase, and supply of farm equipment, fertilizer, pesticides and insecticides, as well as improving agricultural productivity (Ishaya & Abaje, 2008).

8.4 Who is funding agricultural practises in your State? (Q11)

When asked about funding, the Federal Government funded 33% of respondents, while 39% were funded by the State government and 20% by the private sector. Nine percent answered, 'not applicable' suggesting that they received no official funding. The results show that the Nigerian agricultural industry is heavily subsidised. Q12, when asked about sources of income, it was found that most received income from multiple sources. However, 69% percent of respondents received income from agricultural sources. Many also relied on livestock (47%; Table 8.1). While it is unclear of the exact source, 25% of respondents received income from 'non-farm' activities. There were other non-agricultural sources, such as, business (20%), forestry products (17%) and charity (8%; Table 8.1). Results highlight that agriculture is a major source of income among Nigerian farmers.

Table 8.1: Farmers' source of income

Source of Income	Yes	No
Agriculture	69%	31%
Livestock	47%	53%
Forestry products	17%	83%
Non-farm income	25%	75%
Charity	8%	92%
Business	20%	80%

Number of respondents = 227

8.5 What do you think of climate change? (Q13)

The question was subjective, thereby allowing the respondents to express their own views. The majority agreed that globally climate and weather pattern are changing rapidly. Furthermore, most believed that climate change results from human-induced factors. For example, the increasing use and burning of fossil fuel, deforestation, intensive agricultural activities, habitat fragmentation, coupled with the rapid increasing in human population, and a higher demand for natural resources. Others commented that natural occurring processes, such as changing weather patterns, cause climate change.

These comments concur with this research, where it has been shown that higher temperature, rainfall patterns and humidity has increased in almost all the assessed States in Chapter 7. In light of the previous findings, it is unsurprising that the majority of Nigerian farmers understood both the cause and effect of climate change, and the consequential agricultural productivity impacts. This concurs with a study by Nzeadibe *et al*. (2011), who showed that most Nigerian farmers are aware of climate change, particularly those employed in the farming industry for an extended period.

Understanding farmer's concerns and knowledge of climate change is important when Federal and State government incorporate adaptation and mitigation measures to common agricultural policies. Because they will understand the need for changes in practices in other to improve crop and agricultural production across the country.

8.5.1 How did you hear about climate change? (Q14)

This required the respondents to detail the sources from which information regarding climate change and other environmentally-related issues were acquired. The question contained a list of six possible sources and respondents were allowed to make multiple choices.

Mass media is a very powerful tool when it comes to relaying information regarding climate change and other associated environmental issue, such as natural disasters, disease outbreaks, weather forecasts/patterns, and changes in agriculture, both on global and local scales. Results showed that (70%; Q14.1) of respondents had been informed through the mass media (Newspapers, television, radio, internet, *inter alia*). It was generally accepted that the media provided daily information, as well as influencing how respondents perceive the world. The results showed that ***Energy Suppliers*** played a minimal role in providing any detailed information regarding climate change issues, with just (10%; Q14.2) of those that responded had been given any information. The potential reason for this is that globally, the energy sector is a major contributor of carbon emissions through the use fossil fuels and their consequential climate change influence (Whitmarsh, 2005). In most developed countries, energy suppliers are involved in the reduction of climate change largely due to government legislation that restricts CO_2 emissions (Skutsch, 2002). The opposite is probably true in Nigeria.

In many parts of the world, environmental organisations such as Friends of the Earth, World Nature Organisation (WMO), and Global Environment Facility (GEF) *inter-alia* provide significant volumes of information, albeit via multi media outlets. Surprisingly, only (22%; Q14.3) had heard about climate change from ***Environmental Organisations*** (Table 8.2). This suggests that these organisations play a minor role in passing information of climate change in Nigeria. Furthermore, the result showed that the ***Government and Local Council*** played a minimal role in providing climate change information, with only (19%; Q14.4) of respondents admitting that they had received information. In other parts of the world, respective governments through legislation are responsible for the distribution of information with regards to climate change and environmental issues. Surprisingly, ***Family and Friends*** informed (89%; Q14.5) of respondents (Table 8.2).

Table 8.2: Sources of information

Question	Yes	No
Mass Media	70%	30%
Energy suppliers	10%	80%
Environment Organisations	22%	78%
Government	19%	81%
Family and Friends	89%	11%

Number of respondents = 227

8.5.2 How much do you trust your sources of information? (Q15)

Sixty-four percent of farmers trusted the information that they received from mass media ‘A lot’, meaning that majority of the respondents trusted the media (column 2, Table 8.3) and this concurs with Question 14. Unsurprisingly, 46% trusted family and friends, but question 14 highlighted that only 11% of respondents received information in this way. Environment organisations (36%), Energy Suppliers (34%), and Government (50%) information was trusted ‘A Little’ (Column 3, Table 8.3). However, Question 14 showed that there were relatively few details of information given by these organisations, with the range of respondent’s answers between 10-22%. These results suggest that the majority of the Nigerian farmers trusted the information which they derived from the mass media.

Table 8.3: Opinions of trust for certain organisations (Q15)

	A lot	A little	Not at all	Nil
Mass Media	64%	26%	7%	4%
Energy suppliers	34%	41%	17%	8%
Environment Organisations	36%	44%	13%	8%
Government	24%	50%	17%	9%
Family and Friends	46%	36%	8%	8%

Number of respondents = 227

8.5.3 Did you think climate change is affecting Nigeria? (Q16)

The majority of respondents (56%) thought that the Nigerian climate had already been affected, 26% were of the opinion that there had been no effects and 18% were not sure. This concurs with the findings of Mings (2008), who suggested that many farmers are now aware that climate change is affecting Nigeria. Chapter 7 results concur with these findings by showing that Minimum and Maximum temperature extremes, precipitation and humidity has increased in many Nigerian States.

8.6 How Farmers perceive climate change? (Q17)

The questionnaire provided a blank space for farmers to make a personal comment regarding their concerns, awareness, and perceived idea about climate change. The responses showed that most Nigerian farmers were fully aware of climate change and its impacts, complaining that they were little or nothing they could do to address the issues, due to high cost. Supporting this, Moghariya & Smardon (2011), argued that, globally, farmers are aware of the changing weather, and that climate shifts have adverse impacts on crop productivity. Section 2.2 detailed global approaches to addressing climate change issues, suggesting that most involve mitigation and adaptation (Skutsch, 2002; Zemankovics, 2012).

In Nigeria, indigenous knowledge has been the key concept used for climate change adaptation (Mertz *et al*., 2009). In some agricultural States (Table 6.1), farmers have adjusted techniques in an attempt to address climate change issues. This includes, crop diversification (Speranza, 2010). However, most Nigerian farmers face limited resources to mitigate and adapt to climate change. Government intervention is inevitability required (Pettengell, 2010; Ogalleh *et al*., 2012). Improved ways of mitigation and adaptation should be encouraged in Nigeria, particularly involving changes to farming practices and farming techniques.

8.7 Causes of Climate change (Q18)

When the farmers were asked what the causes of climate was, 41% of respondents believed it to be caused by anthropogenic processes, while, 19% believed that these changes could be attributed to natural factors. Twenty-nine percent believed both factors contributed, and 10% of respondents did not know the reasons behind induced changes. There is evidence that climate change is occurring in many parts of the world (Sun *et al*., 2012). Naturally occurring climate change have been attributed to absorbed heat such as infrared radiation, which the earth emits which is causing an increase in atmospheric concentration (Section 2.3). While anthropogenic factors or human-induced factors have been mainly attributed to the increasing burning of fossil fuel, deforestation and the rapid increase in human population coupled with the higher demand of natural resources (Smit & Skinner, 2002).

8.7.1 Responsibilities for tackling climate change (Q 19)

Question 19 required the respondents to detail 'who should be responsible for tackling the issues of climate change' the question contained a list of five possible sources and respondents were advised to provide yes/no answers.

Fifty-three percent suggested that ***International Groups*** such as, the United Nations, and International Panel on Climate Change should respond. However, this is a misconception, as these Intergovernmental Organisations review and assess scientific, technical, and socio-economic information produced worldwide and relevant to the understanding of climate change. They do advise respective governments, but are not responsible for the implementation of any environmental legislation. Some 37% of respondents thought that ***Environmental Organisations*** (e.g. Friends of the Earth) should be responsible for tackling climate change, 33% thought the **Government** should oversee climate change management.

Only 15% thought that **Local Business and Industry** should tackle climate change. Finally, 89% answered yes that it should be **Individuals** who should shoulder the responsibility of tackling climate change. Individuals play a key role in changing attitudes, and this will clearly aid in mitigating and adapting to climate change (Adeoti & Ajibola, 2008; Atilola, 2010). In many parts of the developed world, legislative powers govern climate change. This is particularly true in the EU Countries such as the United Kingdom. Here, reductions in greenhouse gas emissions using a sliding temporal scale have been implemented (Bowen & Rydge, 2011).

8.7.2 How concerned are you about the following environmental factors (Q20).

This section explored what mitigation and adaptation approaches can be adopted to tackle climate change in Nigerian (Table 8.4). When the farmers were asked if they ***'could do a bit to reduce climate change impacts'***, the majority of respondents (80%; Q20.1) either fully or partly agreed, stating that there is a need to do more in reducing the effects of climate change. While a fifth disagreed, the results showed that there was a willingness among Nigerian farmers to make changes. Furthermore, quite a number of the respondents (75%; Q20.2) either fully or partly agreed that ***'people should be encouraged to reduce climate energy consumption'***. Even though a quarter of respondents disagreed. The results highlight that most farmers realize the implications of the production and use of energy supplies, as well as a willingness to accept change and positively to reduce energy consumption.

The majority of the respondent, (Q20.3, 73%) either fully agreed or partly agreed ***'if climate change was inevitable'***, while how many of them fully disagreed and partly disagreed. The results suggest that most respondents believed that climate change was inevitable. Similarly, in Q20.4, most respondents either partly agreed or fully agreed to the statement, '***if climate change is a natural phenomenon'***. While few others either partly disagreed or fully disagreed. The result suggests that most respondents believed that climate change is a natural phenomenon. Likewise, most respondents (62%; Q20.5) also fully and partly agreed that '***climate change will improve Nigerian weather'***. Even though less than half the respondents fully or partly disagreed. This highlights that quite a number of respondents thought climate change will improve the Nigerian weather. Given that, a majority of the respondents (57%; Q20.6) were willing to '***act if everyone else does'***, while others were unwilling. This suggests most respondents were willing to participate in mitigating and adapting to the climate change which they are currently experiencing.

The majority of respondents (55%, Q20.7) believed that it '***was already too late to do anything about climate change***', while, the remainder either agreed or disagreed with the statement. This implies that quite a number of the respondents believed that it was too late to address climate change issues due to its adverse impact experienced in the country. This also suggests that the farmers thought that they had minimal role to play in tackling climate change, due to limited resources as well as increasing use of fossil fuel. Similarly, most farmers (63%; Q20.8) agreed that '***climate change is something frightening***'. However, others thought that climate change were less of a concern. In response to this, there have been numerous natural disasters caused by the effect of climate change, such as flooding, drought, and desertification, which have affected agricultural activities as well as threatened the livelihood of many farmers in Nigeria (Mertz *et al*., 2009). This experience will have undoubtedly influenced responses to this question. In contract, most respondents (62%; Q20.9) were ***'uncertain as to whether climate change is really happening***'? However, 38% either partly or fully disagreed. This implies that many farmers were unsure to the extent by which climate change have impacted the environment. This was quite surprising, as some of the respondents admitted that they have experienced the impact of climate change.

Most respondents (62%; Q20.10) agreed that '***developed countries are to be blamed for climate change***', while the remainder of disagreed. This suggests most farmers believed industrialization, and the high use of fossil fuels has adverse impacts on the environment. Following this, in Q20.11, 60% of farmers either partly or fully agreed that ***'big changes to society are needed to reduce climate change'***. However, a high minority of respondents either fully (20%) or partially (20%) disagreed with this statement, while the remaining respondents had no concern. The result highlights that most farmers believe changes are needed in other to tackle climate change in Nigeria. While in Q20.12, more than half of the respondents either partly or fully agreed to the question about the ***'evidence of climate change is unreliable***'. This accounted for 57% of respondents, while less than 50% disagreed. This implies that most farmers are unsure of the cause of climate change. In Q20.13, most respondents (57%) either fully or partly agreed that '***people are too selfish to do anything about climate change***'? Forty three percent of respondents either partly or fully disagreed. As a result, most respondents were unwilling to devote their time and resources to mitigate and adapt to climate change. Finally, in Q20.14, 81% of respondents both partly agreed and fully agreed that '***no action is needed***'. While just 13% and 6%, fully disagreed and partly disagreed, respectively.

Table 8.4: Opinions on weather, climate and environmental impacts (Q20)

	Question	Partly Agree	Fully Agree	Neither agree nor disagree	Fully Disagree	Partly Disagree
1	We can all do our bit to reduce climate change	43%	37%	-	10%	10%
2	People should be encouraged to reduce their energy consumption	30%	45%	-	10%	15%
3	Climate change is inevitable	25%	48%	-	10%	6%
4	Climate change is a natural phenomenon	23%	52%	-	15%	10%
5	Climate change will improve Nigeria's weather	27%	36%	-	20%	17%
6	I would only take action if everyone else does	22%	35%	-	30%	13%
7	It is already too late to do anything about climate change	24%	31%	-	25%	20%
8	Climate change is something which frightens me	28%	35%	-	17%	20%
9	I am uncertain as to whether climate change is really happening	30%	32%	-	18%	20%
10	Developed countries are to blame for climate change	26%	36%	-	20%	18%
11	Big changes to society are needed to reduce climate change	23%	37%	-	20%	20%
12	The evidence of climate change is unreliable	27%	30%	-	13%	30%
13	People are too selfish to do anything about climate change	27%	30%	-	13%	30%
14	No action is needed	33%	48%	-	13%	6%

Number of respondents = 227

8.7.3 Environmental issues (Q21)

The Likert scale was utilised (1 = very concerned down to 6 = Not at all concerned) to assess major environmental issues that affect Nigerian farmers and the results are displayed in Table 8.5.

Most respondents (81%; Q21.1) answered either 1 or 2, suggesting that there is considerable concern amongst Nigerian farmers with regard to ***increasing rainfall***. When asked about ***decreasing rainfall***, (71%; Q21.2) highlighted greater Likert scale distribution, with most answers ranged between 1 and 3. However, this disguises that fact that 17% of respondents show no concern. This implies that decreasing rainfall is impacting farming and agricultural activities. Furthermore, Q21.3 also showed a similar distribution, with the majority (71%) of answers between 1 and 3, suggesting that there is concern regarding ***increasing runoff***, but 17% also showed no concern. A similar distribution to previous was also observed with 80% (Q21.4), with most answers between 1 and 3, suggesting that there is concern with regard to increasing groundwater levels.

In Q21.5, most respondent results were more evenly distributed across the six possible answers. However, the results do suggest that there is a certain amount of concern about ***decreasing groundwater levels***. There was considerable concern when asked about increased ***drought***, with a significant majority (92%; Q21.6) of the responses between 1 and 2. While Q21.7 showed that there was almost equal concern about decreasing drought, with the majority (82%) of responses between 1 and 2. The result showed that most Nigerian farmers were more concerned about increasing ***rainfall*** and ***drought*** when compared to other environmental issues. The results are counter-intuitive; however, increasing precipitation may be attributed to short duration high intensity storm conditions followed by a period of very little rain that contributes to drought and this have altered farming activities in many agricultural States in Nigeria (Slegers, 2008).

Table 8.5: Concern about environmental factors (Q21)

		1 Very concerned	2 Slightly concerned	3 Somewhat concerned	4 A little concerned	5 Moderately concerned	6 Not concerned
1	**Increase in rainfall**	60%	21%	8%	4%	3%	4%
2	**Decrease in rainfall**	30%	29%	12%	6%	6%	17%
3	**Increase in runoff**	25%	30%	15%	9%	4%	17%
4	**Increase in groundwater level**	33%	31%	16%	10%	6%	15%
5	**Decrease in groundwater level**	19%	29%	15%	12%	7%	19%
6	**Increase drought**	63%	29%	0.4%	0.9%	0.9%	15%
7	**Decrease change of drought**	41%	41%	15%	0.4%	0.9%	0.4%

Number of respondents = 227

8.7.4 What effect do you think climate change will cause? (Q22)

When the farmers were asked what they thought about '***increased rainfall***'. Most respondents (63%; Q22.1) were a lot more concerned that climate change will result in increased precipitation. While, 28% were just a little concerned, and the remainder were unconcerned. The result highlights that most respondents were very concerned that climate change will cause increased rainfall, which have been experienced in several agricultural States. When asked about '***decrease in rainfall***', most respondents (83%; Q22.2; Table 8.6) either agreed a lot or a little that they were more concerned, and even though some felt climate change would not cause a decrease in rainfall, most Nigerian farmers are very concerned of the impact of decreasing rainfall.

In Q22.3, almost 90% of respondents were either concerned a little or a lot about an '***increase in runoff***'. While, some were unconcerned, the result suggests that most respondents are very concerned that climate change will cause an increase in runoff which causes erosion and washing away of the top soil required for crop growth and development.

Most respondents (86%; Q22.4) either answered a little or a lot when asked if climate change will result in the ***increase in groundwater discharge***. Only 14% were unconcerned. The result suggests that most farmers are very concerned that climate change will cause increase in groundwater, which also has an adverse effect on crop yield. Likewise, most farmers (86%; Q22.5) were either concerned a little or a lot about the potential risk of '***decrease in groundwater discharge***'', while, just 14% were unconcerned. Highlighting that most respondents thought that climate change will cause a decrease in groundwater discharge, which on its own contributes to lower crop yield. Furthermore, most respondents (89%; Q22.6) were either concerned a little or a lot when asked about the potential *'**decline in surface water quality***', while, just 11% were unconcerned. Highlighting that most farmers thought climate change will cause a decline in surface water quality, which will alter farming activities. In Q22.7, 81% of the respondents either agreed a lot or a little that they were concerned about '***groundwater quality***', and even though there was a minority that thought climate change would not affect groundwater, the results show that there is real concern amongst Nigerian farmers.

In respect to '***increase risk of flooding**,'* most were either concerned a little or a lot (86%; Q22.8; Table 8.6), while, just 14% were unconcerned. Highlighting that most respondents understood that climate change will result in increased flooding risk which has been occurring in many parts of Nigeria. Finally, most respondents (82%; Q22.9) either agreed a lot or a little that they were very concerned and only (18%) were unconcerned about '***increased risk of drought***'. The results show that most farmers are aware that climate change results in drought and its potential risk on agricultural productivity. In general, most Nigerian farmers were very concerned about climate change related issues, and its impact on agricultural production and the environment.

Table 8.6: Concern about environmental factors (Q22)

	Question	A lot	A little	Not at all
1	**Increase in rainfall**	63%	28%	8%
2	**Decrease in rainfall**	42%	41%	17%
3	**Increase in runoff**	41%	49%	10%
4	**Increase in groundwater**	37%	49%	14%
5	**Decrease in groundwater**	41%	45%	14%
6	**Decline in surface water quality**	52%	37%	11%
7	**Decline in groundwater quality**	38%	43%	19%
8	**Increase risk of flood**	49%	37%	14%
9	**Increase risk of drought**	38%	44%	18%

Number of respondents = 227

8.7.5 Which of the following have been implemented? (Q 23)

This section explores in depth what has been achieved in the agricultural industry over the years in Nigeria. As a result, some questions were asked on planning and implementation. Most respondents said that ***flood protection*** (81%; Q23.1), had either been constructed or was planned and almost a fifth (19%) said that flood protection was needed. For ***drought protection***, most respondents (80%; Q23.2) said that had either been implemented or was being planned, and a fifth thought flood protection was needed. In Q23.3, 73% thought that some form of ***coastal protection*** had been constructed or was planned. It is important to note that more than a quarter thought some form of protection was needed. Most thought that schemes that involve ***natural retention of floodwater*** (79%; Q23.4) were either being implemented or were planned and over a fifth (21%) thought that this was needed. Once again, most respondents (76%; Q23.5) thought that there had been plans to ***restrict development in risk areas*** were either implemented or planned. While over a quarter thought that this was needed.

When asked if there were any form of improved ***standards of development***, most either thought improvements had been planned (47%; Q23.6), while, 31% said that this has already been implemented. Once again, around a fifth thought it was needed. When asked about ***weather forecasting and monitoring of information***, most respondents (52%; Q23.7) said that this was planned and 22% suggested that this was already implemented and once again over a quarter thought it was needed. In Q23.8, 51% said that that there has been improved ***insurance against flooding*** (27%) suggesting that this was planned, while over a fifth thought it was needed. In Q23.9, most farmers were very much concerned about ***increased supply of water***, which accounted for 73%, and thought it was either planned or needed. Importantly, only 27% thought that an increase in water supply had been implemented.

There was an almost even split in the three-possible responses when asked about ***economic instruments***, ***such as water pricing***. Interestingly, most (68%; Q23.10) of respondents said that this had either already been implemented or was planned the remainder suggested that this was needed. In contrast, the majority thought that there have been ***restrictions of water use,*** which was planned or were needed (79%; Q23.11) and just 21% said that this had already been implemented. In Q23.12, the majority were concerned about ***measures to improve the water balance***, which accounted for 79% of the respondents, which thought that this were either planned or needed. While, only 21% said that this had already been implemented. The results suggest that there have been limited measures put in place to improve water balance, which needs to be taken into account.

When asked about ***drought protection***, most farmers thought that improvements had been planned (47%; Q23.13) or were already implemented (24%). The remainder suggested that it is needed. This suggests that drought consideration have been considered for mitigation, which is very essential in agricultural programmes. Similarly, when asked if there was any form of ***new or revised legislation***, (39%; Q23.14) thought that this was planned, while, 32% suggested that this had already been implemented and over a fifth thought it was needed.

The result suggests that new legislation is needed in order to mitigate and adapt to the effect of climate change in Nigeria. Many respondents either thought improvements had been planned (40%; Q23.15) or were already implemented (31%) for ***economic incentives and financial mechanism***. Some 21% of respondents said it was needed. As a result, this suggest that most farmers are of the view that much needed to improve in terms of economic incentives and financial mechanisms in Nigeria. Once again, most respondents (71%; Q23.16) thought that schemes that involve ***awareness raising and campaigns*** were either being implemented or were planned and over a fifth (29%) thought that this was needed. Despite this, the results show campaigns designed to raise awareness do have an impact.

Table 8.7: Implemented, planned and needed measures for adaptation and mitigation (Q23)

		Implemented	Planned	Needed
1	Flood protection	61%	20%	19%
2	Drought protection	52%	28%	20%
3	Coastal protection	47%	26%	27%
4	Natural retention of flood water	38%	41%	21%
5	Restricting development in risk areas	23%	53%	24%
6	Improved standards for development	31%	47%	22%
7	Improved weather forecasting and monitoring information	22%	52%	26%
8	Improved insurance schemes against flooding	27%	51%	22%
9	Increased supply of water	27%	48%	25%
10	Economic instruments such as water pricing	30%	38%	32%
11	Restrictions of water use	21%	42%	37%
12	Measures to improve water balance	21%	44%	35%
13	Drought mitigation	24%	43%	33%
14	New or revised legislation	32%	39%	29%
15	Economic incentives or financial mechanism	31%	40%	29%
16	Awareness raising or campaigns	34%	37%	29%

Number of respondents = 227

8.8 Nigerian farmers feeling the effects of climate change (Q24)

Chapter 2 highlighted that climate change globally is already occurring and Chapter 4 suggests that many Nigerian States are also experiencing the effects. Consequently, Question 24 required respondents to detail when they thought the climate will start to change and have an effect. For Q24.1, 61% admitted that climate change is already having a major impact, while 20% suggested that climate change will happen in the next 10 years (Q24.2, Table 8.8). From Q24.3 – Q 24.6, 8% said in the next 25 years, and 3% in the next 50 years. Only 1% said that climate change will happen in >100 years and 7% stated that climate change will never happen.

Survey results showed most Nigerian famers thought they were already feeling the impacts of climate change, in form of changing crop productivity. However, Chapter 7 results showed temporal increases in most environmental variables and yet, in many cases productivity improved because of improved farming practises (e.g. irrigation) and increasing use of fertilizers in most studied States. With such changing climate, the global agricultural production will be impacted heavily, more especially in developing countries such as Nigeria (Obioha, 2008).

Table 8.8: Feeling the effects of climate change (Q24)

	Percentage of respondents
Already feeling the effects	61%
Next 10 years	20%
Next 25 years	8%
Next 50 years	3%
More than 100 years	1%
Never	7%

Number of respondents = 227

8.8.1 Agricultural Adaptation to climate change: Implementation strategy to tackle the impacts of climate change (Q25)

This section is similar to Question 23, in order to understand the implementation strategies in the agricultural sector in Nigeria (Table 8.9). When asked '***if their local areas are faced with climate change***' (Q25.1), 80% either fully or partially agreed, 14% either fully or partially disagreed, while 6% gave no answer. This shows that most respondents believe that they are currently faced with the effects of climate change. Most respondents (81%; Q25.2,) either fully or partially agreed that '***climate change will affect developing countries***,' only 13% either fully or partially disagreed (6% gave no answer), highlighting that most believe developing countries will be impacted by climate change when compared to other parts of the world. Furthermore, most respondents (83%; Q25.3) either fully or partially agreed that '***climate change will have a big impact on farmers***', with just 10% either fully or partially disagreeing (6% gave no answer). This shows that most respondents are aware of the implications and impacts of climate change on crop yield and agricultural productivity. Therefore, it has resulted to lower crop yield in most agricultural States in Nigeria.

Unsurprisingly, most respondents (72%; Q25.4) either fully or partially agreed that '***energy use will reduce climate change***', while 22% either fully or partially disagreed

(6% gave no answer). Those of the respondents who disagreed believe that energy uses contributes to climate change and it is having an adverse impact on the environment. As a result, reducing energy consumption will aid towards mitigating climate change. Furthermore, when asked about their willingness to ***'pay more for energy efficient products'***, the majority (71%; Q25.5) either fully or partially agreed and almost a quarter (23%) either fully or partially disagreed (6% gave no answer). This shows that most respondents believe that they are currently faced with the effects of climate change and were willing to invest in reducing climate change effects. As in Q25.6, most respondents (71%; Q25.6) either fully or partially agreed '***that the place, where they live, is unique and distinctive***', and 23% either fully or partially disagreed (6% gave no answer). This implies that the farmers thought the area which they live and practise agriculture is distinctive.

Most respondents (72%) either fully or partially agreed that '***they feel they belong to a community***' (Q25.7), while 21% either fully or partially disagreed, 6% giving no answer. The result show that most respondents are comfortable in their community. Once again, most respondents (45%; Q25.8) either fully or partially agreed that '***if I were to move, would they like to farm in a similar place***', while, 22% partly disagreed (7% gave no answer). This suggests that most farmers are very comfortable with the area which they cultivate crops and live with their families. However, when questioned '***if the area allows them to live and farm the way they wanted***', 69% either partly agreed or fully agreed, the remainder of 21% (Q25.9), either partly agreed or fully disagreed (8% gave no answer). The results highlight that most respondents believed that the area which they occupy allow them to live and farm. Unsurprisingly, most respondents (66%; Q25.10) either partly agreed or fully agreed that they were '***concerned about environmental issues***', while, (25%) either partly disagreed or fully disagreed (8% gave no answer).

It is not surprising that most Nigerian farmers are concerned about environmental issues and expressed their willingness to address the issues. Seventy-one percent partly and fully agreed with the statement ***'how being environmentally friendly was important to them'*** (Q25.11), while of the remaining 25% either partly agreed or fully disagreed and 8% gave no answer. Most respondents were willing and very concerned about being environmental friendly which is a way of mitigating and adapting to climate change. Most respondents (66%; Q25.12) either partly agreed or fully agreed '***they identified with the aims of tackling climate change***'. The remaining respondents (28%) either partly agreed or fully disagreed (6% gave no answer). This highlights that most understand it is important to mitigate and adapt to climate change. Finally, the majority (70%; Q25.13) either fully or partially agreed and 24% either fully or partially disagreed (6% gave no answer) '***if people are too selfish to do anything about climate change***'. This shows that most respondents were unwilling to spend most of their resources in mitigating and adapting to climate change.

Table 8.9: Opinions on strategies to tackle climate change (Q25)

		Partly Agree	Fully Agree	Fully Disagree	Partly disagree	No answer
1	My local area is likely to be affected by climate change	55%	25%	9%	5%	6%
2	Climate change will mostly affect developing countries	57%	24%	7%	5%	6%
3	Climate change is likely to have a big impact on farmers	51%	32%	6%	4%	6%
4	I am reducing my energy use to help tackle climate change	44%	28%	14%	8%	6%
5	I am prepared to pay more for energy efficient products	38%	33%	15%	8%	6%
6	The place I live is unique and distinctive	41%	30%	14%	10%	6%
7	I feel like I belong to a community	45%	27%	17%	4%	6%
8	If I were to move, I would like to farm in a similar place	45%	26%	14%	8%	7%
9	This area allows me to live and farm the way I want to	42%	27%	15%	6%	8%
10	I am very concerned with environmental issues	43%	23%	19%	6%	8%
11	Being environmentally friendly is important to me	48%	23%	19%	6%	8%
12	I identify with the aims of tackling climate change	45%	21%	17%	11%	6%
13	People are too selfish to do anything about climate change	42%	28%	16%	8%	6%

Number of respondents = 227

8.8.2 What principles are the farmers in Nigeria abiding to? (Q 26)

This section explores what principles Nigerian farmers abide by. This is to understand their involvement in issues and ways of tackling climate change and other environmental related issues (Table 8.10).

When the farmers were asked if they were involved in '***preventing pollution, protecting natural resources***' almost all (96%; Q26.1) said that they were not involved in any prevention control. This result is unsurprising and similar research has shown that many developing countries tend to be responsible for pollution and depleting of natural resources (Zemankovics, 2012).

Similarly, when asked if they '***respected the earth, and were in harmony with other species***', (80%; Q26.2) said that they were not. This showed that a significant number of Nigerian farmers were not very interested in protecting the earth and its natural environment. In Q26.3, when farmers were asked if they abided with a principle of '***unity with nature and fitting into nature***', 74% said they do not. Even though a quarter of respondents said they did abide with this principle, results suggest that the farmers are not interested in uniting with the natural environment. They are probably more concerned with how climate change is affecting them. Finally, most respondents (70%; Q26.4) answered No, when asked if they were involved in '***protecting the environment and, preserving***' ***nature'***. The remainder answered yes, thus results show most Nigerian farmers did not participate in protecting and conserving the environment. This represents a future challenge, because farmers are traditionally recognized as custodians of the environment. After all, it is the underpinning resource of their business.

Table 8.10: Abiding to farmer principles (Q26)

	Yes	No
Preventing pollution, protecting natural resources	4%	96%
Respecting the Earth, harmony with other species	19%	82%
Unity with nature, fitting into nature	24%	76%
Protecting the environment, preserving nature	30%	70%

Number of respondents = 227

8.8.3 Personal experiences of climate change (Q 27)

This question assessed farmer experiences and perceptions of climate change impacts (Table 8.11). As a result, some environmental factors were considered as a way of understanding farmer perceptions with respect to climate change and the environment. However, the environment is subject to rules and regulations that can be used to mitigate and adapt.

Questionnaire evaluations showed most farmers (62%) had experienced ***drought*** conditions and they were concerned because it had serious consequences for agriculture in some Nigerian States (Q27.1; Table 8.11). However, temporal environmental changes in precipitation, humidity and temperature extremes (Chapter 7) suggested that there had been limited problems caused by drought in the assessed States. With respect to ***flooding,*** most farmers also answered yes (64%; Q27.2; Table 8.11), while the remainder had little or no experience of flooding. This demonstrates that most Nigerian farmers were aware of flooding implications on agricultural practice. When asked of their experiences of ***lack of water,*** most were unaware (52%; Q27.3; Table 8.11). Most agricultural States in Nigeria are facing water shortages, resulting in lower crop yields, forcing most farmers to apply irrigation.

There was an almost even split in the responses received for ***soil erosion***, as most respondents (51%; Q27.4) said that they had experienced erosion. This is because it causes the washing away of the top soil need for plant growth and development. In contrast, most respondents admitted that ***cyclones*** are an uncommon phenomenon in Nigeria and it was no surprise that almost all respondents (91%; Q27.5) had not experienced any. Most respondents (67%; Q27.6) said there was no ***shortage of labour***. This highlights the willingness of Nigerian farmers to work and to earn a living. When followed up by their experiences about ***infertile soil***, most respondents of (59%, Q27.7) said that they had experienced it. This provides a reason for lower crop yield and poor crop output and would explain the increased use of fertilizers in most agricultural States.

When asked if they have experienced ***lack of techniques or knowledge*** (Q27.8), 51% of respondents answered no. This shows that more than half of the respondents had sufficient techniques and knowledge, meaning that farmers are very conversant with the way they have been practising agriculture over a long period of time. However, most respondents (68%; Q27.9) had experienced problems with ***pest and disease*** adversely affecting crop yields, highlighting that most Nigerian farmers have experienced climate change impacts reducing crop output, as shown in Chapter 7.

Table 8.11: Experience of the impacts of climate change (Q27)

Question	Impact	Yes	No
27.1	**Droughts**	62%	38%
27.2	**Flooding**	64%	36%
27.3	**Lack of water**	48%	52%
27.4	**Soil erosion**	51%	49%
27.5	**Cyclone**	9%	91%
27.6	**Shortage of labour**	33%	67%
27.7	**Infertile soil**	59%	41%
27.8	**Lack of techniques or knowledge**	49%	51%
27.9	**Pests and diseases**	68%	32%

Number of respondents = 227

8.9 Other concerns related to climate change (Q28)

In Q28, farmers were asked to make their personal comments related to climate change and environmental issues. All answers to the comments were classified into an overall remark. Most respondents commented that their major concerns were that most developing countries lack the capacity to cope with the effects and impacts of climate change, due to their low adaptive capacity. Other farmers were concerned about increasing depletion of natural disasters and health issues associated with climate change. Other issues of concern to many farmers were issues of habitat degradation and deforestation. Most respondents were of the view that climate change is already happening. Some commented that working together at local, national and international level with good investment would aid mitigating and adapting to climate change.

8.10 Summary

Chapter 8 considers the knowledge, concerns, and perception of climate change of a large sample (n = 227) of the Nigerian farming community. Similar research carried out in other developing countries (Zemankovics, 2012), was shown to contribute towards developing mitigation and adaptation approaches, while at the same time providing important information to be used to improve policy and decision making in the agricultural sector. Most of the Nigerian farmers interviewed were from age groups ranging between 36-45. The major source of farmer's income was agriculture, with most Nigerian farmers being of the view that climate change is already happening. Farmers claimed that climate change is posing a threat in Nigeria and additionally, most farmers believed that climate change is caused by anthropogenic factors. The media was the major source of information on climate change and other environmental issues and importantly farmers trusted this information. The State government oversees funding farming activities in the country, and most farmers are self-dependent, as most farmers are not members of a farming organisation (Section 8.3). The main objectives of Chapter 8, were to analyse farmers' perception of climate change in Nigeria, satisfying two of the main aims of this research project as detailed in Chapter 1 (Section 1.3). Chapter 9 focuses on the climate change perception of members of the public and government organisations. Chapter 10 then presents results of statistical analysis applied to Chapters 8 and 9 and culminates with an evaluation of findings in all three chapters.

Chapter 9: Public and government perception of climate change in Nigeria

9.1 Introduction

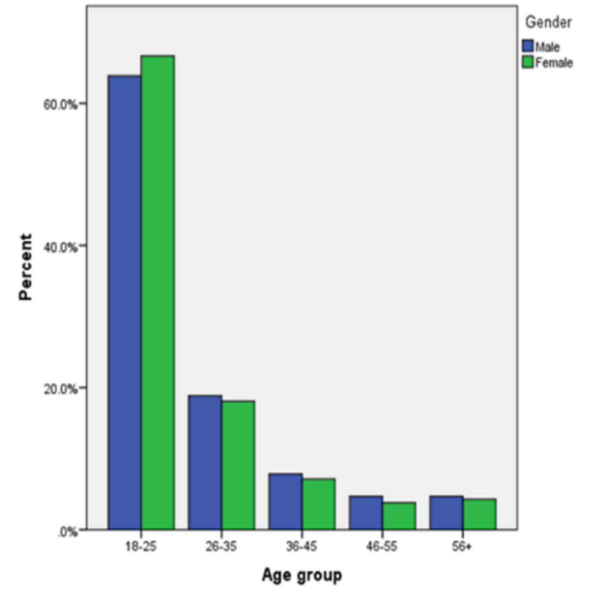
Chapter 4 discussed the importance of identifying how those involved in agricultural activities perceive climate change. This is particularly true for developing nations like Nigeria and it was shown that a better understanding of climate change and other environmental impacts is important. Using a methodological approach (Chapter 6) using questionnaires, Chapter 8 assessed results of Nigerian farmer perceptions on the effects of climate change, adaptation, and mitigation. Using a similar questionnaire format, this chapter explores both members of the public (n = 401) and government officials' (n = 50) perceptions of climate change, and their views on possible adaptation and mitigation. The total questionnaires distributed among the public was 600, similarly, however as was the case with the farmers, some respondents left the questionnaires blank. Only the government officials were interviewed face to face. The use of questionnaires was used to assess how the groups perceive, view and understand issues related to climate change. Results will be used to inform and improve government policies designed to minimise effects of climate change. Individual frequency tables for each question are given in Appendix D.

9.2 Analysis of the public's perception of climate change

9.2.1 Socio-demographic characteristics (Q1-Q6)

Most (52%) respondents were female (a), and most questionnaire responses were received from ages ranging between 18-25 (a). Ten percent of respondents had no formal education, 40% had attended high school, and of those educated, 33% had gained a first degree and 10% a Master's degree, while 6% had a PhD (b). In terms of employment, 32% of respondents were employed by either the government or another organisation, 48% were self-employed and the remainder were classed as unemployed (c). The majority (57%), had been employed >5 years, with 21% being employed between 6-10 years (d). For those employed for longer periods, only 12% had been employed between 11-15 years, with as low as 6% employed >16 years.

Forty three percent were listed as having no dependents, 40% had between 1-3 dependents, 14% between 4-6, and only 3% stated they had >7 dependents (e). When asked how far they travelled to work, most either travelled less than five km or between 6-10 km(64%), or between 11-15km (18%). The percentage of those travelling greater distances reduced to 7% between 16-20 km, with 11% travelling distances >20km (f). Of these, 36% travelled by bus, 4% by train, 45% by car, 4% by bicycle and the remainder walked (g).



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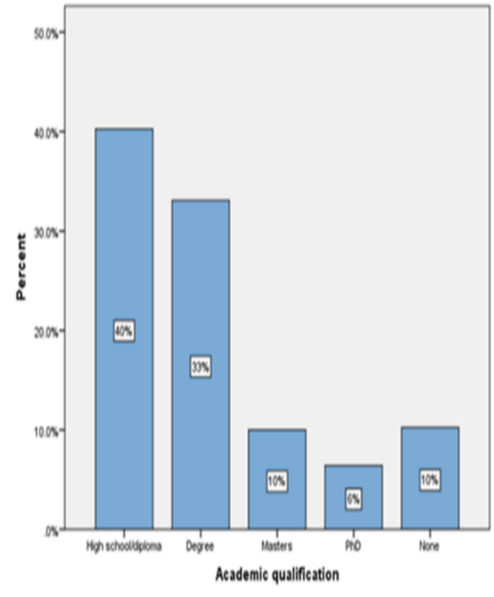

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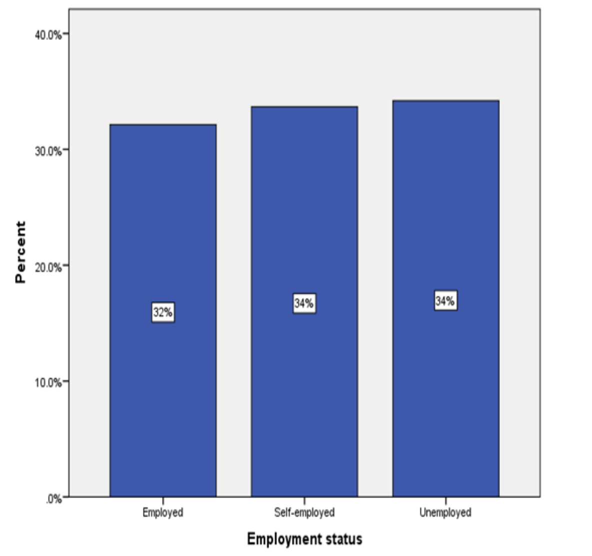

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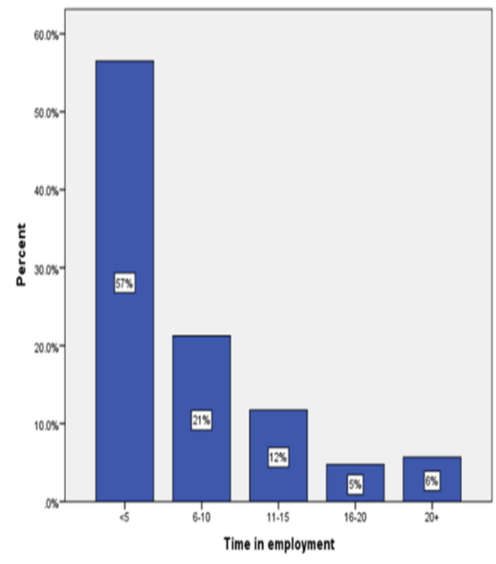

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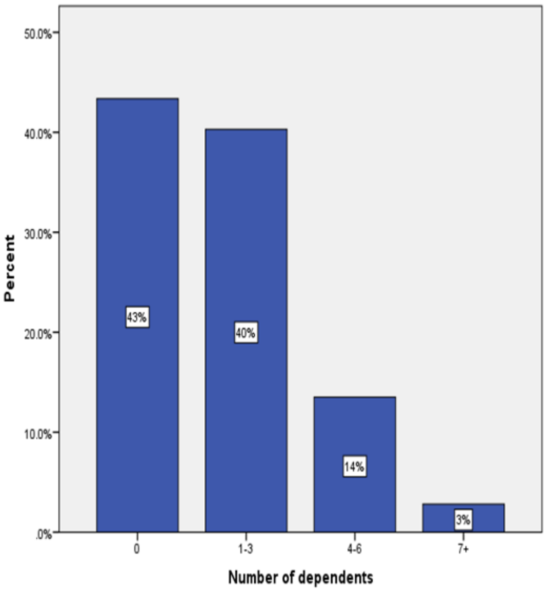

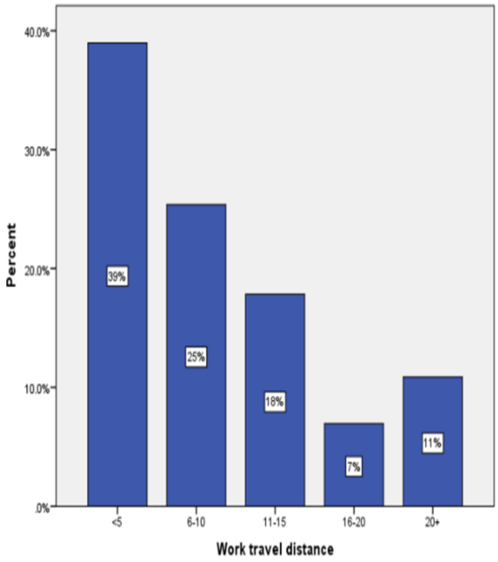

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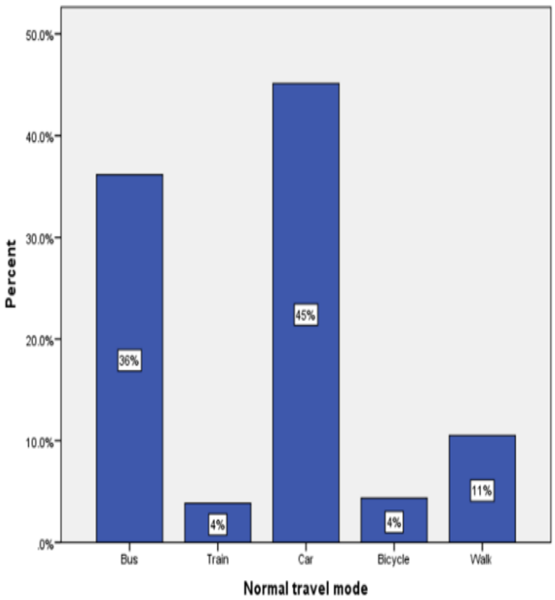

Figure 9.1: a) Public age group, b) Public academic qualification, c) Employment status, d) Time of employment, e) Number of dependents, f) Work travel distance and g) Normal travel mode.

9.2.2 What do you think of climate change (Q7)?

This question was subjective, thereby allowing the respondents to express their own views. Most respondents agreed that climate change is already happening, echoing the farmers' responses (see Chapter 8). However, most respondents said that climate change was caused by both natural and human-induced factors. Q8 required the respondents to detail the sources from which they had acquired information regarding climate change and other environmental issues. The question contained a list of six possible sources, and respondents could make multiple choices (Table 9.1).

Mass media plays a vital role in conveying information regarding climate change and associated environmental issues. Results showed that most respondents (67%; Q8.1) derived their sources of information from mass media, via newspapers, television, radio and internet.

Generally, mass media influences the way we perceive the world. This result was quite similar to Chapter 8, the results showed that ***Energy Suppliers*** slightly influenced the way the respondents heard of climate change issues: only (9%; Q8.2) of those that responded received climate change information.

Only (11%; Q8.3) of respondents said they received information from the ***Environmental Organisations***, against 22% of the farming community (Chapter 8). This also suggests that environmental organisations play a minimal role in passing information regarding climate change and other environmental issues in Nigeria. Similarly, the result highlighted that only (11%; Q8.4) received information from the ***Government and Local Council***, which also played a minimal role in providing climate change information to the public. This result was also similar to Chapter 8. Surprisingly, only (11% Q8.5) of respondents claimed to have derived their sources of information about climate change from ***Family and Friends.*** This was contrary to the percentage of farmers who claimed to have derived their sources of information from Family and Friends (Chapter 8).

Table 9.1: Sources of information (Q8)

Question	Yes	No
Mass Media	66%	33%
Energy suppliers	9%	81%
Environment Organisations	11%	89%
Government	11%	89%
Family and Friends	11%	89%

Number of respondents = 401

9.2.3 How much do you trust your sources of information (Q9)?

Q9, was aimed at exploring how much the respondents trusted their sources of information. This was ranked from 'A lot (a great deal of trust), A little, and Not at all (untrustworthy)'.

Sixty-one percent of the public trusted the information they received from mass media 'A lot' (Column 2, Table 9.2), corresponding with Q15 in Chapter 8. Unsurprisingly, 56% trusted the information they derived from family and friends. Environment organisations (35%), Energy Suppliers (29%), and Government (25%) information was trusted 'A Little' (Table 9.2). However, Q8 showed that there was little detailed information given by these organisations with the range of respondents' answers between 6-11%, respectively. These results suggest that most of the Nigerian public trusted the information they received from mass media.

Table 9.2: Opinions on how much organisations can be trusted (Q9)

	A lot	A little	Not at all
Media (TV, radio, newspapers, magazines, and internet)	61%	33%	6%
Energy suppliers	29%	47%	24%
Environmental organisations	35%	42%	23%
Government and local councils	26%	46%	28%
Family and friends	56%	34%	11%

Number of respondents = 401

9.3 Did you think climate change is affecting Nigeria (Q10)?

Most respondents (71%) thought that the Nigerian climate had been affected; the remainder believed there had been no effects, and 18% were not sure. These percentages were higher than the farmers' responses (Chapter 8). This also concurs with the study by Atilola (2010), who stated that increasing deforestation, exploitation of natural resources, and burning of fossil fuel contributes to climate change.

9.4 How the public perceive climate change (Q11)

The questionnaire provided a blank space for the public to make a personal comment regarding their concerns, awareness, and perceived ideas about climate change. Most respondents stated that they understand the cause and effect of climate change. In addition, most commented that they have been experiencing climate change-related issues, such as drought, pollution, flooding, soil erosion, desert encroachment, heavy rainfall, and lower agricultural productivity.

9.5 Causes of climate change (Q12)

As previously discussed in Chapter 8, it is quite evident that climate change is occurring in many parts of the world. When asked about the causes of climate change, 31% of respondents said they believed that anthropogenic factors were the cause and 36% believed that natural factors were the cause. Twenty-nine percent believed that both factors contributed, and only 9% of the respondents did not know the reasons behind the induced changes. These results contrasted with Chapter 8 results where, most farmers thought that anthropogenic factors were the cause of climate change.

9.6 Responsivities for tackling climate change (Q13)

In Q13, this required the respondents to detail 'who should be responsible for tackling the issues of climate change'. The question contained a list of five possible sources, and respondents were requested to provide yes/no answers in Table 9.3. Only 18% suggested ***International Groups*** such as the United Nations and International Panel on Climate Change, contrary to farmers' responses in Chapter 8. Thirty-eight percent of the respondents thought that ***Environmental Organisations*** (e.g., Friends of the Earth) should be responsible for tackling climate change. Twenty-nine percent thought the ***Government*** should oversee issues of climate change, while 89% of respondents thought that ***Local Business and Industry*** should oversee tackling climate change. Finally, 81% answered that ***Individuals*** should oversee tackling climate change. This was quite similar to the response of farmers (Chapter 8). Surprisingly, results showed that most of the public believe that Local Business and Industry should oversee tackling climate change in Nigeria.

Table 9.3: Responsibility for tackling climate change (Q13)

	Yes	No
International group (e.g. UN, IPCC)	18%	82%
Environmental organisation (e.g. Friends of the Earth)	38%	62%
Government	29%	71%
Local business and industry	89%	11%
Individuals	85%	15%

Number of respondents = 401

9.7 Adaptation and mitigation strategies for climate change (Q14)

In Q20 Chapter 8, this section explored what mitigation and adaptation approaches can be adopted to tackle climate change in Nigeria (Table 9.4). When asked if ***'the public can do a bit to reduce climate change'***, most respondents (84%; Q14.1) agreed that there is a need to do more in order to reduce the effects of climate change. Only 16% disagreed, and the results showed that there was willingness among the Nigerian public to make necessary changes to address climate change issues. Similarly, most respondents (70%; Q14.2) also agreed that ***'people should be encouraged to reduce energy consumption'***. Even though a quarter of respondents disagreed, the results highlight that most respondents are willing to reduce their energy consumption in order to mitigate climate change. This implies that more people are willing to be involved in addressing issues of climate change and its effects. In respect to ***'climate change was inevitable'***, most respondents (62%; Q14.3) agreed, while the remainder disagreed. The results suggest that most respondents thought climate change was inevitable.

Most respondents (67%, Q14.4) agreed that '***climate change is a natural phenomenon'***, while the remaining 33% disagreed. The result suggests that most of the Nigerian public believed that climate change occurred naturally. Surprisingly, more than half of the respondents (54%; Q14.5) disagreed when asked if '***climate change will improve Nigerian weather'***. This was contrary to the farmers' responses (Chapter 8). The result highlights that most respondents thought climate change would affect Nigerian weather negatively. Most respondents (59%; Q14.6) were unwilling to '***act if everyone else does'***, while the remainder agreed to the statement. Others were unwilling, this is because of the cost involved in tackling climate change. In Q14.7, most respondents (67%) disagreed that it '***was it too late to do anything about climate change***', while the remaining 33% agreed. The answer given was opposite to that of the farmers' responses (see Chapter 8, Q15.7). The results suggest that most respondents thought mitigating and adapting to climate change could still be achieved. However, a majority agreed (59%; Q14.8) that '***climate change is something frightening***'. Others were less concerned; the result still highlights that most of the Nigerian public thought climate change was frightening. These are the result of natural disasters occurring in many parts of the country, such as flooding.

Most respondents (56%; Q14.9) were ***'uncertain as to whether climate change is really happening***'. However, 44% agreed. This was not unsurprising as farmers also commented the same. When respondents were asked '***if the developed countries are to be blamed for climate change***'; more than half disagreed, while the remainder (44%; Q14.10) agreed. The result suggests that most of the public did not believe that industrialization and the rise in the use of fossil fuels has adverse effects on the environment. Furthermore, most respondents agreed (62%; Q14.11) that ***'big changes to society are needed to reduce climate change'***. However, a minority of respondents (38%) disagreed with the statement. The result highlights that most of the public believes that big changes are needed in order to tackle the impact of climate change in Nigeria. The public's responses were similar to those of most farmers (Section 8.7.1). When respondents were asked '***if the evidence for climate change is unreliable***', half of them (50%; Q14.12) agreed and the remaining half (50%) disagreed. The result highlights that there were equal responses between the two groups. In Q14.13, most respondents (52%) agreed that '***people are too selfish to do anything about climate change***', while, 48% of the respondents disagreed. As a result, most respondents were unwilling to devote their time and resources to mitigate and adapt to climate change. Finally, most respondents (65%; Q14.14.) agreed that there was '***no action needed***', while just 35% disagreed.

Table 9.4: Opinions on climate change issues (Q14)

		Agree	Disagree
1	We can all do our bit to reduce climate change	84%	16%
2	People should be encouraged to reduce their energy consumption	70%	30%
3	Climate change is inevitable	62%	38%
4	Climate change is a natural phenomenon	67%	33%
5	Climate change will improve Nigerian weather	46%	54%
6	I will only act if everyone else does	41%	59%
7	It is already too late to do anything about climate change	33%	67%
8	Climate change is something which frightens me	59%	41%
9	I am uncertain as to whether climate change is really happening	44%	56%
10	Developed countries are to blame for climate change	44%	56%
11	Big changes to society are needed to reduce climate change	62%	38%
12	The evidence for climate change is unreliable	50%	50%
13	People are too selfish to do anything about climate change	52%	48%
14	No action is needed	35%	65%

Number of respondents = 401

9.8 Economic and social issues (Q15)

Q15, explores what is of most importance to the Nigerian public. This group of questions related to their daily lives and the general environment (Table 9.5). It comprises the options (1) Very concerned, (2) Concerned, (3) Neither, (4) Unconcerned, and (5) Very unconcerned. Seventy-nine percent of respondents were 'very concerned' about employment, 70% were concerned about the environment. Similarly, 73% were very concerned about health issues and 71% were very concerned about education. The number of respondents that were very concerned about cost of living and crime were 63% and 54%, respectively. The result shows that most respondents were more concerned about employment than other issues.

Table 9.5: Concern over economic and social issues (Q15)

	Very Concerned	Concerned	Neither	Unconcerned	Very Unconcerned
Employment	79%	8%	3%	1%	10%
Environment	70%	11%	5%	4%	10%
Health	73%	10%	5%	3%	9%
Education	71%	11%	6%	3%	9%
Cost of living	63%	13%	7%	4%	14%
Crime	54%	13%	9%	3%	22%

Number of respondents = 401

9.9 Environmental issues (Q16)

Q16, explored environmental issues related to climate change, in order to understand how the public perceives issues of the environment, and how concerned they are towards climate change and other environmental issues. Most respondents (67%) were very concerned about air pollution. The results highlight that 65% were very concerned about food security. Furthermore, 57% of respondents were very concerned about drought. One of the major impacts of climate change is drought, as discussed in Chapter 3. The result highlights that 58% of respondents were very concerned about waste disposal. Waste disposal is also another major environmental issue in Nigeria, due to lack of proper waste disposal facilities. Sixty-one percent of respondents were very concerned about water pollution, while 43% and 56%, respectively, were very concerned about sea level rise and storms, and energy security. In general, most of the Nigerian public were very concerned about issues related to climate change. This is because, they are directly affected by the issues and implications of lower crop output.

Table 9.6: Environmental issues (Q16)

	Very Concerned	Concerned	Either	Unconcerned	Very Unconcerned
Air pollution	67%	11%	7%	2%	14%
Food security	65%	11%	8%	3%	12%
Drought	57%	14%	9%	2%	18%
Waste disposal	58%	12%	9%	5%	16%
Water pollution	61%	9%	11%	6%	14%
Sea level rise and storms	43%	11%	15%	8%	24%
Energy security	56%	12%	11%	5%	16%

Number of respondents = 401

9.10 Climate Change Contributors (Q17)

Q17, attempted to understand which sector contributed more to climate change issues in Nigeria. Forty percent attributed climate change to Landfill and Transportation (17%), Industrialization (42%), and Others (1%). The results highlight that most respondents were of the view that landfill contributed more to climate change compared to other sectors. When asked if there was any link to responses to climate change, the majority (54%; Q18) answered yes. While in Q19, when respondents were asked if they had any ***additional comments***. Most commented that climate change is having an adverse effect on humans and the environment, while others said they were willing to make changes to their lifestyles to address the issues of climate change in Nigeria.

When asked '***if making changes to their lifestyle***' will reduce the impacts of climate change, most respondents (59%; Q20) answered yes, that decreasing the use and burning of fossil fuel will help to reduce climate change. The result showed that most people were very willing to make changes to their lifestyle in order to tackle climate change and its vulnerabilities in Nigeria. In Q21, most mentioned that droughts, erosion, sea level rise, flooding, and the weather changes as brief descriptions of the '***impacts of climate change***'.

When asked whether ***reducing greenhouse gas emissions***, especially CO_2 will help solve the problem of climate change, most respondents (60%; Q22) answered yes, suggesting they understand the implication of elevated greenhouse gases in the atmosphere. Similarly, most respondents (61%; Q23) were willing to ***making lifestyle changes that will help reduce*** the impacts of climate change. This highlights that there is willingness among the Nigerian public in adjusting their lifestyle in order to address climate change. In Q24, when asked if they were willing to pay to reduce climate change, 70% of respondents were willing to pay, while the remainder were unwilling.

The results show that most of the Nigerian public were willing to spend money to address climate change issues. Q25 required the respondents to '***give a detailed amount they were willing to spend to mitigate climate change***, most were prepared to pay as much as **500 naira** ($2US), while others were willing to pay up to **1000 naira** ($4US). Finally, Q26 provided a section for ***additional further comments***, in which the majority commented that the government should be more involved in tackling climate change; while, others suggested that the public should also be involved.

9.11 Section B: Analysis of Government perception of climate change

9.11.1 Socio-Demographic characteristics (Q1-Q6)

Most (61%) of respondents were female, and the most questionnaire responses were received from age groups ranging between 46-55. Out of the respondents, 4% attended high school. Of those educated, 35% gained a first degree and 47% a Master's degree, while 13% had a PhD. Most respondents were employed with the Ministry of Agriculture (Department of Agriculture and Natural Resources), the Nigerian Meteorological Agency (Department of Weather Forecasting and Services), and the Ministry of Environment.

Out of those employed by the government, 9% had been employed for less than five years, 13% between 6-10 years, 35% between 11-15 years, and 9% employed between 16-20 years. When asked how far they travelled to work, most either travelled less than five km or between 6-10km (30% and 22% respectively), or between 11-15 miles (22%). The percentage of those travelling greater distances (between 16-20km) was 17% and 9% (> 20km).

9.12 What do you think climate change is (Q7)?

Most government respondents were aware and concerned about climate change. Additionally, the majority defined climate change as a long-term shift in the earth weather patterns because of naturally occurring processes or anthropogenic factors. In most cases, this can result in extreme weather events, such as flooding, drought, desertification, and changing rainfall (UNCCD, 2005).

9.13 How did you hear about climate change (Q8)?

Q8, required respondents to detail the sources from which they acquired information about climate change and other environmental issues. The question contained a list of six possible sources, and respondents could make multiple choices (Table 9.7).

The ***Mass media*** results showed that only a minority 20% (Q8.1) of respondents derived their sources of information via newspapers, television, radio and the internet. Generally, mass media influences the way we perceive the world. The results oppose the responses given by both farmers (Chapter 8) and members of the public (Chapter 9 Section A). Similarly, the results showed that (20%; Q8.2) of the respondents said that they heard about climate change from the ***Energy Suppliers*** (the result was similar to Chapter 8). While in Q8.3, similar to previous results (Chapter 8 and Chapter 9, Section A), only 15% of the respondents said they received their information from ***Environmental Organisations.*** Furthermore, most respondents (80%, Q8.4) received their information from the ***Government***, suggesting that they play a major role in providing climate change information. This opposes the views of both farmers and members of the public; here, however, the results were probably influenced by the fact that the government employs the respondents. In Q8.5, only 10% of government respondents claimed to have derived their sources of information about climate change from ***Family and Friends***.

Table 9.7: Sources of information (Q8)

Question	Yes	No
Mass Media	20%	80%
Energy suppliers	20%	80%
Environment Organisations	15%	75%
Government	80%	20%
Family and Friends	10%	90%

Number of respondents = 50

9.14 How much do you trust your sources of information (Q9)?

Q9, explored how much the government trusted their sources of information. This was ranked from: A lot, A little, and Not at all. Of these, the source with the highest percentage was considered the one the respondent trusted most in Table 9.8.

Sixty-two percent of government officials trusted the information they received from mass media ‘A lot’ (Column 2, Table 9.8); this corresponds with Q15 in Chapter 8. Unsurprisingly, 25% trusted the information they derived from family and friends. Environment organisations (30%), Energy Suppliers (30%), and Government (75%) information was trusted ‘A Little’ (Table 9.8). The result highlights that the government trusted themselves over other sources where they derive their information. The result of the Environmental organisation and Government was similar to that of the farmers (see Chapter 8). The government list trusted the information they derived from family and friends, which accounts for the highest response.

Table 9.8: Opinions on how much organisations can be trusted (Q9)

	A lot	A little	Not at all
Media (TV, radio, newspapers, magazines and internet)	62%	34%	4%
Energy suppliers	30%	40%	30%
Environmental organisations	30%	40%	30%
Government and local councils	75%	15%	10%
Family and friends	25%	25%	50%

Number of respondents = 50

9.15 Do you think climate change is something already affecting Nigeria (Q10)?

Most government respondents (80%) said that climate change is evident and already affecting Nigeria. In Q7, most the respondents defined climate change and understood its effects. The result also concurs with the responses of both the farmers and the public, as most respondents claimed that climate change is already affecting Nigeria.

9.16 In what way do you think climate change is affecting Nigeria (Q11)?

The questionnaire provided a blank space for the officials to make a personal comment regarding their concerns, awareness, and perceived ideas about climate change. As mentioned in Q7 and Q10, most government respondents understood and defined climate change. In addition, most respondents were policy makers and understood the need to address climate change. They also admitted their involvement in improving policies to mitigate and adapt to climate change issues in Nigeria.

9.17 Causes of climate change (Q12)

As discussed in Chapters 2 and 8 (Q18), climate change is caused by either naturally occurring or anthropogenic factors and in some case attributed to both factors. Twenty percent believed climate change to be attributed to anthropogenic factors, and 20% believed the cause to be natural, while 40% believed both factors combined were the cause, and 20% did not know the reasons behind induced changes. The results show that most government respondents believed that climate change is caused by both anthropogenic and natural processes; this too concurs with the findings from public respondents (Chapter 9, Section A).

9.18 Responsivities for tackling climate change (Q 13)

Similar to, Q19 (Chapter 8) and Q13 (Chapter 9, Section A), government officials were required to provide details about 'who should be responsible for tackling the issues of climate change'. The question contained a list of five possible sources and respondents were advised to provide yes/no answers, (Table 9.9).

Fifty-three percent suggested the ***International Groups*** such as the United Nations and the International Panel on Climate Change (see Chapter 8). Fifty-two percent of respondents thought that ***Environmental Organisations*** (e.g., Friends of the Earth) should be responsible for tackling climate change. Sixty-five percent thought the **Government** should oversee issues of climate change; this was contrary to the response of farmers (Chapter 8). Only 10% thought that **Local Business and Industry** should oversee tackling climate change. Finally, 30% answered that **Individuals** should oversee tackling climate change. The results showed most of the government believe that they should oversee tackling climate change in Nigeria.

Table 9.9: Responsibility for tackling climate change (Q13)

	Yes	No
International group (e.g. UN, IPCC)	53%	47%
Environmental organisation (e.g. Friends of the Earth)	52%	48%
Government	65%	35%
Local business and industry	10%	90%
Individuals	30%	70%

Number of respondents = 50

9.19 Adaptation and mitigation strategies to climate change (Q14)

Similar to Q20 in Chapter 8 and Q14, this section aimed to explore what mitigation and adaptation approaches can be adopted to tackle climate change in Nigeria (Table 9.10). When government officials were asked if ***'they can do a bit to reduce climate change'***, most respondents (74%; Q14.1) agreed; most said more should be done to address climate change, while only 26% disagreed. This was contrary to the response of the farmers (Section 8.7.1). Similarly, most respondents (61%; Q14.2) agreed that ***'people should be encouraged to reduce climate energy consumption'***. Even though

39% of respondents disagreed, the results show that most respondents showed their willingness to reduce their energy consumption.

When asked if ***'climate change was inevitable'***, most respondents (61%; Q14.3) agreed, while the remainder disagreed. This was contrary to the response of the farmers (Chapter 8). Most government respondents agreed (74%; Q14.4), when asked '***if climate change is a natural phenomenon'***, while 26% disagreed. This implies that most thought that climate change is something that occurs naturally. Unsurprisingly, over half of respondents (70%; Q14.5) disagreed, that '***climate change will improve Nigerian weather'***, this was quite contrary to farmers' responses in Chapter 8. The result highlights that most government respondents thought climate change would negatively affect Nigerian weather. Also, most respondents (70%; Q14.6) disagreed with the statement they will '***act if everyone else does'***, while the remainder agreed to the statement.

When asked if it '***was it too late to do anything about climate change***', most respondents (57%; Q14.7) disagreed, while 33% agreed. This was contrary to the response of farmers (Chapter 8). However, most government respondents (61%; Q14.8) agreed that '***climate change is something frightening***', while others seem to believe that climate change is not frightening. Most of the government officials disagreed (61%; Q14.9) that they were ***'uncertain as to whether climate change is really happening***'. The remainder of the respondents agreed with the statement. Unsurprisingly, most respondents (57%; Q14.10) agreed that '***the developed countries are to be blamed for climate change***'. This implies that most government officials thought that the industrialized nations contribute more to climate change. This was contrary to the response of farmers (Chapter 8).

The majority of government respondents (61%; Q14.11) agreed that ***'big changes to society are needed to reduce climate change***'. However, a minority of respondents (39%) disagreed. The result highlights that most government officials believe that behavioural changes are needed in other to mitigate and adapt to climate change in Nigeria.

In contrast, most respondents (74%; Q14.12) disagreed, that **'*the evidence for climate change is unreliable***', while others agreed to the statement. This implies that most respondents were quite unsure of climate change information which was quite surprising. The result shows that most of the government officials (52%; Q14.13) believe that people were too '***selfish to do anything to mitigate and adapt to climate change'***. This was contrary to the response of farmers (Chapter 8). As a result, most of the respondents were unwilling to devote their time and resources to mitigate and adapt to climate change. Finally, most respondents 54% (Q14.14) disagreed that there was '***no action needed***' to address the impacts of climate change, while the minority (46%) agreed. This was the same with farmer's responses (Chapter 8). The result shows that most government officials of Nigeria thought that much is required to address climate change impacts.

Table 9.10: Opinions on weather, climate and environmental impacts (Q14)

		Agree	Disagree
1.	We can all do our bit to reduce climate change	74%	26%
2.	People should be encouraged to reduce their energy consumption	61%	39%
3.	Climate change is inevitable	61%	39%
4.	Climate change is a natural phenomenon	74%	26%
5.	Climate change will improve Nigeria's weather	30%	70%
6.	I will only take action if everyone else does	30%	70%
7.	It is already too late to do anything about climate change	44%	57%
8.	Climate change is something which frightens me	61%	39%
9.	I am uncertain as to whether climate change is really happening	39%	61%
10.	Developed countries are to blame for climate change	57%	43%
11.	Big changes to society are needed to reduced climate change	61%	39%
12.	The evidence for climate change is unreliable	26%	74%
13.	People are too selfish to do anything about climate change	52%	48%
14.	No action is needed	46%	54%

Number of respondents = 50

9.20 What effect do you think climate change will cause (Q15)?

When asked if climate change will impact ***Coastal zones***, most government respondents (60%; Q15.1) were a lot more concerned, while 20% were either little or not at all concerned (Table 9.11). The result highlights that most respondents believed that climate change would affect coastal zones. In responses to ***Urban areas***, the majority (90%; Q15.2) answered a lot, while the remainder either agreed a little or not at all. Climate change is already affecting urban areas in Nigeria. This highlights that most government officials thought that climate change is having adverse impacts on urban areas. Similarly, when asked about ***Low areas***, (90%; Q15.3) answered a lot, while others said either a little and not at all. The result shows that most respondents believe that low areas are vulnerable to climate change. A majority of the government respondents (86%; Q15.4) agreed a lot when asked if climate change will affect ***Agricultural areas***. This corresponds with Chapter 2 and Chapter 8. A minority either answered a little or not at all. The result shows that most respondents were very concerned that climate change will have adverse effects on agricultural areas.

Table 9.11: Effect of climate change (Q15)

	Question	A lot	A little	Not at all
1	**Coastal zones**	60%	20%	20%
2	**Urban areas**	90%	5%	5%
3	**Low areas**	90%	5%	5%
4	**Agricultural areas**	86%	10%	4%
5	**Industrial area**	66%	14%	10%
6	**Military areas**	50%	30%	20%

Number of respondents = 50

In respect to ***industrial areas***, most respondents (66%; Q15.5) answered a lot, while the remainder either said a little or not at all. This highlights that most respondents thought industrial areas will be influenced by climate change. When asked about ***military areas***, most the respondents (50%; Q15.6) agreed a lot, while just 30% answered a little, and the remainder answered not at all. Once again, most respondents believe that military areas will be impacted.

Finally, in responses to ***airport and harbours***, most respondents (80%; Q15.7) agreed a lot, even though a minority thought climate change would have little or no effect on airports and harbours. The results show that most agreed a lot with the statement meaning that climate change will influence various sectors across Nigeria.

9.21 What impacts do you think climate change will have (Q16)?

Most the respondents (52%; Q16.1) agreed a lot, that climate change will '***reduce water availability***', while 28% said they were a little concerned, and the remainder answered not at all (Table 9.12). The result shows that most respondents answered that climate change will result in reduced water availability. Similarly, most respondents (55%; Q16.2) agreed a lot, when asked about '***pressure on drainage and sewage***', 40% agreed a little, and just 5% said not at all. The results show most of the Nigerian government said the climate change will put pressure on drainage and sewage systems. Furthermore, most respondents (63%; Q16.3) agreed a lot to '***increase in need for irrigation***', while 32% agreed a little with the statement. The remainder (5%) said not at all. The result suggests that most government officials believe that increased irrigation is needed due to water shortage and drought in some agricultural States.

When asked if climate change will ***impact hydropower***, (61% Q16.4) answered a lot and 31% answered a little. The result highlights that the majority were concerned that climate change will influence hydropower; this has been experienced in some States in Nigeria. Furthermore, most respondents (57%; Q16.5) agreed a lot about the potential risk of '***increased flooding***', while 38% answered a little, highlighting that most respondents think climate change will result in increased flooding (see Chapter 8). In Q16.6, most government officials (65%) thought climate change will impact '***infrastructure***', agreed a lot, while others either agreed a little or not at all, highlighting that most government officials in Nigeria were concerned that climate change will cause damage to infrastructural facilities. In respect to the impact of climate change on '***loss of land***', most respondents (71%; Q16.7) agreed a lot, while others answered a little and not at all (12% and 17%, respectively). Finally, the majority (65%; Q16.8) agreed a lot '***increased risk of drought***'. While others agreed a little (25%), and the remainder answered not at all, highlighting that most were concerned that climate change will result in increased risk of drought (see Chapter 3).

In general, most the governmental officials are aware of the causes and effects of climate change.

Table 9.12: Impact of climate change (Q16)

	Question	A lot	A little	Not at all
1	**Reduced water availability**	52%	28%	20%
2	**Pressure on drainage and sewage**	55%	40%	5%
3	**Increase in need for irrigation**	63%	32%	5%
4	**Impact on hydropower**	61%	31%	8%
5	**Increased flooding**	57%	38%	5%
6	**Infrastructure damage**	65%	22%	13%
7	**Loss of land**	71%	12%	17%
8	**Decrease in drought**	65%	25%	10%

Number of respondents = 50

9.22 What do you think is the major concern in Nigeria (Q17)?

These section attempts to understand which environmental and social issues are of concern to government officials (Table 9.13). Most respondents answered yes to Flooding (70%), Litter (75%), and Hole in the ozone layer (65%), Poor waste management (75%), Climate change (90%), Deforestation (85%), Traffic congestion (70%), Pollution (80%), and Animal extinction (65%). The results show that most government officials were more concerned with climate change and deforestation (95% and 90%, respectively).

Table 9.13: Major concerns

Question	Yes	No
Flooding	70%	30%
Litter	75%	25%
Hole in the ozone layer	65%	35%
Poor waste management	75%	25%
Climate change	95%	5%
Deforestation	90%	25%
Traffic congestion	70%	30%
Pollution	80%	20%
Animal extinction	65%	35%

Number of respondents = 50

9.23 Which of the following have been implemented (Q18)?

This section was similar to Q23, Chapter 8, and aims to explore in depth achievements of the agricultural industry over the years in Nigeria. As a result, some questions were asked regarding what has been implemented, planned and needed. The following section comprises answers from what the government respondents thought should be ***Implemented, planned or were needed*** (Table 9.14).

Most government respondents (70%; Q18.1) said ***flood protection***, and 20% said that it had either been constructed or was planned, and the remainder said it was needed. Similarly, most thought that ***drought protection*** was implemented, which accounted for (75%; Q18.2), while 15% said it was planned and 10% said it was needed. In Q18.3, 70% thought that some form of ***coastal protection*** had been constructed, while others thought it has been planned or was needed. Furthermore, in respect to ***natural retention of floodwater,*** most government officials (90%; Q18.4) thought that they have been involved in schemes that have already been implemented, while just 5% thought that this was required. Once again, the majority (85%; Q18.5) thought that plans to ***restrict development in risk areas*** were implemented, while others thought it was either planned or needed.

Most respondents (70%; Q18.6) thought ***improved standards of development***, have already been implemented, while, 21% said that this has been planned and just 19% said it was needed. This highlights that the majority was of the view that improved standard of development have been implemented. Most government officials (77%; Q18.7) also said that improved ***forecasting and monitoring of information***, have been implemented and 10% said it was planned, while, just a few thought it was needed. The results show that most government officials claimed it was implemented. Unsurprisingly, (75%; Q18.8) said that ***improved insurance against flooding***, have been implemented, 20% suggested that this was needed and the remainder said it was planned. The result highlights that most respondents claimed that improved insurance against flooding has been achieved; however, others claimed it was needed.

In responses to ***increased supply of water***, most respondents (63%; Q18.9) said that this was either planned or needed. Importantly, only 17% thought that increased water supply had been planned, while 20% said it was needed. Once again, most respondents claimed that increasing water supply has been achieved. When asked about ***economic instruments such as water pricing*** most respondents (64%; Q18.10) said that had already been implemented, 20% of the respondents thought it was needed and others said it was planned. Even though most respondents said that it was implemented, others thought it was needed. In contrast, (59%; Q18.11) said ***restrictions of water use,*** had been implemented, while 30% said it was needed, and others said planned. The results suggest that most government officials said it was implemented, while some suggested that it was needed.

Most governmental officials (79%; Q18.12) said that ***measures to improve water balance*** have already been implemented, while only 15% said that this had already been planned and others said it was needed. The results suggest that there have been limited measures put in place to improve water balance.

When asked about ***drought protection***, most respondents (73%; Q18.13) said it has been implemented, while others said it has been planned (20%), and the remainder suggested that it is needed. The result suggests that drought protection has been considered for mitigation. Once again, most respondents (86%; Q18.14) said that this was implemented, while 10% suggested that this had been planned, and just 4% thought it was needed. The result suggests that new legislation should be implemented in order to mitigate and adapt to the effect of climate change in Nigeria.

When government officials were asked about ***economic incentives and financial mechanism***, most thought improvements had already been implemented (79%; Q18.15), and 10% said that this has already been planned, while 11% of respondents said this was needed. This suggests that most respondents believe that improved economic incentives and financial mechanisms have been implemented in Nigeria. Once again, the majority (71%; Q18.16) thought that schemes that involve ***awareness raising and campaigns*** have been implemented, and just 5% say it was planned and 14% thought this was needed. The results show that campaigns designed to raise awareness implemented in Nigeria have been effective.

Table 9.14: Implemented, planned and needed measures for adaptation and mitigation (Q18)

		Implemented	Planned	Needed
1	**Flood protection**	70%	20%	10%
2	**Drought protection**	75%	15%	10%
3	**Coastal protection**	70%	20%	10%
4	**Natural retention of flood water**	90%	5%	5%
5	**Restricting development in risk areas**	85%	10%	5%
6	**Improved standards for development**	70%	21%	9%
7	**Improved forecasting and monitoring information**	77%	10%	3%
8	**Improved insurance schemes against flooding**	75%	5%	20%
9	**Increased supply of water**	63%	17%	20%
10	**Economic instruments such as water pricing**	64%	16%	20%
11	**Restrictions of water use**	59%	11%	30%
12	**Measures to improve water balance**	79%	15%	6%
13	**Drought mitigation**	73%	20%	7%
14	**New or revised legislation**	86%	10%	4%
15	**Economic incentives or financial mechanism**	79%	10%	11%
16	**Awareness raising or campaigns**	34%	37%	29%

Number of respondents = 50

9.24 Climate change adaptation initiative action (Q19)

When respondents were asked if any climate change adaptations have already been put in place most respondents of (85%) said yes. This suggests that most respondents believe that improvements have been considered to mitigate and adapt to climate change in Nigeria.

9.25 Which organisations are you involved with (Q20)?

Most government officials worked for the **Ministry of Agriculture**, **Nigerian Meteorological Agency** and the **Ministry of Environment**. Most worked with the Department of *Agriculture and Natural Resources* and others worked with the Department of *Weather Forecasting and Services*. As a result, most of the respondents were informed about climate change from their jobs.

9.26 Further comments (Q21)

Most government officials commented that they were fully involved both individually and collectively in addressing climate change issues in Nigeria, as well as providing policies and legislation to address environmental issues.

9.27 Summary

This chapter comprised two sections – public and government perceptions of climate change. Results show that most respondents between the two groups are fully aware and concerned about climate change. Most respondents were females and most of those interviewed were between the ages of 18-25. The result also showed that male and female views aged 18–25 were quite similar when compared to the older aged respondent. This is because most of the older respondents tend to have experienced the effects of climate change more especially among the farming communities when compared to the younger age groups. Most of Nigerian public are aware of the causes and impacts of climate change, with most of them obtaining information from mass media. However, most of the public claimed that climate change is caused by both human and natural factors, and they are willing to adjust their lifestyle in order to mitigate climate change. Analysis of questionnaires showed that the majority are willing to spend their resources as a means of addressing climate change issues. The government has a vital role to play and as a result, most government officials claimed to be involved in regulations and climate change adaptation strategies. The main objectives of Chapter 9 were to analyse the Nigerian public and government perception to climate change in Nigeria, satisfying two of the main aims of this research project, as detailed in Chapter 1 (Section 1.3). The next chapter presents results of statistical analyses applied to Chapters 8 and 9 results, and will conclude with an evaluation of results from all three chapters.

Chapter 10: Comparative analysis of questionnaires

10.1 Introduction

It was clear from earlier results that most respondents, irrespective of sample group, were concerned about climate change and related environment issues. Therefore, by direct comparison and statistical analysis this chapter draws together the results of Chapters 8 and 9, to identify differences between the three studied groups in terms of climate change concerns.

10.2 Analysis of socio-economic factors among groups

The results of Sections 8.2, 9.2.1 and 9.11.1 showed that in each sample group most respondents were female, with percentages that ranged between 52% and 61%. Interestingly, the age groups of the respondents varied with the youngest group emanating from members of the public (18-25 yrs.), and oldest from government officials (46-55 yrs.). Most responses received from farmers were in the age group 36-45 yrs.

10.2.1 Educational Qualifications

Forty percent of farmers had no formal education, and just 23% had attended high school. Ninety percent of the populous were educated and 40% had attended high school and 99% of government officials had attended high school.

Of those respondents that had qualifications at degree level and above, 21% were farmers, while 33% of the public, and 35% of the government had a first degree also. In addition to the above, 11% of farmers, 10% of the public and 47% of those employed by the Government had attained a Master's degree. Significantly, the results show that >80% of Government employees had attained a degree or higher qualification. This is as a consequence of the audience requested to complete the questionnaire (government policy makers). Six percent of public respondents and 13% of government officials had achieved PhD status but no farmers had received such an accolade. These results were unsurprising, as the farming community are generally made up of manual workers not requiring higher degree level status. However, what is of interest is the apparent lack of formal education amongst this populous, when consideration is given to the study by Whitmarsh, (2005), who suggested that those who are highly educated, holding a Master's degree and a PhD, are more likely to have heard about climate change and other environmental issues when compared to a less educated population.

Across the globe, most farmers are faced with issues such as lack of education that may influence their adaptive capacity to climate change. Education plays a vital role towards the knowledge, concerns, and perceptions of this phenomena. For instance, most government officials were able to define climate change and its implications, but very few farmers and public respondents could make that distinction. The results suggest that encouraging education within Nigerian farming communities would increase awareness and contribute to the potential of mitigation and adaptation to future climate change.

10.2.2 Employment status and time of employment

Forty-eight percent of both farmers and public were self-employed and all government officials were directly employed by the respective government agency. In terms of employment time, 39% of farmers, 57% of the public, and only 9% of governmental officials had been employed for less than five years. But over the longer term these percentages were almost reversed, with 28% of farmers, 12% of the public, and 35% of government officials had been employed for between 11-15 years, with a small percentage of farmers (4%), public (96%), and government officials (9%) employed for over 16 years. This highlights that most government officials had longer working experience compared with other groups.

10.2.3 Distance and mode of travel

Most public respondents travelled less than five miles or between 6-10km (64%, Section 9.2.1). In contrast, the distance travelled to work by farmers and government officials showed a wider spread across the mileage ranges, but the percentages for both groups were between 11-15km (Sections 8.2 and 9.11.1). Results also showed that farmers were more likely to travel greater distances to find work, with 12% travelling >20km.

10.2.4 Number of dependents

Most public respondents (43%) were listed as having no dependents. Most farmers (50%) had between 1-3 dependents, and 21% had between 4-6 dependents (Section

8.2) and 5% farmers had >7 dependents. However, this question was not integrated in the questionnaires of the government officials. Even though these results suggest that farmers had more dependents when compared to public responses, this is obviously a function of the respondent age groups, where most public responses emanated from a much younger sample group (Section 10.2).

10.3 Responsibilities for tackling climate change: farmers, public and government

10.3.1 International groups

Table 10.1 shows that most public responses (52%) were of the view that international groups, such as the UN and IPCC should oversee climate change controls. Similarly, 82% of farmers also suggested that international groups should oversee climate change. This is perhaps because many had been involved in the financial mechanisms employed to address climate change throughout the African regions.

Table 10.1 : Should international groups be responsible for tackling climate change

International groups	Yes	No
Farmers	82%	18%
Public	52%	47%
Government	30%	70%

Number of respondents = 678

10.3.2 Environmental groups

Table 10.2 shows that most public respondents (63%) were of the view that environmental groups should oversee climate change, while most farmers (62%) did not hold environmental groups responsible. One of the reasons for this difference is perhaps that a higher percentage of the public have been part of environmental organisations, and are involved in awareness campaigns against climate change organisation such as Friends of the Earth. For example, these environmental groups mainly consist of the public who are actively willing to raise climate change awareness.

Table 10.2: Should environmental groups be responsible for tackling climate change

Environmental groups	Yes	No
Farmers	38%	62%
Public	63%	37%
Government	53%	47%

Number of respondents = 678

10.3.3 Government

Table 10.3 results highlight most government officials (44%) were of the view that the government should oversee climate change, while most farmers (70%) did not hold the government responsible. Most government officials claimed to have been involved in addressing issues relating to climate change. This corresponds with the results of the government.

Table 10.3: Should government be responsible for tackling climate change

Government	Yes	No
Farmers	30%	70%
Public	33%	67%
Government	44%	56%

Number of respondents = 678

10.4 Causes of climate change: farmers, public and government

Table 10.4 results highlighted that most public respondents thought climate change was caused by natural factors (24%). In contrast, most farmers (41%) thought it was caused by anthropogenic factors, and most government officials (49%) thought it was caused by a combination of both. Anthropogenic factors are attributed to have resulted from the increasing use and burning of fossil fuel, coupled with the rapid increase in human population and industrialization (de las Heras, 2014).

Table 10.4 : Causes of climate change

Causes of climate change	Anthropogenic	Natural	Both	I don't know
Farmers	19%	41%	29%	10%
Public	24%	31%	34%	9%
Government	13%	39%	49%	Nil

Number of respondents = 678

10.5 Adaptation and mitigation strategies to climate change: farmers, public and government

When assessing relationships between categorical variables, it is not possible to use the mean or similar static, because the variables have been measured continuously. In such cases, the Pearson chi-square test is most appropriate (Field, 2005; Fitch, 2002).

When asked whether ***'the public can do a bit to reduce climate change'*** most farmers and public respondents (84%) agreed, while most government respondents (26%) disagreed. The results highlight that most of the public and farmers thought something can be done to reduce climate change, whereas the government thought more is needed externally to address climate change. Table 10.5 shows, the chi-square result was invalid. This result clearly shows a difference in opinion and therefore this is an area that needs addressing when considering adaptation and mitigation approaches.

There was an insignificant relationship between the three groups when asked ***'the public can do a bit to reduce climate change'*** and this was given by the Pearson Chi-Square test, $X^2(2) = 1.495$; $p > 0.05$. However, when odds ratios were assessed against each group, it was clear that the results are influenced by the government responses. It can be observed that the odds of agreement were 2.85 times more likely, whereas both farmers and members of the public where much more likely to agree with the statement (Odds Ratio = 5.25) (Table 10.5).

Table 10.5:a) Percentage results table and b) Chi-square tests

Can we do a bit to reduce climate change?	Agree	Disagree	Odds Ratio
Farmers	84%	16%	5.25
Public	84%	16%	5.25
Government	74%	26%	2.84
a)			

Chi-Square tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.495[a]	2	0.474
Chi-Square Tests	1.331	2	0.514
Linear-by-Linear Association	0.335	1	0.563
No. of Valid Cases	632		
a. 1 cells (16.7%) have expected count <5. The minimum expected count is 3.86. **Result = Invalid** **b)**			

When the question whether *'**people should be encouraged to reduce climate energy consumption**'* was assessed among the groups, most farmers (79%) agreed, while most government officials (39%) disagreed (Table 10.6a). The results suggest that most farmers were willing to reduce their energy consumption in order to mitigate climate change. There was a significant relationship between the three groups when asked ***'people should be encouraged to reduce energy consumption'*** and this was once again given by the Pearson Chi-Square test, $X^2(2) = 6.812$; $p < 0.05$. The odds ratios appear to show that farmers are 3.76 times more likely to agree with the statement and both members of the public and government officials are far less likely to agree (Odds Ratio = 2.33 and 1.57, respectively) (Table 10.6b).

Table 10.6 Reducing energy consumption

Reducing energy consumption	Agree	Disagree	Odds Ratio
Farmers	79%	21%	3.76
Public	70%	30%	2.33
Government	61%	39%	1.57
a)			

Chi-Square Tests			
	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	6.812[a]	2	0.033
Likelihood Ratio	6.895	2	0.032
Linear-by-Linear Association	1.557	1	0.212
No. of Valid Cases	636		

a. 0 cells (.0%) have expected count <5. The minimum expected count is 6.40.

Result = χ^2 Significant & adjusted residuals >2

b)

When the question of whether ***'climate change was inevitable'*** was assessed, once again, most farmers (79%) agreed, while most government officials (39%) disagreed (Table 10.7a). There was a significant relationship between the three groups when asked ***'climate change was inevitable'*** and this was given by the Pearson Chi-Square test, $X^2(2) = 20.508$; $p < 0.01$. The odds ratios appear to show that farmers are 3.76 more likely to agree with the statement and both members of the public and government officials are far less likely to agree (Odds Ratio = 1.63 and 1.56, respectively) (Table 10.7b).

Table 10.7: Inevitability of climate change

Climate change is inevitable	Agree	Disagree	Odds Ratio
Farmers	79%	21%	3.76
Public	62%	38%	1.63
Government	61%	39%	1.56
a)			

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	20.508[a]	2	<0.001
Likelihood Ratio	21.449	2	<0.001
Linear-by-Linear Association	11.165	1	<0.001
No. of Valid Cases	631		

a. 0 cells (.0%) have expected count <5. The minimum expected count is 7.44.

Result = χ^2 Significant &adjusted residuals >2

b)

When asked '***if climate change is a natural phenomenon'***, similarly, most farmers (79%) agreed, while most public respondents (33%) disagreed (Table 10.8a). Quite a substantial percentage of government officials also agreed that climate change is a natural process. There was a significant relationship between the three groups when asked ***'if climate change is a natural phenomenon'***, and this was given by the Pearson Chi-Square test, $X^2(2) = 9.861$; p <0.01. The odds ratios appear to show that farmers are 3.76 times more likely to agree with the statement. Government and members of the public are less likely to agree (Odds Ratio = 2.03 and 2.85, respectively) (Table 10.8b).

Table 10.8: Climate change is a natural phenomenon

Climate change is a natural phenomenon	Agree	Disagree	Odds Ratio
Farmers	79%	21%	3.76
Public	67%	33%	2.03
Government	74%	26%	2.85

a)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.861[a]	2	0.007
Likelihood Ratio	10.161	2	0.006
Linear-by-Linear Association	7.623	1	0.006
No. of Valid Cases	633		

a. 0 cells (.0%) have expected count <5. The minimum expected count is 6.58.

Result = χ^2 Significant &adjusted residuals >2

b)

When asked if '***climate change will improve Nigerian weather'***, most farmers (66%) agreed, while most government officials (70%) disagreed (Table 10.9a). A substantial percentage of public also disagreed with the statement. There was a significant relationship between the three groups when '***climate change will improve Nigerian weather'***, and this was given by the Pearson Chi-Square test, $X^2(2) = 27.246$; $p <0.01$. However, when odds ratios were assessed against each group, it was clear that the results are influenced by the farmer's responses. The odds ratios appear to show that farmers are 1.94 times more likely to agree with the statement. Government and members of the public are less likely to agree (Odds Ratio = 0.43 and 0.85, respectively) (Table 10.9b).

Table 10.9: Climate change will improve Nigerian weather

Will climate change improve Nigerian weather?	Agree	Disagree	Odds Ratio
Farmers	66%	34%	1.94
Public	46%	54%	0.85
Government	30%	70%	0.43

a)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	27.246[a]	2	<0.001
Likelihood Ratio	27.705	2	<0.001
Linear-by-Linear Association	7.744	1	<0.05
No. of Valid Cases	631		

a. 0 cells (.0%) have expected count <5. The minimum expected count is 10.94.

Result = χ^2 Significant & adjusted residuals >2

b)

Sixty percent of the farmers agreed that they were willing to '***act if everyone else does'***. On the contrary, most government officials (70%) disagreed with the statement (Table 10.10a). There was a significant relationship between the three groups when asked '***act if everyone else does'***, and this was given by the Pearson Chi-Square test, $X^2(2) = 24.163$; $p < 0.01$. However, when odds ratios were assessed against each group, it was clear that the results are influenced by the farmer's responses. The odds ratios appear to show that farmers are 1.54 times more likely to agree with the statement, while, government and members of the public are less likely to agree (Odds Ratio = 0.69 and 0.43, respectively) (Table 10.10b).

Table 10.10: Willingness to act if everyone else does

Willingness to act if everyone else does	Agree	Disagree	Odds Ratio
Farmers	60%	39%	1.54
Public	41%	59%	0.69
Government	30%	70%	0.43

a)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	24.163[a]	2	<0.001
Likelihood Ratio	24.346	2	<.0.001
Linear-by-Linear Association	8.605	1	<0.005
No. of Valid Cases	632		

a. 0 cells (.0%) have expected count <5. The minimum expected count is 10.95.

Result = χ^2 Significant &adjusted residuals >2

b)

When asked if it '***was it too late to do anything about climate change***', most farmers (58%) disagreed, while most of the public (67%) disagreed (Table 10.11a). This suggests that the farmers believed it was never too late to make changes towards addressing climate change. There was a significant relationship between the three groups when asked '***was it too late to do anything about climate change***', and this was given by the Pearson Chi-Square test, $X^2(2) = 36.797$; p <0.01. However, when odds ratios were assessed against each group, it was clear that the results are influenced by farmer's responses. The odds ratios appear to show that farmers are 1.38 times more likely to agree with the statement, while, government and members of the public are less likely to agree (odds ratio = 0.75 and 0.49, respectively) (Table 10.11b).

Table 10.11: is it too late to do anything about climate change?

Is it too late to do anything about climate change?	Agree	Disagree	Odds Ratio
Farmers	58%	42%	1.38
Public	33%	67%	0.49
Government	43%	57%	0.75

a)

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	36.797[a]	2	<0.001
Likelihood Ratio	36.737	2	<0.001
Linear-by-Linear Association	26.427	1	<0.001
No. of Valid Cases	631		

a. 0 cells (.0%) have expected count <5. The minimum expected count is 9.66.

Result = χ^2 Significant &adjusted residuals >2

b)

Most farmers (67%) agreed that '***climate change is something frightening***', while most of the public (42%) disagreed (Table 10.12a). This result suggests that farmers' experiences have led them to believe that climate change will impact their occupation and livelihood. There was an insignificant relationship between the three groups when asked '***climate change is something frightening***', and this was given by the Pearson Chi-Square test, $X^2(2) = 4.187$; $p > 0.05$. The odds ratios appear to show that farmers are 2.03 times more likely to agree with the statement, while, government and members of the public are less likely to agree (Odds Ratio = 1.50 and 1.38, respectively) (Table 10.12b).

Table 10.12: Climate change is frightening

Climate change is frightening	Agree	Disagree	Odds Ratio
Farmers	67%	33%	2.03
Public	58%	42%	1.38
Government	60%	40%	1.50

a)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.187[a]	2	0.123
Likelihood Ratio	4.231	2	0.121
Linear-by-Linear Association	2.769	1	0.096
No.of Valid Cases	633		

a. 0 cells (.0%) have expected count <5. The minimum expected count is 8.83.

Result = χ^2 Not significant

b)

Most farmers (65%) agreed that they were ***'uncertain as to whether climate change is really happening***'. Most government officials (60%) disagreed (Table 10.13a). There was a significant relationship between the three groups when asked ***'are you certain as to whether climate change is really happening***', and this was given by the Pearson Chi-Square test, $X^2(2) = 21.829$; $p < 0.01$. However, when odds ratios were assessed against each group, it was clear that the results are influenced by farmer's responses. The odds ratios appear to show that farmers are 1.86 times more likely to agree with the statement, while government and members of the public are less likely to agree (Odds Ratio = 0.89 and 0.67, respectively) (Table 10.13b).

Table 10.13: Uncertainty of climate change

The uncertainty of climate change	Agree	Disagree	Odds Ratio
Farmers	65%	35%	1.86
Public	47%	53%	0.89
Government	40%	60%	0.67
a)			

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	21.829[a]	2	<0.001
Likelihood Ratio	22.133	2	<0.001
Linear-by-Linear Association	8.867	1	<0.005
No. of Valid Cases	633		

a. 0 cells (.0%) have expected count <5. The minimum expected count is 10.79.

Result = χ^2 Significant &adjusted residuals >2

b)

When asked '***if the developed countries are to be blamed for climate change***', most farmers agreed, while most of the public disagreed. There was a significant relationship between the three groups when asked '***if the developed countries are to be blamed for climate change***', and this was given by the Pearson Chi-Square test, $X^2(2) = 21.829$; $p < 0.01$. However, when odds ratios were assessed against each group, it was clear that the results are influenced by farmer's responses. The odds ratios appear to show that farmers are 1.86 times more likely to agree with the statement, while, government and members of the public are less likely to agree (Odds Ratio = 1.27 and 0.79, respectively) (Table 10.14).

Table 10.14: Are developed countries to be blamed for climate change?

Are developing countries to be blamed for climate change?	Agree	Disagree	Odds Ratio
Farmers	65%	35%	1.86
Public	44%	56%	0.79
Government	56%	44%	1.27
a)			

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	27.174[a]	2	<0.001
Likelihood Ratio	27.527	2	<0.001
Linear-by-Linear Association	21.106	1	<0.001
No. of Valid Cases	632		

a. 0 cells (.0%) have expected count <5. The minimum expected count is 11.14.

Result = χ^2 Significant & adjusted residuals >2

b)

Most (62%) public respondents agreed that ***'big changes to society are needed to mitigate climate change'***. Most farmers (64%) agreed with the statement, while most government officials disagreed. There was an insignificant relationship between the three groups when asked ***'big changes to society are needed to mitigate climate change'***, and this was given by the Pearson Chi-Square test, $X^2(2) = 0.351$; $p > 0.05$. The odds ratios appear to show that farmers are 1.78 times more likely to agree with the statement, while, government and members of the public are slightly less likely to agree (Odds Ratio = 1.63 and 1.56, respectively) (Table 10.15).

Table 10.15: Changes are needed to mitigate climate change

Big changes are needed to mitigate climate change	Agree	Disagree	Odds Ratio
Farmers	64%	36%	1.78
Public	62%	38%	1.63
Government	61%	39%	1.56
a)			

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.351[a]	2	0.839
Likelihood Ratio	0.352	2	0.839
Linear-by-Linear Association	0.141	1	0.708
No. of Valid Cases	634		

a. 0 cells (.0%) have expected count <5. The minimum expected count is 8.60.

Result = χ^2 Not significant

b)

When asked '***if the evidence for climate change is unreliable***', most farmers (61%) agreed, while most government officials (74%) disagreed. The results suggest that most government officials believe that there are reliable sources of climate change which are evident today. There was a significant relationship between the three groups when asked '***if the evidence for climate change is unreliable***', and this was given by the Pearson Chi-Square test, $X^2(2) = 14.120$; $p < 0.01$. The odds ratios appear to show that farmers are 1.56 times more likely to agree with the statement, while, government and members of the public are far less likely to agree (Odds Ratio = 0.35 and 1.00, respectively) (Table 10. 16).

Table 10. 16 : Unreliable evidence of climate change

Unreliable evidence of climate change	Agree	Disagree	Odds Ratio
Farmers	61%	39%	1.56
Public	50%	50%	1.00
Government	26%	74%	0.35
a)			

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	14.120[a]	2	0.001
Likelihood Ratio	14.389	2	0.001
Linear-by-Linear Association	.640	1	0.424
No. of Valid Cases	630		

a. 0 cells (.0%) have expected count <5. The minimum expected count is 10.84.

Result = χ^2 Significant & adjusted residuals >2

b)

Most farmers (52%), agreed that '***people are too selfish to do anything about climate change***', while 48% of the government disagreed. There was a significant relationship between the three groups when asked '***people are too selfish to do anything about climate change***', and this was given by the Pearson Chi-Square test, $X^2(2) = 11.573$; $p < 0.01$. The odds ratios appear to show that farmers are 1.94 times more likely to agree with the statement, while government and members of the public are less likely to agree (Odds Ratio = 1.08 and 1.08, respectively) (Table 10.17).

Table 10.17: People too selfish to do anything about climate change

People too selfish to do anything about climate change	Agree	Disagree	Odds Ratio
Farmers	66%	34%	1.94
Public	52%	48%	1.08
Government	52%	48%	1.08
a)			

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.573[a]	2	0.003
Likelihood Ratio	11.740	2	0.003
Linear-by-Linear Association	6.391	1	0.011
No. of Valid Cases	632		

a. 0 cells (.0%) have expected count <5. The minimum expected count is 9.83.

Result = χ^2 Significant & adjusted residuals >2

b)

10.7 Overall analysis

The three groups showed a high degree of understanding with regards to the effects of climate change. However, these groups displayed differing views about the cause of climate change.

Most of the public thought that climate change is caused by natural factors. Farmers attributed climate change to anthropogenic factors and government officials held the view that it was caused by a combination of both factors. Group responses differed when consideration was given to those who should be responsible for tackling climate change. Most farmers agreed that the international community should oversee climate change issues and unsurprisingly the government officials suggested that they should oversee the issues of climate change. The literature review (Chapter 2) highlighted that Nigerian agriculture faces climate change challenges that was partially confirmed quantitatively, in Chapter 7. The agricultural adaptation in response to climate change is relevant and dependents on several factors. For instance, , farmers had the lowest level of educational qualification compared to other group(Section 10.2.1) . As a result, it would appear that they need more education to aid adaptation and mitigation of climate change. Analysis shows that the farming community is definitely aware of climate change (Section 8.8), as they see physical changes but it is the interpretation of documented evidence that would be of concern.

This study has shown that farmers' perceptions are essential to policy making, as most respondents fully understand the cause and effect of climate change. The public were also aware of the causes and effect of climate change, as many claimed to have experienced rapid changes in weather patterns, as well as the natural disasters that have been occurring in many parts of the world. The government, who are the policy makers, showed a deep understanding and were able to define climate change.

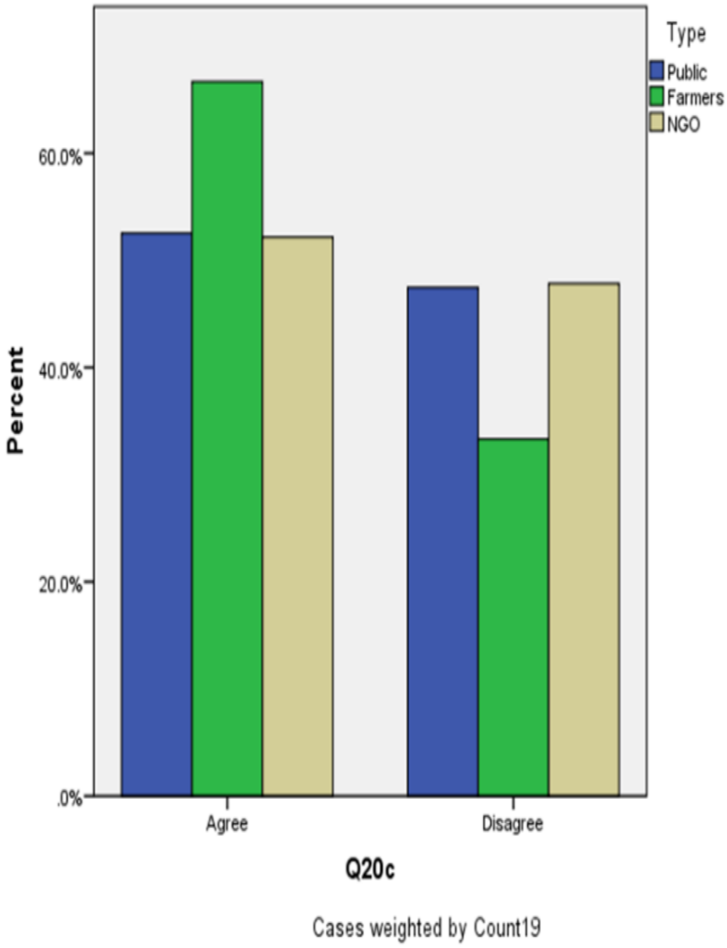

Figure 10.1: Percentages of all groups that agreed and disagreed

10.8 Implemented, planned and needed measures for adaptation and mitigation

The following section comprises what the farmers and government respondents thought should be ***Implemented and planned, or were needed*** to address climate change and associated environmental issues.

10.8.1 Flood protection

Figure 10.2 highlights that 70% of government officials think that flood protection (e.g. drainage, dams and levees) have been implemented, likewise most (61%) of the farming community thought it has been implemented. This suggests that flood protection has been incorporated to mitigate and adapt to climate change in Nigeria.

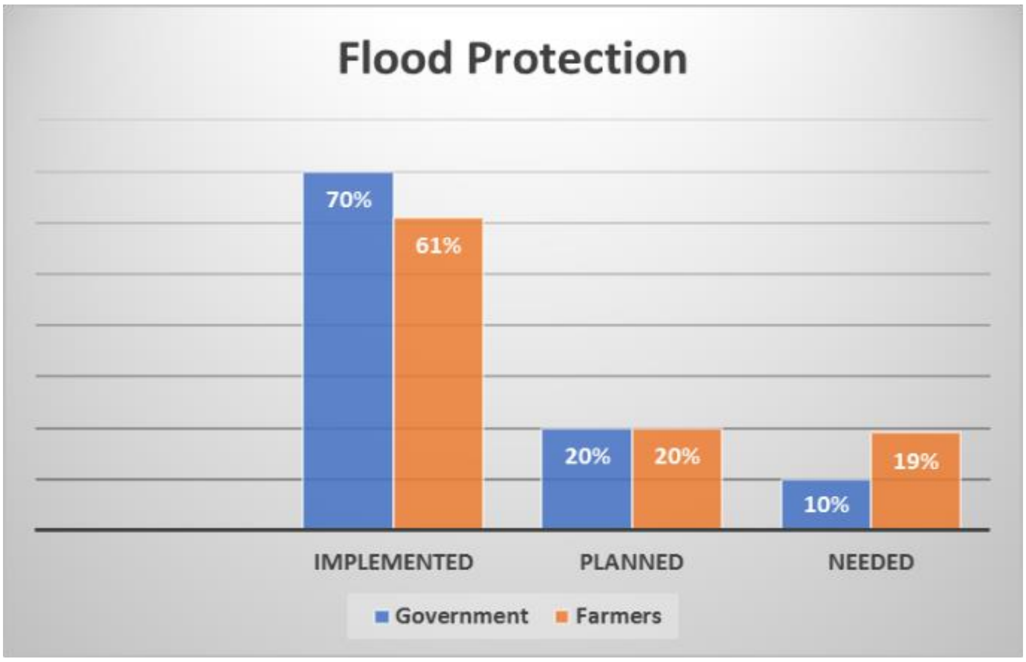

Figure 10.2: Flood protection.

10.8.2 Drought protection

Figure 10.3 highlights that 75% of government officials think that drought protection has already been implemented, while 52% of farmers acknowledge this to be the case. The difference in results might suggest a lack of communication between the people on the ground and officials in that more might have been done than the farmers are aware of. Alternatively, most farmers may just feel they need further drought protection to be considered. Drought is a major issue faced by most farmers (Section

3.2), resulting in lower crop yields, and increased use of fertilizers, increased vulnerability to pests and diseases, as well as higher costs of irrigation practises, especially in northern Nigeria. Farmers' ability to cope with the impact of drought in Nigeria is highly dependent on governmental adaptation policies.

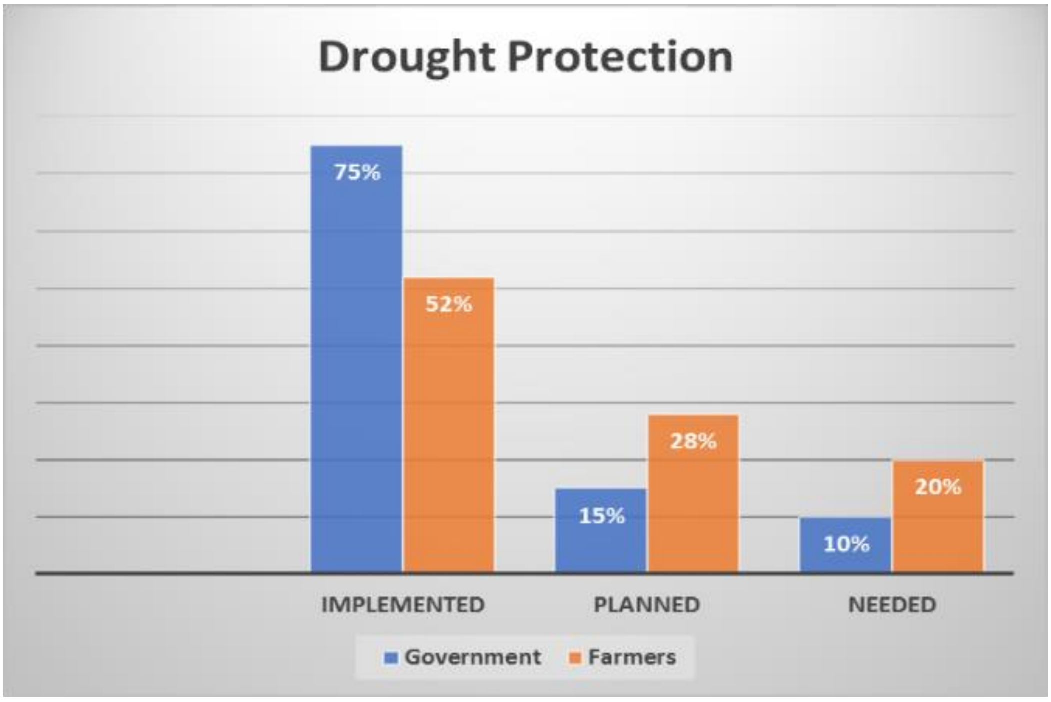

Figure 10.3: Drought protection.

10.8.3 Coastal protection

Figure 10.4 highlights that 70% of government officials think that coastal protection has been implemented and yet the farming community suggest that little has been implemented. In contrast, and influenced by the previous results, farmers are under the impression more is needed or planned (47%). This implies that farmers consider that coastal protection needs to be integrated into climate change mitigation and adaptation polices. According to Awolaja (2014), many local communities in Nigeria are vulnerable to coastal erosion, which has caused loss of farmlands and erosion of top-soil. As a result, many of communities are seeking government intervention.

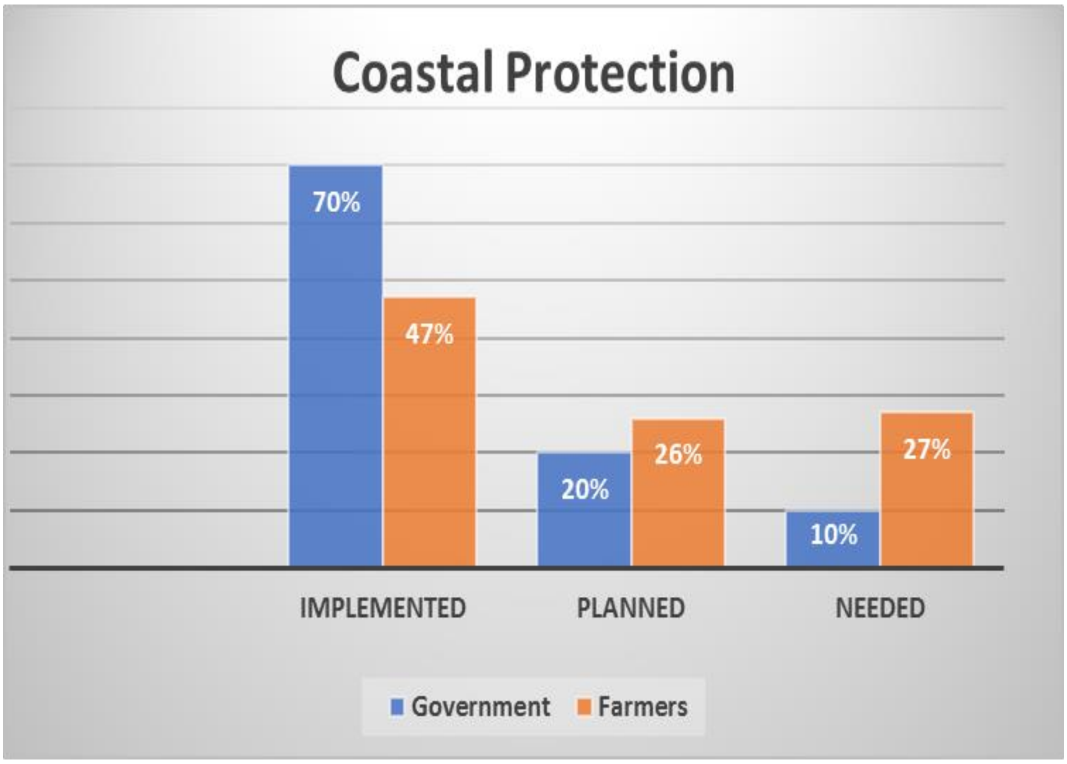

Figure 10.4: Coastal protection.

10.8.4 Natural retention for flooding

Figure 10.5 highlights that 90% of government officials think that natural retention of water for flooding (e.g. drainage, dams and levees) has been implemented and yet the farming community suggest that too little has been implemented. In contrast, and influenced by the previous results, farmers are under the impression that works are planned (41%). This suggests that the varying views require further analysis.

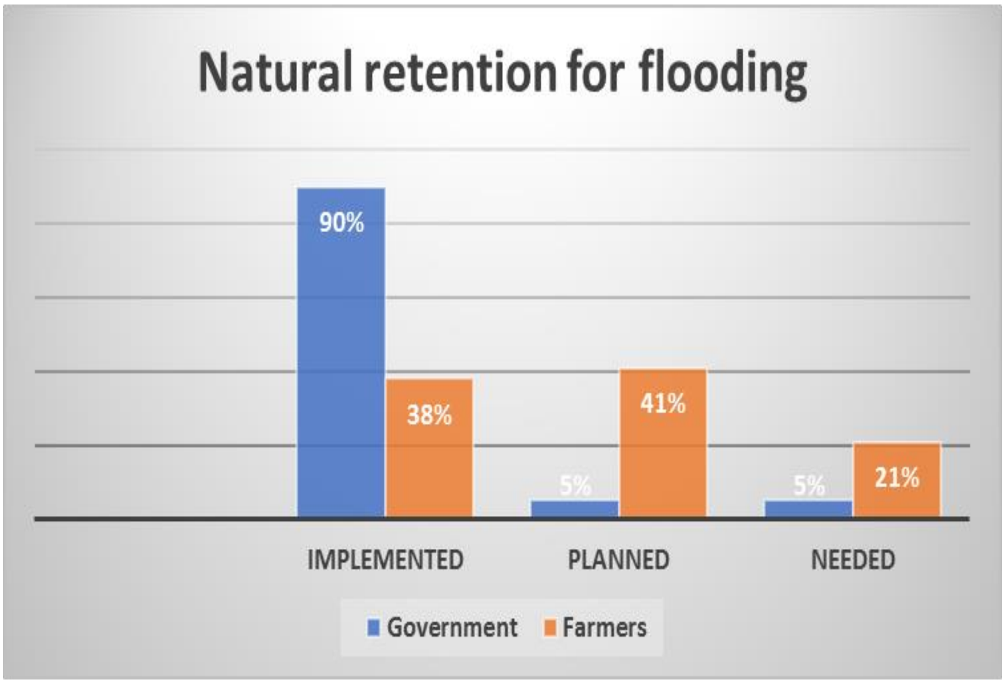

Figure 10.5: Natural retention for flooding.

10.8.5 Restricting development in risk areas

Figure 10.6 highlights that 85% of government officials think that restricting development in risk areas had been implemented. This is contrary to the farmer's views, as just 23% thought restricting development in risky areas had been implemented. Instead, 77% of farmers thought it is either planned or needed. This suggests that the varying views require further analysis. Furthermore, the results suggest that according to government records, minimal progress has been made towards restricting development in risky areas. However, most farmers consider this to be planned.

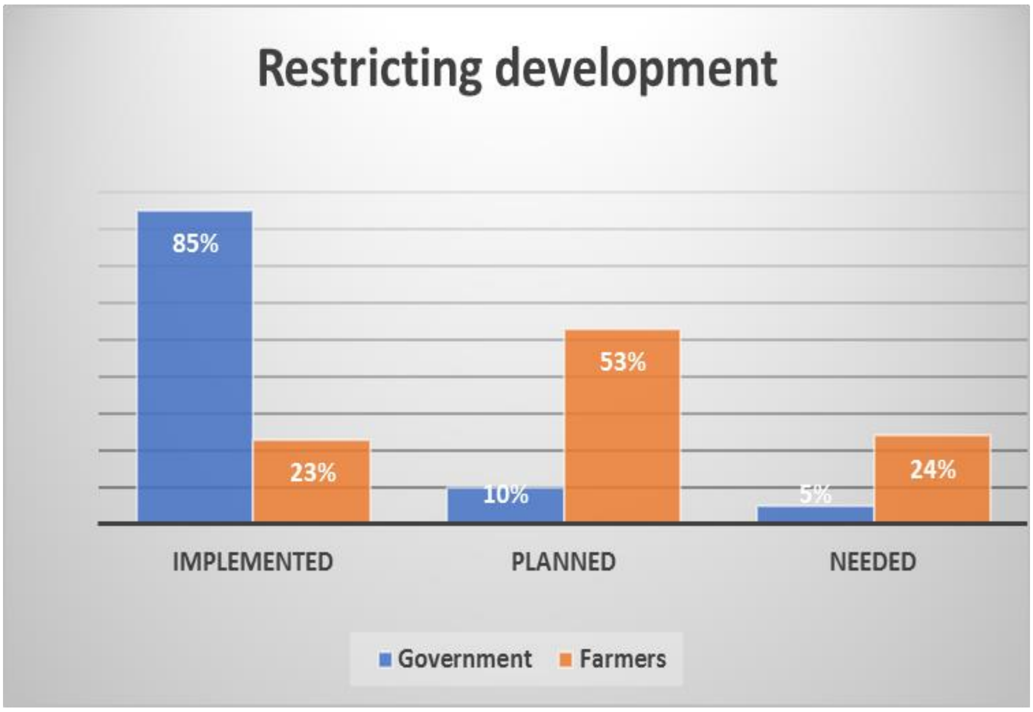

Figure 10.6: Restricting development in risk areas.

10.8.6 Improved development

Figure 10.7 highlights that 85% of government officials think that improved development has been implemented. However, most farmers (69%) thought this to be merely planned or needed. This is because most improved development occurs in urban Nigeria, whereas most farmers are situated in rural areas. Therefore, much is needed to improve development across Nigeria. This suggests that the varying views require further analysis.

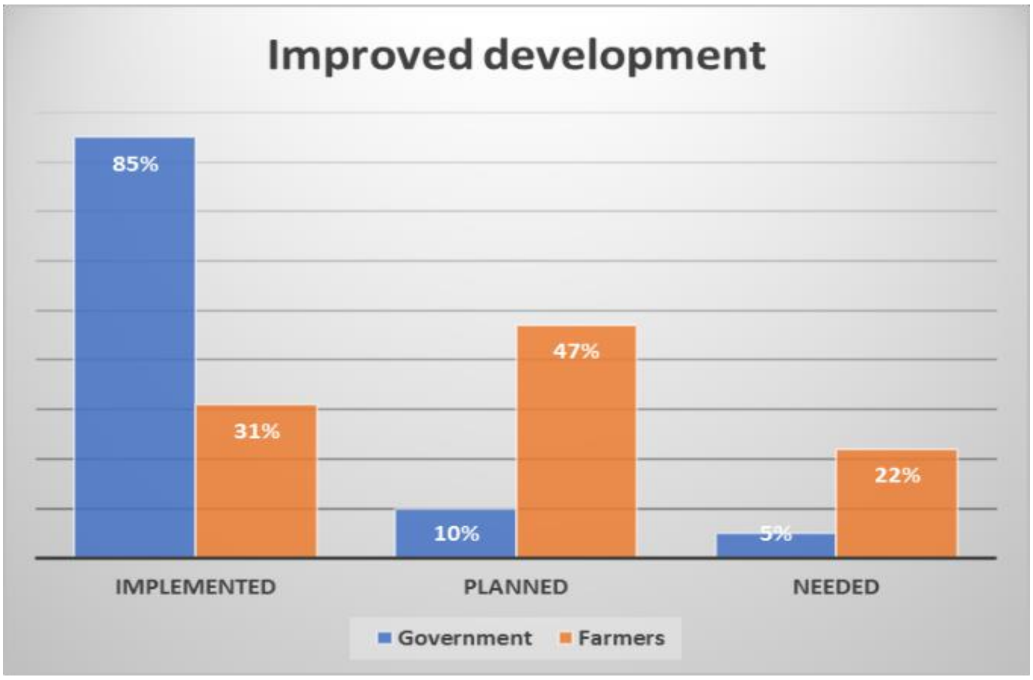

Figure 10.7: Improved development.

10.8.7 Improved forecasting and monitoring of information

Figure 10.8 highlights that 77% of government officials think improved forecasting and monitoring of information has been implemented. This was contrary to farmers' (22%) responses, where the majority considered improved forecasting and monitoring of information as either planned or needed. Improved forecasting and monitoring of information is one of the ways of mitigating climate change. This suggests that the varying views require further analysis, as very few farmers considered that improved forecasting and monitoring had been implemented. This can help pass information to farmers during natural disasters, especially those that may impact farmlands.

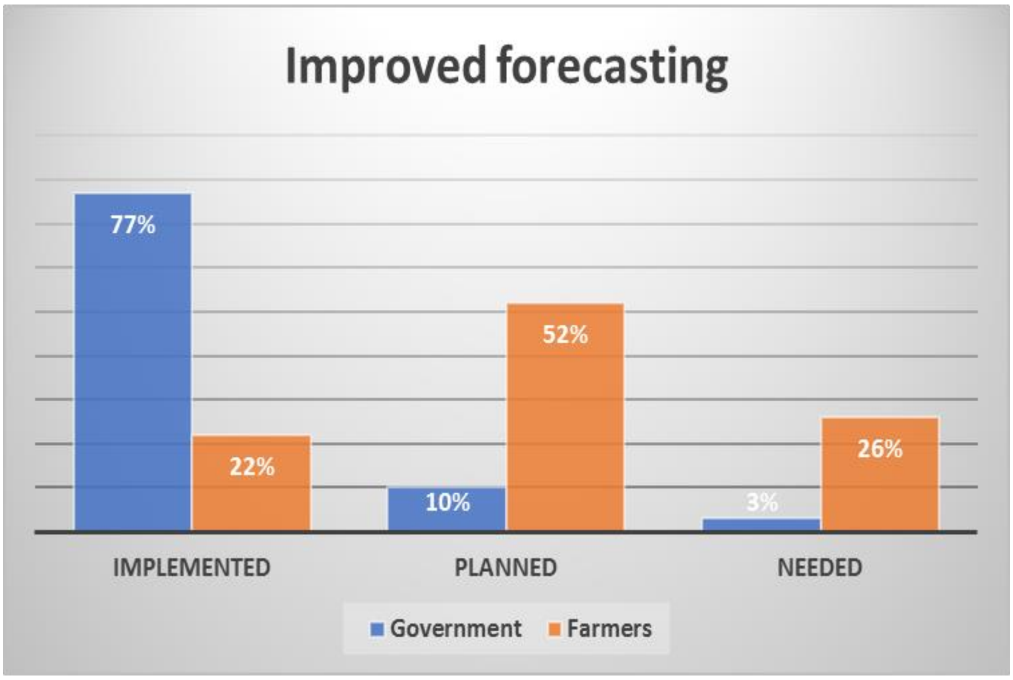

Figure 10.8: Improved forecasting.

10.8.8 Insurance against flooding

Figure **10.9** highlights that 75% of government officials think insurance and against flooding has already been implemented, while, just 27% of the farmers thought this have been achieved. Instead, most farmers (73%) considered this either planned or needed. In most parts of Nigeria, flooding has caused severe losses to farming communities but most farmers are unable to afford insurance.. The result suggest that more is needed in order to mitigate and adapt to climate change.

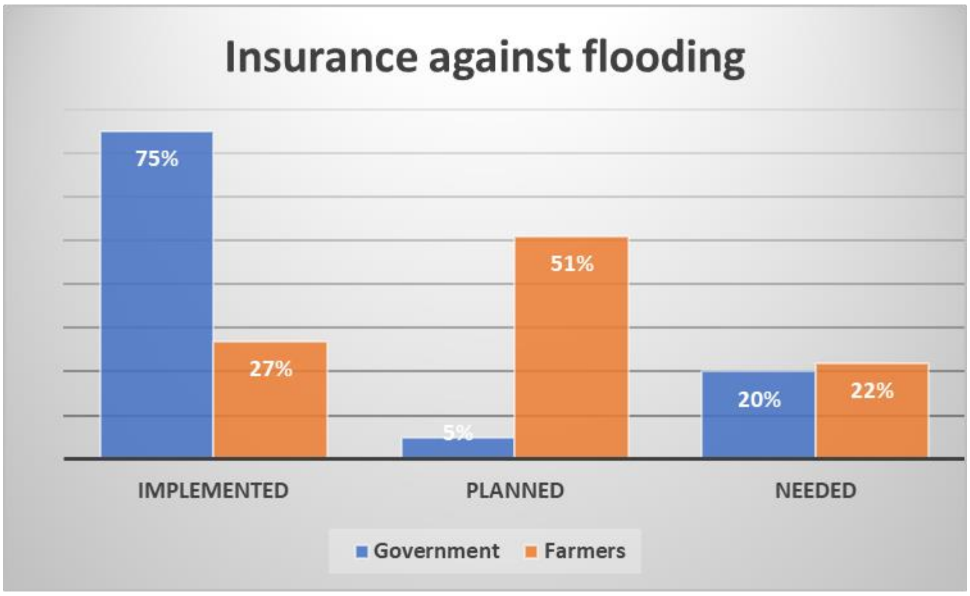

Figure 10.9: Insurance against flooding.

10.8.9 Increased water supply

Figure 10.10, highlights that 63% of government officials think increased water security has been implemented while, just 27% of farmers thought this was the case. Most farmers (69%) answered that it was either planned or needed and this indicates that much more is needed to improve water supply, especially in rural areas. Water supply is essential to agriculture: inadequate water supply causes poor crop yield (see Chapter 7), as well as threatening food security, as experienced in many parts of Africa.

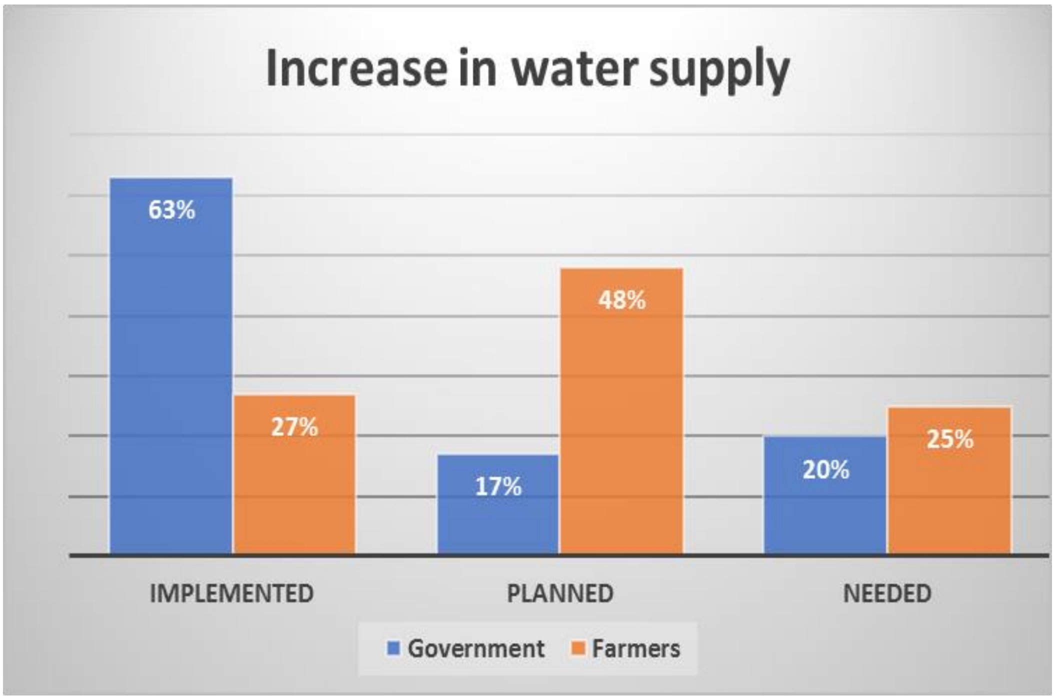

Figure 10.10: Increase in water supply.

10.8.10 Economic instruments

Figure 10.11 result shows that 75% of government officials think that economic instruments such as permits, pollution taxes and laws protecting natural resource depletion, have been implemented in comparison to just 30% of farmers. Most farmers (70%) believe that the implementation of economic instruments is either needed or planned. This implies that the farmers were of the view that more is needed. The result suggests economic instruments are needed to improve farming in Nigeria.

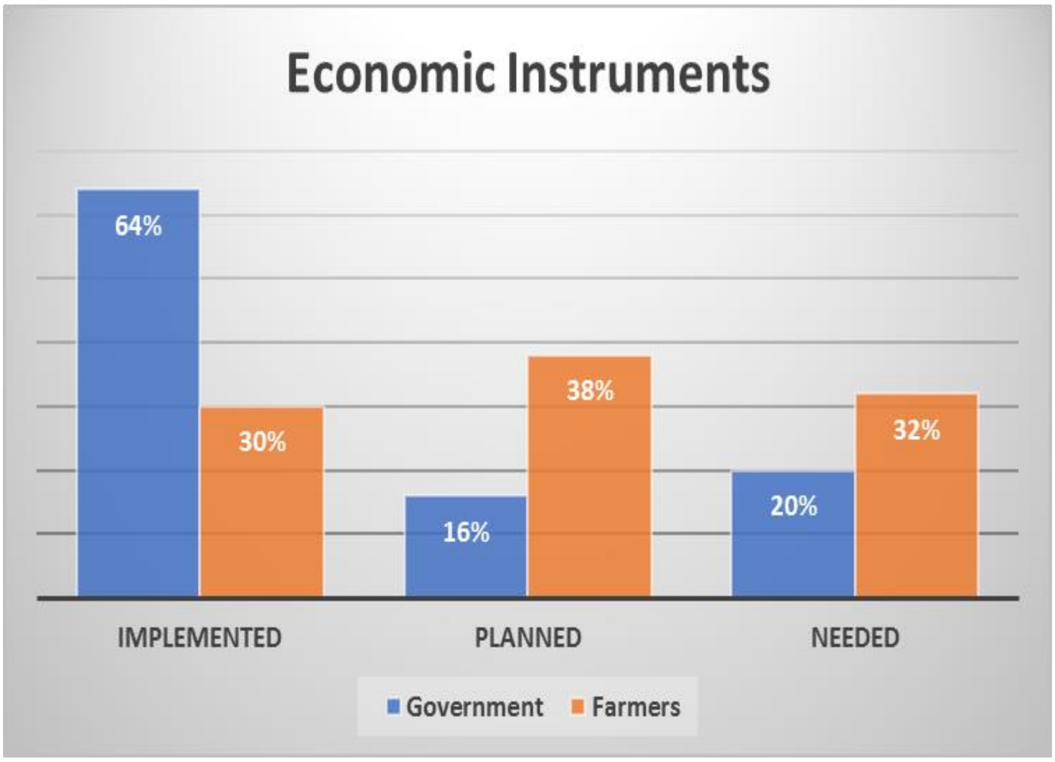

Figure 10.11: Economic Instruments.

10.8.11 Restriction of water supply

Figure 10.12 highlights that 59% of government officials think that restrictions in water supply have been implemented, but 21% of farmers believed this to be the case. Instead, most farmers (79%) thought this is needed or planned and suggests that water supply restriction is also an issue among farmers. As a result, improved policies are required throughout the country, both in the urban and rural areas. This will aid towards improved crop production as well as mitigating and adapting to climate change.

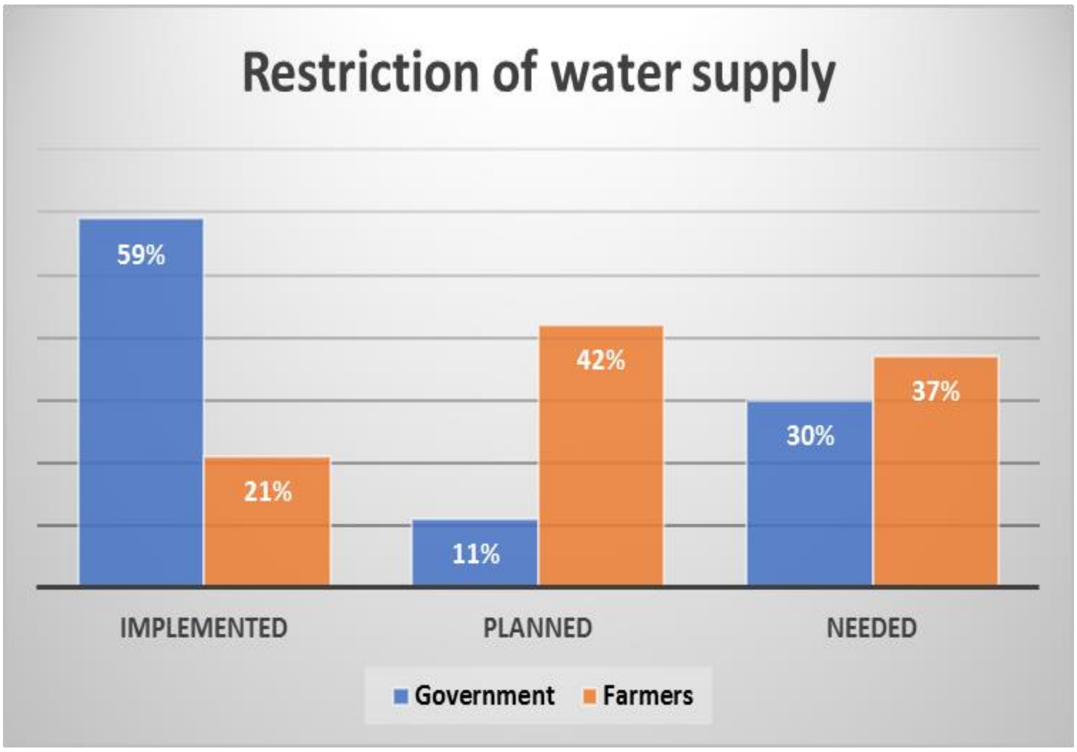

Figure 10.12: Restriction of water supply.

10.8.12 Measures to improve water balance

Figure 10.13 results shows that 79% of government officials think improved water balance has been implemented. On the contrary, most farmers (79%) thought that this was either planned or needed. This implies that little has been achieved towards improving water balance in rural Nigeria. This concurs with the study by Apata *et al*. (2009), who identified that most farmers in rural Nigeria need improved water supply and balance to improve their agricultural practises.

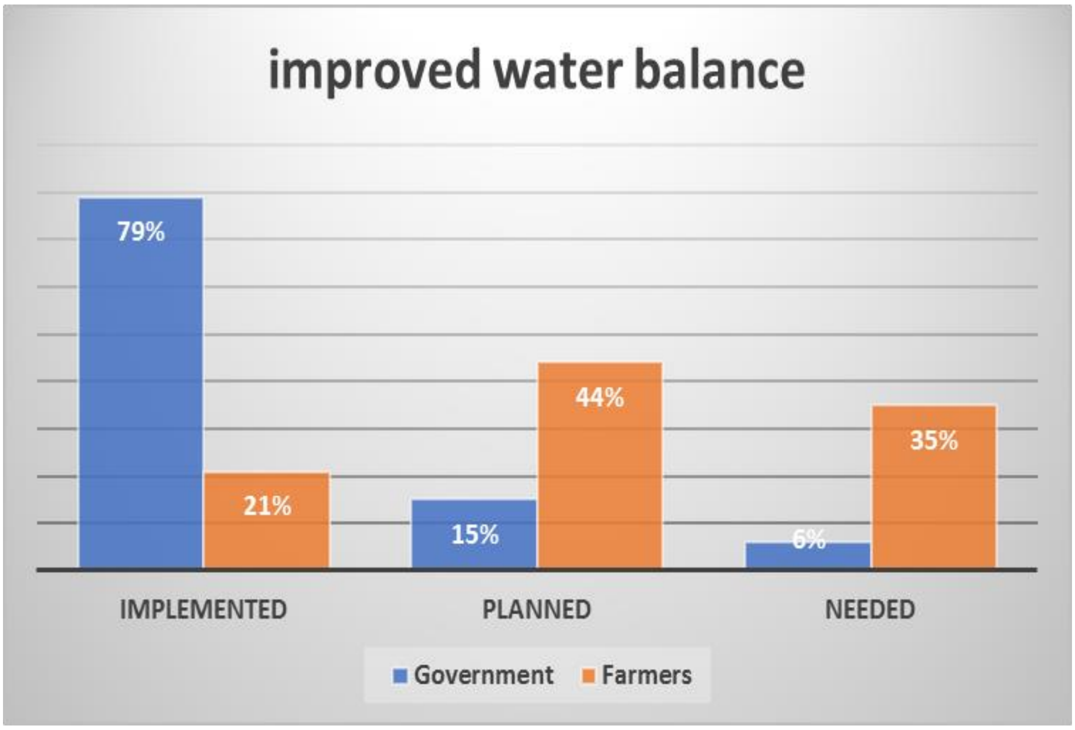

Figure 10.13: Improved water balance.

10.8.13 Drought mitigation

Figure 10.14 highlights that 73% of government officials think that drought mitigation has been implemented in Nigeria. This concurs with the result of 10.8.2, where high percentages of the respondents said drought protection has been implemented and is echoed by responses in Section 10.8.2. In contrast, most farmers (76%) believed that drought mitigation was either planned or is needed. This corresponds with Chapter 2, which discussed the impact of drought in Nigeria.

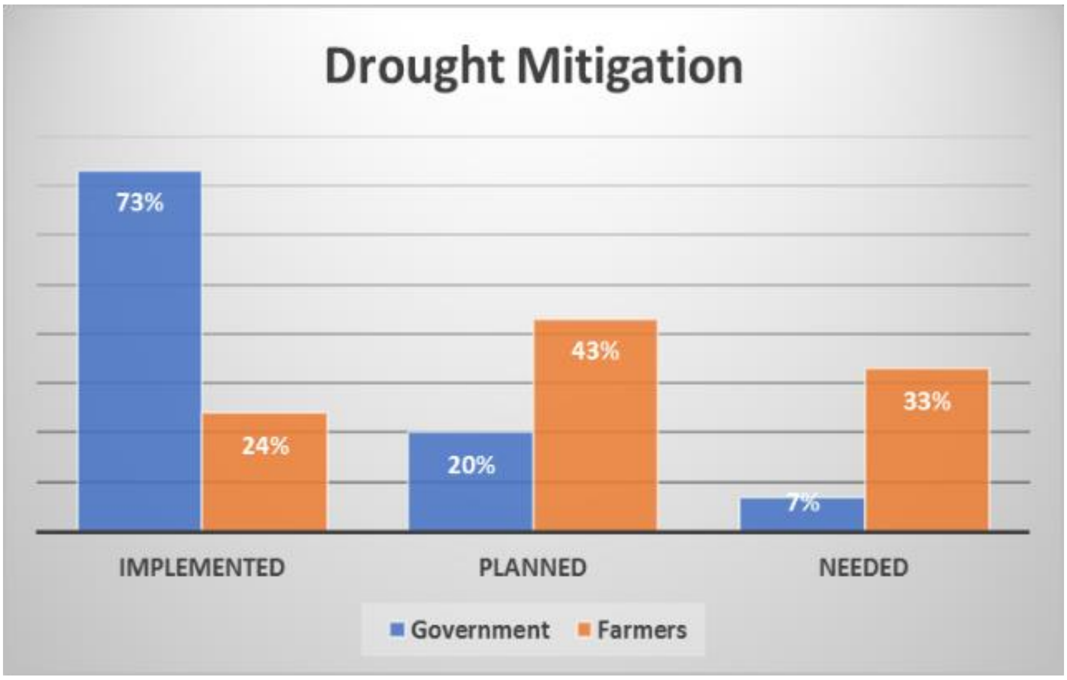

Figure 10.14: Drought mitigation.

10.8.14 New and revised legislations

Figure 10.15, shows that most government respondents (86%) said these have been implemented, while just 32% of farmers were of the view that these have been implemented. Once again, most farmers (68%) were of the opinion that this was either planned or needed. This suggests that more improvement needs to be considered when it comes to new legislation concerning climate change. In some developed countries, improved policies and new legislation have been used as a way of mitigating and adapting to the impacts of climate change (Atilola, 2010).

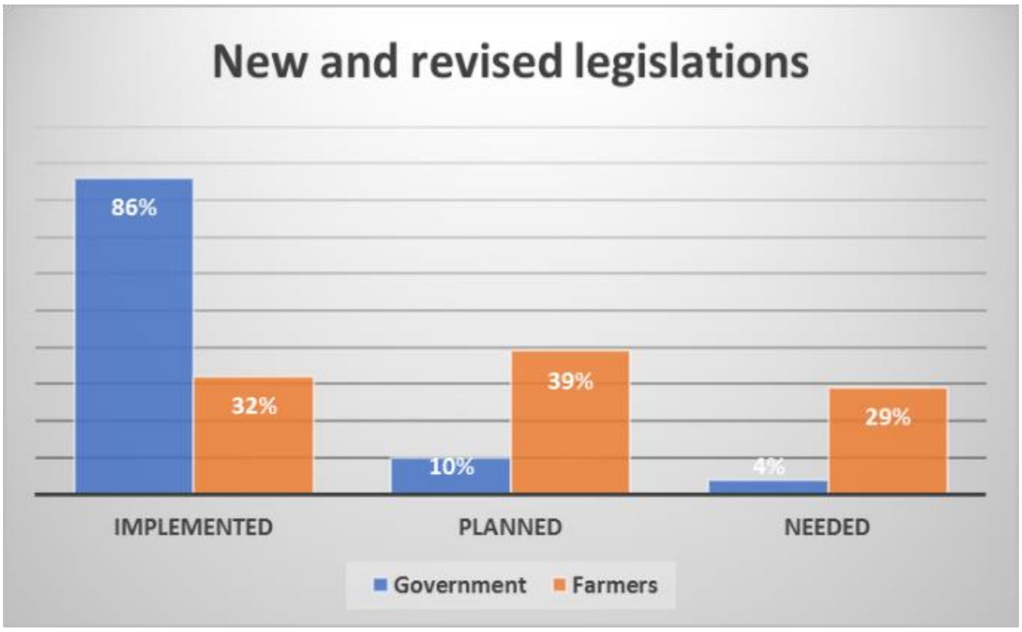

Figure 10.15: New and revised legislation.

10.8.15 Economic incentives or financial mechanism

Figure 10.16 shows that most government officials (79%) claimed that economic and financial mechanisms have been implemented. However, most farmers (40%) said this is only in the planning stage, while others (29%) thought it was needed. This suggests that most Nigerian farmers depend on the government for improved economic and fiscal mechanisms to improve agriculture.

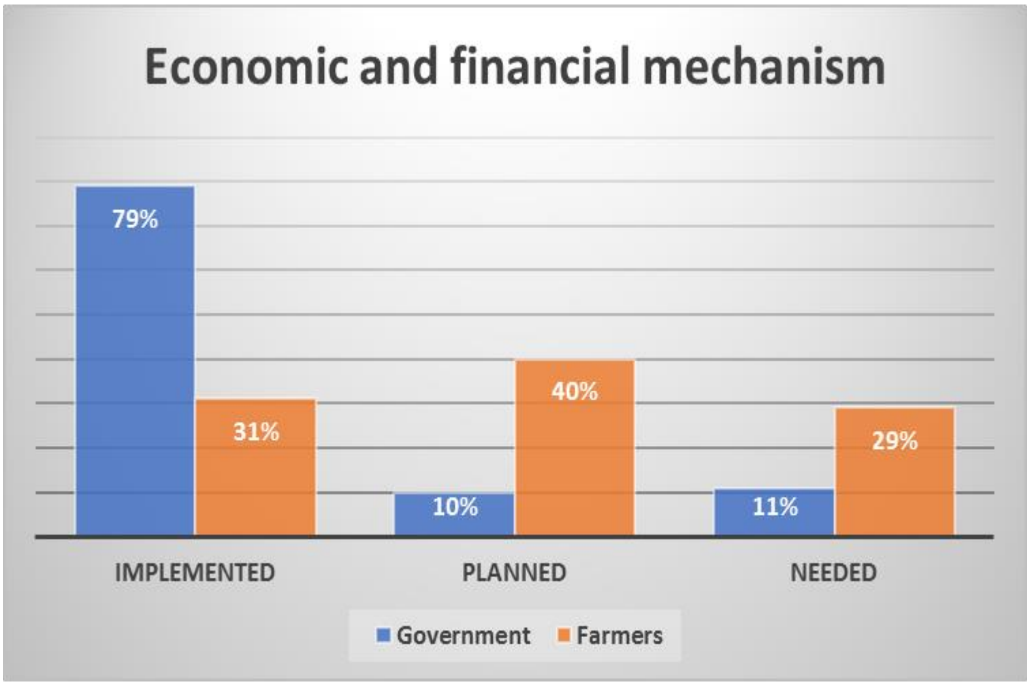

Figure 10.16: Economic and financial mechanisms.

10.8.16 Awareness-raising or campaigns

Figure 10.17 show that results show an equal response among government officials (34%) and farmers (34%) in Nigeria. This suggests that there have been increasing awareness and campaigns for climate change mitigation and adaptation. This also suggests that every group is now involved in mitigating and adapting to climate change. The awareness and campaigns of climate change will aid in reducing its impacts and vulnerabilities in Nigeria.

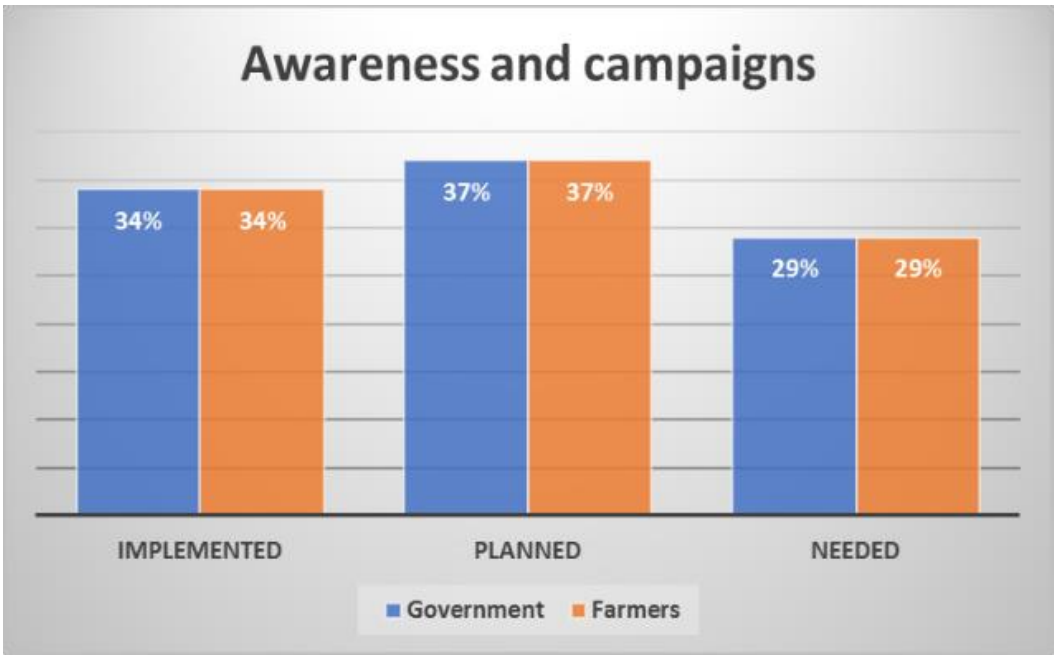

Figure 10.17: Awareness and campaigns

10. 9 General discussion of government and farmers' responses

Section 10.8 provides a general overview of what has been achieved in mitigating and adapting to climate change in Nigeria. As a result, the response among farmers and government officials differed. Most government officials claimed that climate change mitigation and adaptation has been implemented, whereas most farmers were of the view that such adaptation strategies were either planned or needed. In addition, most farmers considered improved climate change strategies to be required. Climate change perception is needed among all groups, because this will aid towards implementing better polices in Nigeria.

10.10 Summary

The general view is that farmers are more likely to agree with questions related to climate change issues, while members of the public and government officials are more likely to disagree. There are two possible reasons for this. Firstly it may be attributed to the sample size comprising of (n=227) for famers, (n=401) for the public and (n=50) for government officials. The public were typically younger and may not have attained experience of climate change to the same degree as the farmers questioned. Most farmers were aged between 36-45, the majority of the public were aged between 18-25, while most government officials were aged between 46-55. The government officials were mostly educated when compared to other groups, while farmers had the lowest level of education. All respondents had different views on the impact of climate change. However, most respondents admitted that climate change is already happening and is something that affects them. Unsurprisingly, farmers tend to be more concerned about climate change compared to other groups. Most government officials accepted that much has been done in mitigating and adapting to climate change. However, this was contrary to farmers' responses, as many still believe that several things need to be implemented. The government respondents differed from some answers because of the size of the demograph.. The main objectives of Chapter 10, was to make a comparative analyse of the Nigerian farmers, public and government perception to climate change in Nigeria, satisfying two of the main aims of this research project, as detailed in Chapter 1 (Section 1.3).

Chapter 11: Conclusions

11.1 Introduction

This final Chapter which brings together all aspects of the thesis and demonstrates that the main aims and objectives shown in Chapter 1 have been met. A thorough review of current literature (Chapter 2) showed growing concerns with regards to climate change, particularly within Western African States. Chapters 3 and 4 set out the study in the context of Nigerian climate change impacts, being informed by global findings from Chapter 2. Chapter 5 set out the work in the context of physical background and Chapter 6 detailed the methodological approach used for data acquisition and analysis. Temporal changes in extreme temperature, precipitation and humidity, alongside crop yield and fertilizer use across agro-ecological zones were analysed in Chapter 7. Subsequently, Chapter 8 assessed climate change perceptions from three population groups: farmers, members of the public and government officials, with Chapter 9 providing a comparative analysis of both public and government officials. Chapter 10 then provided an overall comparative analysis of the three groups alongside temporal changes in the physical environment, leading to the development of management strategies. Although some previous small-scale studies had explored Nigerian farmer perceptions of climate change, no large-scale studies assessing temporal climate and crop yield variations linked to perceptions of climate change had previously been undertaken. Therefore, results from this study fill important research gaps and make new contributions to knowledge.

11.2 Comparative analysis of climatic analysis, crop yield and perception

Environmental forcing data collected between 1970-2011 comprised information on ***minimum and maximum temperature, humidity and precipitation***. Between 1980-2010 data on yield and corresponding fertilizer use for 10 staple crops was assessed across different agro-ecological zones. Results showed that temperature extremes, crop yield, and fertilizer use increased in most States, such as Enugu, Kano, Edo and Niger State, but in others they declined, such as Ogun, Kwara and Benue State. Consequently, differences in results and their causes were subsequently evaluated. In Enugu State, data analysis of crops such as groundnut and maize (Figure 7.2), showed that increases in yield resulted from increasing temperatures and precipitation (Figure

7.1). This concurs with the perceptions of most farmers (60%), who said that they have been experiencing increased precipitation (Table 8.5).

In Kano State, rice and millet production declined (Figure 7.5e and Figure 7.5f). This was caused by the rapid increasing precipitation. Consequently, this caused an increase in runoff, resulting in the washing away of topsoil and nutrients (63%; Table 8.6). In Ogun State, most crop yields declined. However, all temperature extremes, increased steadily, which should have supported crop yield. However, the rapid increasing precipitation (Figure 7.7c), caused flooding, and as well as soil erosion, impacting rice yield in the State (Table 8.11), even though rice normally requires high precipitation. Flooding and erosion causes the washing away of nutrient required for growth and development and concurred with farmer perception that increased runoff resulting from the changing climate (Chapter 8; Table 8.5).

Cocoyam and Cassava yield declined in Ogun State (Figure 7.8c and Figure 7.8d), resulting from the increase in pest and diseases caused by changing climate (Table 8.11). This also concurs with most farmers (68%), who said that increased pest and disease were major causes for concern (Table 8.11). Yam and maize production also declined (Figures 7.8e and 7.8f) and was caused by increasing precipitation resulting in increases in ground water level, and infertile soil (37%; Table 8.6) and (89%; Table 8.11). It resulted in the washing away of top-soil and loss of nutrients. In Edo-Benin, maximum temperatures increased steadily (Chapter 7; Figure 7.10a) and rice and yam yields declined (Figure 7.11f and Figure 7.11g). This was caused by decrease in groundwater levels (41%; Table 8.6), and decreased surface water (52%; Table 8.6), and increased drought (38%; Table 8.6). However, other crops, such as Cocoyam (Figure 7.11a), Melon (Figure 7.11b), Groundnut (Figure 7.11c) and Cassava (Figure 7.11e) increased alongside as a result of increased fertilizer use.

In Kwara State, Maize and Cassava yield, both declined, which was caused by soil erosion and flooding (Figure 7.14b and Figure 7.14c). However, temperature extremes increased in the State (Figure 7.13). Once again, this concurs with the farmers who were very concerned about soil erosion and flooding (Table 8.11). In addition, this validated 61% of the farmers who claimed that they were already feeling the effect of climate change (Table 8.11). In Kogi State, temperature extremes increased slightly, as well as all other crops cultivated in the State, such as cassava, rice, groundnut, guinea corn, millet, maize, beans and yam (Figure 7.17). This concurs with most government officials who said that they have implementation strategies to improve agricultural production across States (Chapter 9; Q18). Kogi State is one of the major States in Nigeria where improved climate change adaptation polices have been considered in the agricultural sector. This contributed to overall crop yield production.

In Benue State, all temperature extremes increased (Figure 7.19) alongside Guinea corn and groundnut yield (Figure 7.20b and Figure 7.20c). However, other crops, such as millet, rice, yam, maize and beans declined (Figure 7.20). This resulted from the changing climate and other environmental constraints (Chapter 8, Table 8.4; Table 8.5; Table 8.6 and Table 8.11). In Niger State, temperature extreme increased (Figure 7.19). This supported the growth and yield of crops such as millet, beans and cassava (Figure 7.23a; Figure 7.23d and Figure 7.23g). However, other crop yields such as guinea corn, groundnut, maize and rice declined (Figure 7.23b, Figure 7.23c; Figure 7.23f and Figure 7.23i). This was attributed to increased ground water, increased in runoff, and increased rainfall (Table 8.6). Other associated factors which caused decline in crop yield included flooding, soil erosion and infertile soil (Table 8.7).

11.3 Analysis

Most farmers (63%), confirmed that increasing precipitation was a major cause of concern to Nigerian agriculture (Table 8.6). As a result, increasing precipitation was identified in most agricultural States used for the study. For instance, in Kano State (Figure 7.4c); Ogun State (Figure 7.7c); Edo State (Figure 7.10c); Kwara State (Figure 7.13c); (Kogi State; Figure 7.16c); Benue State (Figure 7.19c) and Niger State (Figure 7.22c). The increasing precipitation caused increased runoff (41%), increased groundwater (37%), and flooding 49% (Table 8.6). In addition, (Chapter 8; Q27) also confirmed that most farmers were very concerned about flooding (64%), soil erosions (59%) and infertile soil (59%; Table 8.11). Kogi was the only State where all crop yields increased, without being impacted by increased precipitation. This was achieved through improved climate change adaptation strategies such as crop diversification, irrigation practises and appropriate tillage methods. Most farmers (56%) (Chapter 8; Q16) were of the view that climate change is already affecting Nigeria. As a result, improved climate change mitigation and adaptation strategies are needed, even though most governmental officials claimed to have implemented climate change mitigation and strategies (Chapter 9; Q18). As a result, climate change adaptation must be integrated at all levels.

Most farmers (41%), thought climate change was caused by anthropogenic factors (Chapter 8). Most of the public (52%) also claimed that people are too selfish to address issues relating to climate change issues (Chapter 9; Q14). As a result, it is crucial that the Nigerian Government to incorporates climate change mitigation and adaptation into policy making. This can only be achieved through improved policies, primarily in the agricultural sector. Most of the public (79%) were very concerned about employment (Table 9.5). As a result, the Government should provide employment in agriculture which will aid in providing employment among the Nigerian public, since most are youths. Climate change adaptation in Nigeria is highly influenced by numerous factors, such as education, demography, and legislative factors. For instance most farmers were less educated. This could influence their ability to adapt to climate change and embrace new and improved technologies. This may also affect their understanding of policies and legislation. Generally, education plays a vital role in passing information regarding climate change, and other environmental issues. The more educated people are, the more likely they can understand climate change related issues. Most governmental officials understood issues relating to climate change, because they were more educated.

11.4 Overall analysis

The research result show that maximum temperature increased in the central (orientated from south towards north) States of Edo, Kwara and Benue all showed statistically moderate correlation with R^2 values that ranged between 30-40% ($p <0.01$). Statistically, the central northern State of Kwara classified under the derived and southern Guinea savannah showed the strongest positive correlation. In addition to this, four other states showed a positive significant correlation at the 99% ($p< 0.01$), namely, Enugu State, Ogun State Edo State and Benue State, classified as derived savannah and humid forest. Analysis also showed that ***Precipitation*** increased between 1970-2011 in all assessed States and agro-ecological zones. Statistically, Kano State showed the highest temporal correlation with an R^2 value that explained 50% of data variation. ***Humidity*** was assessed, with all states displaying a positive correlation indicative of increasing temporal trends. Statistically, Kwara State displayed the strongest correlation.

Ten major crop types were assessed (Chapter 6) within the eight States and agro-ecological zones. ***Beans*** were produced in seven States. Geographically, Kogi State classified as derived savannah had the strongest positive correlation, indicative of an increasing crop yield trend. ***Yam*** was also cultivated in seven States and had similar results. Kogi State had the strongest positive correlation indicative of increasing crop yield trends. ***Rice*** was cultivated in all eight States and statistically, both Kwara and Kogi States had the strongest positive correlation, indicative of increasing crop yield trends (R^2 = 71% and 68%, respectively, Figure 7.14a and Figure 7.17b). ***Melon*** was cultivated in four States and statistically, all showed positive correlations indicative of increasing crop yields. This showed that the crop has been increasing across the State. Edo State showed the strongest correlation with an R^2 value that explained 70% of data variation (Figure 7.11b). ***Groundnut*** was cultivated in seven States and statistically, Kano State showed the strongest positive correlation and an R^2 value explaining 77% of data variation (Figure 7.5b). In addition, Enugu and Edo States showed strong positive correlations (R^2 = 50% and 70%, respectively, Figure 7.2a, and Figure 7.11c). ***Maize*** was cultivated in all States and statistically, Enugu State showed the strongest positive correlation, and an R^2 value explaining 40% of data variation (Figure 7.2b). Kogi State also showed high positive correlation (R^2 = 36%). In addition, Edo and Ogun States were also positively correlated (R^2 = 2% and 10%, respectively). ***Cassava*** was cultivated in seven States and statistically, Kogi State showed the strongest positive correlation, indicative of an increasing trend and an R^2 value explaining 92% of data variation (Figure 7.17a). ***Millet*** was cultivated in five States and statistically, Kano State showed the strongest positive significant correlation indicative of increasing crop yield trend and an R^2 value explaining 53% of data variation (Figure 7.5a). ***Guinea corn*** was cultivated in five States and statistically, Kano State showed the strongest positive significant correlation, indicative of increasing crop yield trends and an R^2 value explaining 77% of data variation (Figure 7.5c).

Survey results show that most Nigerian farmers were female (Section 8.2) and most of public respondents were also female (Section 9.2.1). This research identified that the Nigerian agricultural labour force and market was mainly dominated mainly by female farmers supported their families, as well as contributing to economic growth. As discussed in Chapter 2 and 3, agriculture remains one of the major sectors which provides employment to many. However, lack of education, poverty and lack of government incentives are the major issues by farmers. As a result, most farmers (39%) said that they received minimal funding from the State government their agricultural practices. Most farmers (69%), said that economic incentives or financial mechanisms were either planned or needed (Table 8.7). This suggests that more is required to improve Nigerian agriculture, as most are highly dependent on the government.

11.5 Recommendations

11.5.1 Future Management plan for improving agricultural productivity and tackling climate change

Improved policies and regulations are required in tackling climate change in Nigeria. Furthermore, addressing climate change will require funding and the introduction of new and improved technologies to cope with its impacts.

1. There should be improved crop cultivation strategies. For instance, in Kano State, groundnut yield increased steadily. Meanwhile, in Niger State, the crop yield declined drastically. Consequently, more groundnut should be cultivated in Kano State when compared to other States and agro-ecological zones.

2. Nigerian women should be included in climate change policies and strategies since they are the majority. This will help in knowledge and experience sharing, as well as mainstreaming climate change mitigation and adaptation in the long-run.

3. Educational programmes, such as climate change awareness, should be integrated into all forms of Agricultural Development Programmes. This will aid supporting climate change mitigation and adaptation among farming communities in Nigeria.

4. Land ownership remains one of the major issues faced by most farmers. In this study (42%) were identified to have rented lands used for farming. As a result, the Nigerian Government should provide affordable agricultural lands to those

interested in farming. This will improve food production in the country, as well as create employment and economic growth.

5. Lack of proper investment in the agricultural sector is also one of the major issues faced by most farmers. Most farmers derive their funding from the State government, but this is insufficient. Employment opportunities should be created in the agricultural sector. Most of the Nigerian public (79%), claimed that that employment was their major cause for concern (Table 9.5). Investing in agriculture will aid in reducing unemployment among the Nigerian public.

6. In most States used for the study, precipitation was rapidly increasing, resulting in loss of crops and farm lands. Furthermore, most farmers said that flood protection (39%), natural retention for flooding (62%), and insurance against flooding (73%), was either planned or needed. As a result, improved climate change mitigation and adaptation strategies are required in this context.

7. Accurate climate forecasts are crucial, because they help to make farmers prepared for any cause of future uncertainty of climate change, such as natural disasters. Most farmers (78%) said that improved forecasting and monitoring of information is required (Figure 10.7).

8. Communication is also an effective tool used for raising awareness about climate change. This can be achieved using the mass media, such as television, radio and newspapers. Farmers obtained much climate change information from the media.

9. There should be information sharing among academics, scientists and government on how to mitigate and adapt to climate change in Nigeria. All groups and sectors should be taken into consideration.

10. Precautionary measures should also be considered before carrying out any agricultural activities. For instance, in areas vulnerable to flooding, farmers should move aware from such areas. Studies need to be carried out before farming activities occur, and the government should provide them with areas less vulnerable to natural disasters so not to incur losses.

11. Crop diversification should be applied as a way of mitigating and adapting to climate change in Nigeria. Government should also improve agricultural programmes such as, farmer's association. Most farmers (78%), were not members of farming organisations (Section 8.3.1). This will aid in educating farmers, as well as passing information of climate change mitigation and adaptation.

12. More perception studies are required in Nigeria, currently, there are limited empirical studies. This will aid understanding all group concerns, knowledge, and how they perceive climate change, which can then be integrated into policy making.

13. More climate change studies should be carried out across agricultural States and agro-ecological zones in Nigeria. This will aid improved adaptation strategies. Government should also provide comprehensive capacity building for enhancing education among farming communities in Nigeria.

14. Long-term climate change adaptation strategies should be put in place in any case of climate change-related disasters. More investments are needed in the Nigerian agricultural sector, as a way of improving crop production and climate change issues owing to the rapid increase in population. This is a way of safeguarding national food security.

11.6 Limitations of the research

Lack of data related to fertilizer used in each crop type, the geographical location of crop planting within each agro-ecological zone, and within those States with multiple zones, makes detailed analysis more difficult. However, these limitations notwithstanding, constructed regression models and correlation matrices did reveal distinct temporal variations in the assessed environmental forcing agents and crop yield. Consequent to this and with differing levels of statistical significance, variations in crop yield were non-related with environmental forcing, alongside interesting variations between fertiliser used and crop yield.

11.7 Summary

Climate change poses threats across agricultural States and agro-ecological zones in Nigeria. As a result, this threatens the livelihoods of farmers and particularly national food security. This suggests that there have been minimal agricultural knowledge and technological improvement among farmers in Nigeria. However, there have been some changes in crop patterns, which may enable famers to better cope with the climatic fluctuations. It is important governmental agencies take into consideration policies that will enhance farm level adaptations, particularly through investment. Policy-makers must ensure that local farmers are supported, and their institutions improved and should be educated on the threats, uncertainties and opportunities of climate change. Farmers should be informed of the current and future adaptability of agriculture but this should not just focus on improved crop yield, but better approaches to avoid losses of crops. Nigerian government should take advantage of these aspects, in order to support famers. Regardless of that, as new technological innovation evolves, farmers should be made aware of these rapid changes, and should be informed and provided with the best available technological amenities to tackle climate change.

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Appendices

Appendix A

Sample of environmental forcing agent, Crop yield and Fertilizer use data.

KANO STATE MONTHLY AVERAGE MAXIMUM TEMPERATURE (°C)									
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
	1971	28.4	25.9	30.3	38.6	38.3	36.0	31.4	29.8
	1972	30.6	33.4	37.4	38.9	37.2	32.9	33.1	30.9
	1973	31.7	34.7	36.7	39.9	39.5	37.3	32.4	30.8
	1974	26.8	32.5	36.7	40.0	36.6	36.0	30.2	30.2
	1975	26.4	32.7	36.5	35.4	37.3	34.8	30.6	30.3
	1976	29.8	35.2	36.3	38.8	37.3	33.3	31.1	31.10
	1977	29.8	31.1	34.9	38.4	38.1	35.1	32.3	30.2
	1978	29.2	33.5	36.9	38.1	37.7	32.9	29.4	31.0
	1979	30.1	33.7	36.7	38.7	37.5	34.3	32.5	30.6
	1980	31.0	32.2	36.7	38.9	36.1	33.3	31.5	30.9
	1981	27.3	32.1	36.1	38.8	37.6	36.1	31.6	31.6
	1982	30.2	31.6	36.5	39.0	37.8	35.1	31.6	30.5
	1983	23.4	33.1	33.3	39.2	39.8	35.8	32.8	31.2
	1984	27.8	31.5	31.5	38.9	36.6	35.0	31.5	33.6
	1985	31.7	29.9	36.5	36.8	38.3	34.4	30.3	31.0
	1986	29.1	34.7	37.5	40.4	39.0	35.2	30.7	31.4
	1987	29.8	33.3	36.0	37.6	40.0	35.4	33.6	31.2
	1988	28.1	31.7	36.7	38.7	39.1	34.6	30.5	29.3
	1989	24.9	28.0	34.9	38.7	37.4	35.6	32.5	30.2
	1990	30.5	33.5	40.0	38.2	36.3	35.1	31.0	31.1
	1991	28.9	35.4	37.0	38.8	34.2	33.9	30.6	29.9
	1992	26.8	30.0	36.0	38.1	36.3	34.6	31.0	31.8
	1993	26.3	32.1	36.0	39.6	38.6	34.6	31.7	30.0
	1994	30.0	31.7	38.6	39.1	39.0	36.2	32.7	31.8
	1995	28.9	33.1	37.2	41.3	38.2	35.5	31.5	30.7
	1996	32.0	34.7	38.0	39.3	39.0	33.0	32.0	30.0
	1997	31.6	28.7	35.6	38.2	37.0	34.3	32.5	31.5
	1998	29.1	34.1	34.4	40.5	25.0	38.9	34.5	31.2
	1999	30.0	33.8	38.7	39.1	38.5	36.9	30.3	29.5
	2000	31.1	28.8	35.1	40.5	39.2	34.4	31.0	30.3
	2001	29.4	30.2	30.8	35.7	36.9	32.8	31.2	30.1
	2002	26.0	31.4	37.4	40.0	25.9	40.3	35.9	32.8
	2003	29.1	31.7	36.5	39.9	35.9	35.8	31.9	30.6
	2004	30.8	34.2	38.4	40.0	39.4	37.4	33.8	30.8
	2005	28.2	36.5	38.5	39.9	38.2	34.9	33.9	33.6
	2006	30.0	32.3	37.1	39.0	36.7	35.0	32.9	30.4

KANO STATE MONTHLY AVERAGE MAXIMUM TEMPERATURE (°C)									
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
	2007	29.8	34.1	36.3	39.6	37.3	34.5	32.5	30.2
	2008	26.5	29.6	38.3	38.5	38.4	36.0	30.7	29.8
	2009	31.8	34.6	37.1	40.0	38.2	36.4	32.4	30.9
	2010	32.0	36.1	37.2	39.9	38.6	35.1	31.3	30.9
	2011	27.8	35.4	38.2	39.2	39.1	34.9	32.3	30.1

KANO STATE MONTHLY AVERAGE MINIMUM TEMPERATURE (°C)									
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**
Kano	1971	11.1	14.2	19.2	23.4	24.2	22.4	22.4	21.1
	1972	9.90	15.3	19.7	23.9	23.7	23.4	21.4	21.0
	1973	13.7	13.9	18.5	22.2	25.7	24.2	22.5	21.6
	1974	14.1	16.1	19.8	23.9	25.4	23.9	22.3	21.5
	1975	11.3	17.1	17.9	23.8	26.8	25.0	23.2	22.4
	1976	12.7	18.0	23.4	26.2	26.6	25.2	21.9	21.8
	1977	11.1	13.8	18.9	23.1	25.1	24.4	22.2	21.7
	1978	11.3	15.0	19.7	22.7	24.9	23.1	21.1	20.7
	1979	12.5	13.5	19.5	23.7	24.2	22.1	20.0	19.1
	1980	12.6	16.0	20.2	23.1	24.7	24.1	24.5	20.4
	1981	11.8	15.9	20.7	23.0	24.3	23.1	21.7	21.6
	1982	14.9	16.5	22.0	24.0	25.0	23.2	21.5	20.9
	1983	11.6	16.8	17.9	24.2	26.0	23.9	21.1	21.0
	1984	13.0	16.3	22.5	25.6	24.9	23.8	21.8	22.2
	1985	16.7	15.4	23.5	24.6	25.8	23.0	21.4	21.7
	1986	12.9	17.7	22.8	25.8	25.7	23.9	22.1	20.2
	1987	13.8	17.1	22.2	23.5	25.6	24.5	22.9	22.0
	1988	14.9	17.1	22.9	25.3	26.1	23.3	21.5	20.5
	1989	10.6	14.0	18.6	22.7	24.6	24.2	19.9	18.4
	1990	15.4	15.3	18.3	25.3	25.4	24.2	20.2	21.5
	1991	14.0	18.1	21.4	25.3	23.8	22.7	20.9	20.6
	1992	12.7	14.1	21.3	24.3	24.3	22.5	21.0	21.6
	1993	12.5	15.1	15.1	25.5	23.9	23.0	22.2	21.2
	1994	14.0	16.0	20.9	25.2	25.7	23.7	20.8	21.7
	1995	13.7	15.4	19.5	24.2	24.6	23.6	23.0	21.6
	1996	13.6	15.3	19.5	24.3	24.5	23.8	22.9	21.5
	1997	14.9	14.1	21.1	24.4	24.5	23.2	22.9	22.4
	1998	13.6	17.4	19.9	25.0	26.2	23.9	27.5	22.3
	1999	14.0	17.4	21.4	24.4	25.5	24.6	21.9	21.6
	2000	14.7	13.7	18.4	24.0	25.1	23.4	22.3	21.1
	2001	13.6	11.6	14.1	19.7	24.3	24.3	22.9	21.8
	2002	12.6	15.3	21.7	25.9	21.6	24.1	22.5	21.5
	2003	12.1	17.4	19.8	25.3	24.4	22.8	21.8	21.2
	2004	14.4	16.0	19.7	24.9	25.0	23.3	22.0	21.4
	2005	13.3	20.8	22.8	24.8	25.6	24.1	20.6	16.2
	2006	16.0	19.4	20.5	23.0	25.2	24.4	23.0	22.1
	2007	14.2	16.6	20.3	25.2	25.6	23.2	22.5	21.2
	2008	12.8	14.1	21.0	23.6	25.3	24.3	22.0	21.9
	2009	15.7	18.3	20.6	26.0	25.1	24.1	22.5	22.4
	2010	13.8	18.0	21.5	24.6	26.8	24.5	22.7	22.2
	2011	22.4	24.7	26.0	25.4	25.1	24.1	23.4	23.6

KANO STATE MONTHLY TOTAL RAINFALL (mm)									
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**
Kano	1971	0	0	0	12.9	68.6	24.0	173.9	222.7
	1972	0	0	0	78.7	99.5	132.9	71.4	201.7
	1973	0	0	0	0	2.5	38.7	193.6	171.4
	1974	0	0	0	0	41.6	42.4	261.5	181.3
	1975	0	0	0	18.3	39.6	127.4	125.3	224.1
	1976	0	2.2	0	0	44.0	117.4	131.7	123.5
	1977	0	0	0	0	6.9	198.2	32.5	438.5
	1978	0	0	0	34.5	73.7	197.9	308.6	257.6
	1979	0	0	0	0	32.0	110.5	191.9	257.2
	1980	0	0	0	0	93.5	122.8	282.6	310.5
	1981	0	0	0	19.5	36.2	62.1	142.8	202.5
	1982	0	0	0	18.6	66.2	62.3	157.9	261.3
	1983	0	0	0	0	27.2	47.4	91.4	266.1
	1984	0	0	0	0.3	52.7	81.7	157.5	50.5
	1985	0	0	21.5	0	27.4	164.6	169.8	162.2
	1986	0	0	0	2.1	9.8	136.6	259.2	175.2
	1987	0	0	0	0	82.2	68.9	164.5	110.1
	1988	0	8.1	0	32.8	1.6	149.2	213.6	488.5
	1989	0	0	0	0	10.4	36.0	142.4	382.1
	1990	0	0	0	0	40.1	54.8	233.1	142.4
	1991	0	0	1.7	63.0	104.8	148.6	287.3	455.1
	1992	0	0	0	37.4	122.1	45.1	191.4	324.8
	1993	0	0	0	0	48.2	222.3	174.9	406.9
	1994	0	0	0	17.2	6.5	6.5	149.1	325.2
	1995	0	0	0	7.4	25.9	155.0	189.4	145
	1996	0	0	0	0	37.2	143.1	253.8	417.6
	1997	0	0	0	30.9	100.6	161.4	253.9	451.9
	1998	0	0	0	14.1	69.6	170.1	573.0	571.8
	1999	0	0	0	0	44.5	88.8	533.5	466.9
	2000	0	0	0	0	98.3	167.7	364.2	332.4
	2001	0	0	0	41.1	10.0	231.1	604.1	521.1
	2002	0	0	0	2.8	1.0	124.4	274.9	376.6
	2003	0	0	0	10	66.8	247.2	394.5	465.4
	2004	0	0	0	0	175.7	189.9	406.7	277.7
	2005	0	0	0	1.9	118.9	188.1	383.6	442.9
	2006	0	0	0	0	149.7	114.9	374.5	334.4
	2007	0	0	6	42.1	107.3	329.3	198.4	410
	2008	0	0	0	16.6	10.2	171.4	449.9	254.9
	2009	0	0	0	2.8	25.2	84.8	376.0	321.3
	2010	0	0	0	61.4	43.6	121.0	266.0	175.5
	2011	0	0	0	12.5	114.3	148.6	242.6	378.9

KANO STATE CROP YIELD (tonnes)						
Timescale	**Millet**	**Guinea Corn**	**Ground Nut**	**Beans**	**Maize**	**Rice**
1980	325.23	311.17	0.48	133.25	89.41	86.12
1981	322.23	321.32	0.62	135.25	84.23	84.74
1982	356.45	324.23	0.51	142.52	85.34	85.64
1983	345.67	356.34	0.53	135.24	90.10	82.36
1984	334.21	302.12	0.57	136.54	92.41	84.71
1985	333.23	236.52	0.54	142.23	98.56	82.41
1986	325.34	345.23	0.61	142.15	96.56	84.44
1987	298.23	354.23	0.60	132.25	97.35	86.32
1988	334.53	345.54	0.61	136.27	98.88	84.71
1989	345.21	362.62	0.63	135.26	99.10	86.66
1990	367.43	364.56	0.82	134.25	98.45	85.42
1991	365.23	325.42	0.75	134.62	96.75	83.24
1992	324.23	365.12	0.72	132.42	93.24	87.56
1993	354.80	365.23	0.63	133.56	94.68	83.45
1994	356.74	342.12	0.61	134.52	99.56	80.67
1995	356.78	365.23	0.59	134.25	97.45	81.45
1996	334.20	356.12	0.43	127.23	96.95	81.34
1997	394.53	355.32	0.62	122.34	99.54	78.54
1998	387.56	345.34	0.63	122.37	98.45	66.54
1999	367.45	355.55	0.95	134.45	89.30	57.27
2000	345.67	368.49	0.99	132.45	76.45	53.45
2001	367.89	372.21	0.89	132.34	70.77	49.18
2002	384.67	381.23	0.93	134.76	69.68	40.41
2003	345.67	396.26	0.95	134.54	68.45	41.44
2004	378.90	325.66	1.05	134.34	67.45	40.34
2005	379.45	360.34	1.05	139.23	64.32	43.57
2006	378.45	317.84	1.23	143.36	66.87	52.34
2007	377.65	325.62	1.32	142.32	65.32	51.20
2008	376.56	315.23	1.33	141.35	64.54	52.36
2009	378.94	342.13	1.32	145.54	64.52	57.54
2010	379.67	345.23	1.24	144.44	63.99	56.54
2011	380.45	344.24	1.26	143.44	65.51	54.44

KANO STATE Quantity of fertilizer (tonnes)

Timescale	Tonnes
1980-1981	398
1981-1982	452
1982-1983	453
1983-1984	525
1984-1985	542
1985-1986	456
1986-1987	523
1987-1988	475
1988-1989	653
1989-1990	562
1990-1991	536
1991-1992	546
1992-1993	576
1993-1994	586
1994-1995	423
1995-1996	421
1996-1997	580
1997-1998	632
1998-1999	451
1999-2000	412
2000-2001	542
2001-2002	475
2002-2003	632
2003-2004	452
2004-2005	412
2005-2006	432
2006-2007	342
2007-2008	562
2008-2009	412
2009-2010	541
2010-2011	452

OGUN STATE MONTHLY AVERAGE MAXIMUM TEMPERATURES (ºC)									
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
	1981	34.3	36.3	35.1	33.8	31.9	30.8	28.9	29.0
	1982	34.4	35.0	35.0	33.9	31.8	30.3	28.7	28.1
	1983	33.0	37.2	38.0	35.8	33.2	30.3	29.0	28.3
	1984	34.4	36.8	34.9	33.4	32.7	31.1	30.6	30.0
	1985	34.4	36.6	35.1	33.8	32.1	30.5	29.0	29.5
	1986	34.4	35.5	34.2	33.9	33.1	31.0	28.4	29.0
	1987	35.5	36.7	35.2	36.0	34.7	31.7	31.7	31.0
	1988	34.3	36.0	35.1	33.8	33.0	30.5	28.9	28.6
	1989	34.1	36.0	34.6	33.5	31.7	31.3	29.2	28.6
	1990	33.8	35.6	38.1	33.9	32.7	31.6	38.5	29.0
	1991	34.3	35.4	35.6	33.7	32.6	31.6	29.5	28.4
	1992	34.5	37.3	36.3	35.0	32.7	30.3	28.3	28.0
	1993	35.1	35.8	34.6	35.0	33.1	31.1	28.9	29.7
	1994	34.0	36.3	35.6	34.3	32.5	31.2	28.5	29.2
	1995	35.5	37.1	34.7	34.1	33.1	31.2	29.2	29.3
	1996	35.0	35.8	35.2	34.0	32.5	31.4	29.9	28.6
	1997	34.9	36.9	35.2	33.1	32.0	30.2	29.1	28.6
	1998	34.6	37.3	37.8	36.2	33.2	32.0	29.1	28.7
	1999	34.4	38.4	35.5	33.4	32.4	30.6	28.9	28.4
	2000	34.5	38.5	35.6	34.1	33.6	31.2	29.2	28.8
	2001	34.7	36.5	35.7	33.4	33.3	30.8	29.9	27.7
	2002	34.8	36.8	35.6	33.6	33.2	31.3	29.8	29.0
	2003	34.5	36.3	36.0	33.5	33.4	30.4	29.8	29.1
	2004	33.0	34.9	34.1	32.7	31.4	29.6	28.4	27.6
	2005	33.8	37.9	36.4	35.3	32.7	31.3	30.1	29.5
	2006	34.6	36.0	35.1	35.3	32.5	31.6	30.5	29.3
	2007	35.5	36.7	35.1	35.9	34.5	31.8	31.0	30.1
	2008	34.6	36.9	36.0	34.7	33.2	31.1	30.1	29.9
	2009	34.9	35.9	35.4	33.6	32.8	31.5	30.5	28.9
	2010	35.3	37.8	35.3	34.5	33.7	32.2	30.4	29.7
	2011	34.7	35.2	35.6	35.2	33.8	31.6	29.3	30.0

OGUN STATE MONTHLY AVERAGE MINIMUM TEMPERATURES(°C)									
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
	1981	23.4	24.9	24.6	24.1	23.7	22.9	22.9	22.5
	1982	21.5	23.0	24.0	23.6	23.0	22.7	21.9	21.5
	1983	18.8	23.6	25.2	24.3	23.3	22.4	21.9	21.5
	1984	22.8	24.1	24.9	24.4	23.6	23.1	22.8	22.5
	1985	24.0	24.4	25.0	24.6	23.7	17.2	21.9	22.5
	1986	18.1	22.0	23.4	23.7	22.7	21.9	21.3	21.8
	1987	24.6	25.1	25.0	25.6	24.5	24.1	23.6	23.5
	1988	22.8	25.0	25.4	24.6	24.3	23.2	22.9	22.6
	1989	19.0	22.6	24.5	24.6	23.9	23.3	22.6	22.7
	1990	24.4	24.0	26.1	24.0	23.9	24.0	22.9	22.6
	1991	23.8	25.1	25.2	23.7	24.2	23.8	23.1	22.7
	1992	20.1	24.1	25.5	23.5	24.0	22.9	22.9	22.6
	1993	21.1	24.5	23.7	24.5	24.2	23.5	22.9	23.1
	1994	23.1	25.1	24.8	25.1	23.7	23.3	22.9	23.0
	1995	22.2	24.8	24.4	24.9	23.9	23.3	23.1	23.3
	1996	24.7	25.0	24.7	24.2	24.0	23.8	22.6	22.8
	1997	24.6	23.1	25.0	24.5	23.7	24.0	22.8	23.0
	1998	21.6	25.7	26.5	26.3	24.9	24.1	23.7	22.8
	1999	24.2	24.7	24.7	24.3	24.2	23.9	23.0	23.0
	2000	24.7	22.7	25.5	25.0	24.5	23.9	23.1	22.8
	2001	24.4	24.4	25.7	24.8	24.5	23.3	23.3	22.7
	2002	23.0	25.1	25.9	25.2	24.8	24.1	24.0	23.4
	2003	24.1	26.2	26.4	25.1	25.0	23.8	23.4	23.5
	2004	24.5	24.5	25.3	24.9	24.3	23.4	23.3	23.2
	2005	21.9	25.6	25.5	25.6	24.4	24.0	23.4	23.0
	2006	25.7	26.1	25.1	25.3	24.7	23.6	24.0	23.2
	2007	24.6	25.1	24.9	25.6	24.4	23.7	23.6	23.5
	2008	22.9	24.5	25.1	24.7	24.1	23.3	23.0	22.8
	2009	23.2	25.3	25.2	24.5	24.1	23.5	22.8	22.2
	2010	24.3	25.5	25.6	25.3	24.6	24.1	23.1	23.1
	2011	21.1	24.1	24.9	24.0	23.8	23.3	22.4	22.2

OGUN STATE MONTHLY AVERAGE RELATIVE HUMIDITY, %						May	Jun	Jul	Aug
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**
	1982	67	69	74	79	83	85	87	89
	1983	67	69	74	79	83	87	86	86
	1984	35	65	69	76	82	86	85	87
	1985	67	62	76	80	84	83	84	86
	1986	71	64	74	79	82	84	85	86
	1987	68	74	76	78	80	84	87	83
	1988	71	72	75	74	78	83	85	88
	1989	65	70	76	79	83	86	87	87
	1990	58	55	77	81	85	85	88	89
	1991	67	55	54	72	77	80	85	81
	1992	64	70	68	74	78	80	84	84
	1993	43	50	61	69	76	80	86	84
	1994	42	61	63	68	75	80	82	81
	1995	59	57	66	70	75	78	84	80
	1996	61	68	78	80	82	85	88	88
	1997	75	75	75	79	82	84	87	88
	1998	72	56	71	81	82	85	85	87
	1999	61	66	65	74	81	81	87	84
	2000	73	71	78	79	80	84	88	86
	2001	72	52	64	80	82	84	85	88
	2002	62	60	71	77	80	86	87	89
	2003	60	67	75	80	81	85	87	85
	2004	72	74	73	80	81	88	85	84
	2005	71	68	70	79	83	83	83	86
	2006	56	72	75	79	83	85	87	84
	2007	77	71	75	78	82	84	86	85
	2008	62	69	71	75	82	90	91	88
	2009	57	60	74	76	80	96	88	86
	2010	74	72	67	77	81	84	85	86

OGUN STATE MONTHLY TOTAL RAINFALL, mm										
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
	1981	0	3.0	101.2	100.3	149.4	436.3	222.4	61.0	136.6
	1982	3.4	52.7	29.5	121.2	155.6	124.9	80.6	8.0	84.8
	1983	0	0	7.0	75.3	214.0	207.8	131.9	38.3	150.8
	1984	0.2	1.2	202.5	89.5	194.0	154.8	76.7	116.3	135.8
	1985	0	0	80.6	89.1	123.8	123.2	168.4	180.1	200.9
	1986	0	52.9	32.5	133.2	148.3	143.0	80.2	14.4	120.2
	1987	0	99.2	57.4	57.3	69.6	105.3	145.9	292.7	312.3
	1988	14.5	35.5	75.7	257.7	221.1	260.6	138.8	123.5	308.3
	1989	0	3.8	160.9	139.0	101.4	247.4	271.2	163.7	180.4
	1990	32.5	27.4	1.6	140.2	152.0	173.2	220.3	22.2	164.8
	1991	2.5	60.0	38.1	118.1	127.1	179.0	286.2	84.3	194.4
	1992	0	0	8.4	145.7	116.9	175.7	235.0	44.3	224.3
	1993	0	67.8	74.2	45.5	167.0	255.6	155.9	70.3	188.4
	1994	12.1	1.6	104.1	60.2	87.9	120.7	130.5	21.2	193.9
	1995	0	4.0	152.6	124.8	69.4	230.8	133.0	195.7	163.5
	1996	0	88.1	63.4	82.4	142.2	161.6	270.6	165.6	372.7
	1997	0	0	70.9	254.6	117.7	187.9	145.6	130.8	184.6
	1998	0	1.1	12.8	82.8	173.6	162.2	150.0	97.5	251.2
	1999	13.1	87.7	39.8	113.5	104.0	177.9	319.3	305.3	119.8
	2000	4.3	0	74.1	113.3	78.2	144.5	166.5	284.9	246.3
	2001	0	0	32.8	145.0	183.2	154.8	89.6	22.4	194.5
	2002	0	0	55.3	164.9	109.1	228.7	309.7	91.4	122.9
	2003	3.0	54.1	23.8	126.8	113.3	341.7	147.4	40.0	281.1
	2004	13.9	41.2	90.0	66.3	268.5	179.3	46.1	150.8	91.9
	2005	0	15.1	88.8	105.3	211.4	134.0	109.1	34.7	145.4
	2006	7.6	37.5	56.1	144.4	130.5	276.7	103.8	67.8	219.9
	2007	0	0	24.1	58.4	201.4	324.2	508.2	169.2	170.3
	2008	0	2.6	28.2	79.2	135.4	177.3	269.3	166.6	365.8
	2009	0	14.3	23.8	236.1	261.6	213.1	152.3	208.8	130.6
	2010	1.0	6.8	3.0	104.1	173.4	51.0	385.9	207.0	259.6
	2011	0	68.2	19.6	56.5	148.0	102.5	284.7	41.8	294.3

Quantity of fertilizer in metric tonnes

Timescale	tonnes
1980-1981	245
1981-1982	321
1982-1983	352
1983-1984	345
1984-1985	321
1985-1986	421
1986-1987	235
1987-1988	352
1988-1989	342
1989-1990	361
1990-1991	388
1991-1992	366
1992-1993	344
1993-1994	389
1994-1995	398
1995-1996	397
1996-1997	398
1997-1998	388
1998-1999	397
1999-2000	395
2000-2001	397
2001-2002	398
2002-2003	399
2003-2004	379
2004-2005	399
2005-2006	400
2006-2007	396
2007-2008	385
2008-2009	401
2009-2010	423
2010-2011	425

OGUN STATE CROP YIELLD (tonnes)						
Timescale	**Cocoyam**	**Melon**	**Cassava**	**Yam**	**Maize**	**Rice**
1980	51.21	3.10	1058	89.52	72.63	15.41
1981	92.43	4.46	1142.23	74.52	96.35	16.23
1982	111.85	3.37	1520.52	69.56	86.56	18.23
1983	181.58	4.21	1423.21	54.65	77.54	17.23
1984	111.76	6.18	1456.23	85.56	76.56	19.45
1985	109.9	7.12	1642.52	68.23	65.23	17.77
1986	51.14	8.15	1325.23	75.56	66.88	16.54
1987	60.75	7.56	1452.23	86.52	74.23	18.52
1988	74.56	8.45	1356.23	45.62	64.23	17.54
1989	89.56	9.23	1523.56	72.25	75.56	18.45
1990	88.55	7.56	1456.23	85.64	66.52	17.25
1991	101.3	5.55	1465.12	75.26	66.52	16.96
1992	120.3	5.75	1523.89	64.56	85.26	14.23
1993	112.32	5.98	1472.45	85.26	67.56	18.52
1994	96.56	5.65	1322.32	68.88	68.98	17.77
1995	85.96	5.86	1321.14	74.56	69.56	16.52
1996	99.85	5.74	1452.21	66.66	64.45	18.52
1997	99.98	6.12	1321.74	69.89	56.23	13.45
1998	102.52	6.54	1425.23	65.45	68.56	15.23
1999	103.56	6.89	1324.54	64.56	74.23	16.52
2000	112.65	6.78	1523.23	72.13	69.89	13.41
2001	100.5	6.45	1423.25	70.52	68.56	15.23
2002	102.3	7.12	1233.33	71.12	64.85	16.23
2003	89.56	7.54	1455.23	74.12	67.77	14.44
2004	89.99	7.23	1334.21	71.21	69.85	15.23
2005	98.96	7.45	1423.25	72.24	67.23	12.89
2006	98.56	7.65	1324.52	75.23	71.45	13.52
2007	97.56	7.54	1334.23	74.65	81.23	13.24
2008	102.56	7.45	1252.32	72.35	67.87	13.24
2009	103.52	6.98	1324.23	72.54	72.14	13.33
2010	99.56	7.01	1333.42	74.33	71.23	13.45
2011	97.82	7.05	1452.32	75.55	71.45	13.99

EDO- BENIN MONTHLY AVERAGE MAXIMUM TEMPERATURES (ºC)									
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**
	1971	31.4	33.2	32.7	32.6	32.2	30.0	27.8	27.6
	1972	32.8	32.9	32.8	31.9	31.9	30.1	28.8	27.7
	1973	33.0	34.7	34.2	33.3	32.4	30.3	29.7	28.5
	1974	31.6	33.8	33.4	32.2	31.6	30.6	28.2	28.4
	1975	32.7	33.4	33.0	33.1	31.5	30.2	28.3	27.4
	1976	31.8	32.2	32.7	31.3	30.9	29.9	27.1	27.2
	1977	31.3	33.5	33.4	33.4	32.1	29.6	28.0	28.1
	1978	33.4	33.1	32.9	31.6	31.5	30.0	28.0	28.6
	1979	33.1	33.4	33.5	33.6	30.3	30.1	28.9	27.9
	1980	33.2	33.7	33.3	32.8	31.6	30.2	28.1	28.1
	1981	32.2	34.9	34.0	32.8	31.5	31.3	28.0	28.9
	1982	33.0	32.3	33.8	33.2	32.0	30.5	28.5	28.3
	1983	33.7	35.3	35.2	37.0	33.2	30.0	29.2	27.8
	1984	33.0	35.0	34.0	32.9	32.0	31.3	30.1	30.2
	1985	33.3	34.5	34.0	32.9	31.7	28.7	30.3	28.5
	1986	33.0	34.2	33.3	33.4	31.8	31.0	27.8	28.4
	1987	33.3	33.7	32.9	33.7	32.8	30.9	30.0	29.0
	1988	33.0	34.4	33.4	32.9	32.2	30.7	28.8	28.6
	1989	33.3	35.1	33.2	33.3	31.6	31.6	28.4	28.1
	1990	33.0	34.1	36.0	33.3	32.1	30.6	27.6	28.4
	1991	32.7	33.6	33.5	32.0	31.7	31.0	28.4	27.9
	1992	33.3	35.9	34.6	33.3	32.3	29.9	27.5	27.5
	1993	33.6	35.3	33.7	33.1	32.5	30.6	28.4	28.5
	1994	32.1	34.0	34.1	32.6	32.0	30.6	27.9	27.4
	1995	34.1	34.5	33.3	32.8	32.0	30.5	28.5	28.8
	1996	33.3	33.8	33.7	32.7	32.2	30.8	28.8	28.4
	1997	33.2	35.3	33.1	31.9	31.7	30.5	28.9	28.3
	1998	33.3	36.5	37.0	35.5	33.7	31.2	28.8	29.1
	1999	31.9	33.5	33.6	32.6	32.2	30.6	28.8	29.1
	2000	33.3	34.6	34.8	33.4	32.2	30.3	29.0	27.9
	2001	32.8	34.8	34.0	32.2	31.7	30.3	28.8	27.8
	2002	33.7	34.6	33.1	32.3	31.6	30.3	29.3	28.1
	2003	33.3	35.2	34.1	32.8	32.3	30.1	29.5	29.1
	2004	32.9	34.2	33.7	32.9	31.9	30.4	28.6	28.3
	2005	33.6	34.9	33.3	33.0	31.9	30.3	28.5	28.8
	2006	33.4	34.3	34.1	34.1	31.5	31.2	29.3	28.5
	2007	34.6	34.7	34.8	32.9	31.7	28.7	30.3	28.5
	2008	33.8	35.8	34.0	32.8	32.3	30.9	29.7	29.1

EDO-BENIN MONTHLY AVERAGE MINIMUM TEMPERATURES (ºC)										
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	1971	21.3	23.1	23.1	23.0	23.2	22.5	21.8	21.7	22.1
	1972	23.1	23.2	23.6	23.4	23.3	22.6	22.7	22.3	22.4
	1973	24.4	25.3	24.2	24.0	23.2	22.7	22.4	22.6	22.4
	1974	22.2	24.3	24.0	23.4	22.9	22.3	22.3	22.5	22.1
	1975	20.4	23.1	24.8	23.6	23.1	22.0	21.9	21.8	21.8
	1976	22.1	23.4	23.7	23.6	22.9	22.3	21.7	21.6	21.8
	1977	23.4	24.1	24.7	24.8	23.9	22.4	21.6	21.7	21.7
	1978	21.0	24.2	23.8	23.5	23.5	23.1	22.3	22.4	22.5
	1979	23.9	23.9	24.1	23.7	23.4	23.1	22.8	22.6	22.5
	1980	24.1	24.7	24.6	23.7	23.4	23.5	22.8	22.4	22.4
	1981	22.1	24.0	24.1	23.9	22.7	23.0	22.3	22.7	22.3
	1982	23.1	23.2	22.3	23.9	23.6	23.2	22.2	22.2	22.5
	1983	18.4	24.2	25.5	24.8	24.0	23.0	18.6	22.2	22.8
	1984	21.0	22.9	23.1	22.1	21.7	20.8	22.5	21.2	22.7
	1985	24.0	23.6	24.0	23.5	23.3	21.8	22.5	22.5	22.2
	1986	23.6	24.7	23.9	24.3	23.4	23.1	22.4	22.1	22.6
	1987	24.0	24.3	24.1	23.9	24.0	23.4	23.0	23.3	23.0
	1988	23.0	24.6	24.2	23.7	23.6	22.6	22.6	22.5	22.7
	1989	19.2	22.7	23.5	24.2	23.4	22.8	22.4	22.5	22.7
	1990	24.2	23.6	25.2	24.2	23.6	23.4	22.7	22.7	22.5
	1991	23.2	24.3	24.3	23.3	24.0	23.4	22.8	22.7	22.6
	1992	21.1	23.9	24.8	24.2	23.7	22.3	22.0	21.9	22.1
	1993	21.1	23.4	23.1	23.5	23.3	22.6	22.1	22.5	22.5
	1994	22.0	24.0	24.5	24.1	23.5	23.1	22.8	23.0	23.3
	1995	22.9	24.4	24.3	24.8	24.0	23.2	23.1	23.1	23.4
	1996	24.5	24.8	21.9	24.2	24.0	23.7	23.1	22.9	22.7
	1997	23.9	23.0	24.3	23.7	23.4	23.3	22.4	22.8	30.0
	1998	21.7	24.3	25.5	25.3	24.5	23.7	22.6	22.5	22.6
	1999	22.7	24.6	24.3	24.0	23.6	23.5	22.6	22.5	22.6
	2000	23.9	23.1	24.7	24.3	23.6	22.6	23.0	22.5	22.9
	2001	23.1	24.0	24.0	23.7	23.9	23.3	23.3	22.8	22.9
	2002	22.8	24.1	25.1	24.3	24.3	23.1	23.2	22.9	23.1
	2003	23.3	25.3	24.9	24.4	24.3	23.3	22.8	23.0	22.9
	2004	23.5	24.1	24.9	23.9	23.8	22.9	22.9	22.7	22.8
	2005	21.8	25.1	24.5	24.9	23.9	23.3	22.9	22.5	23.2
	2006	22.0	25.2	24.3	24.9	23.2	23.3	22.2	22.7	22.7
	2007	23.4	24.9	25.2	24.4	23.5	22.4	21.6	21.7	22.7
	2008	21.4	23.8	24.3	24.1	23.7	23.3	23.1	22.6	23.2
	2009	23.5	24.6	24.8	24.0	23.8	23.2	23.3	22.9	23.2
	2010	24.4	25.2	25.6	24.2	24.9	24.0	23.0	23.0	22.9

	EDO-STATE MONTHLY AVERAGE RELATIVE HUMIDITY, %								
Timescale	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
1981	76	73	79	81	85	83	89	89	88
1982	75	75	77	83	83	86	88	88	88
1983	39	70	74	76	82	88	87	89	88
1984	71	68	78	80	83	82	86	86	86
1985	78	70	78	81	83	85	88	90	86
1986	74	75	79	79	81	82	88	87	86
1987	74	79	81	79	83	85	89	93	88
1988	69	77	81	82	83	85	90	90	90
1989	56	60	79	79	83	87	90	91	87
1990	77	71	71	80	82	86	93	90	89
1991	73	90	81	83	85	91	92	93	88
1992	58	65	75	82	84	88	93	91	88
1993	58	71	77	81	84	87	90	93	89
1994	72	74	80	82	83	85	92	93	91
1995	66	75	81	83	83	88	92	92	89
1996	80	81	81	82	83	86	89	92	91
1997	76	60	78	83	84	87	90	91	86
1998	64	70	69	78	82	85	92	90	91
1999	78	79	81	81	83	87	91	89	91
2000	75	59	72	80	83	86	90	91	90
2001	75	68	79	81	84	87	89	91	90
2002	60	69	84	84	84	86	91	92	90
2003	77	76	78	82	83	87	88	90	91
2004	75	68	72	83	85	86	90	91	88
2005	67	74	80	83	83	90	92	88	88
2006	82	80	78	81	85	85	91	90	90
2007	70	95	94	95	96	98	98	98	98
2008	41	35	62	66	71	74	80	81	82
2009	83	83	84	83	83	92	94	94	94
2010	92	90	90	90	90	91	94	94	93

EDO-STATE MONTHLY TOTAL RAINFALL, mm									
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
1971	24.1	20.4	147.3	115.4	108.4	229.9	372.8	288.2	539.0
1972	9.9	124.9	26.1	266.1	151.8	149.2	323.6	209.7	30.3
1973	0	29.8	41.5	192.7	178.6	258.9	328.8	354.6	380.4
1974	0	37.4	77.8	116.5	128.3	363.1	489.1	268.0	410.9
1975	0	55.6	55.2	218.5	228.7	334.7	510.8	257.5	291.6
1976	0	130.6	141.5	153.4	133.3	357.9	316.0	129.2	385.8
1977	7.5	58.7	68.0	107.3	25.8	351.5	229.7	153.4	276.1
1978	20.5	148.8	149.4	294.6	326.4	235.6	242.4	219.7	437.1
1979	0	89.1	44.2	203.9	173.0	233.1	359.5	529.0	309.3
1980	3.2	58.3	77.8	140.4	296.3	298.5	407.8	482.3	445.8
1981	0	6.8	108.4	119.8	277.2	180.6	276.1	230	394.8
1982	101.9	111.4	98.2	211.4	146.0	174.1	243.9	66.8	391.0
1983	0	49.4	39.0	76.8	267.4	277.2	166.5	142.8	425.2
1984	0	45.8	87.3	59.3	120.4	134.1	223.8	181.8	235.2
1985	8.7	16.0	110.5	33.2	173.4	202.5	244.3	305.2	197.9
1986	5.6	45.1	109.6	52.3	162.7	65.1	214.2	117.7	222.3
1987	0.8	74.5	100.2	112.5	151.4	217.0	269.5	722.5	348.21
1988	7.0	71.1	154.8	136.5	168.0	227.0	393.0	191.2	445.4
1989	0	25.8	66.1	152	140.4	343.4	279.2	427.8	157.3
1990	19.6	18.8	0	256.8	181.4	204.1	353.4	614.5	296.9
1991	0	58.1	123.5	386.3	196.7	207.2	656.2	382.6	268.0
1992	0	0.2	41.4	222.7	240.0	335.8	515.9	76.4	256.3
1993	0	9.6	135.0	95.4	198.2	208.8	191.4	433.9	257.6
1994	27.5	14.6	111.4	149.8	327.9	351.3	444.4	461.4	391.7
1995	0	50.6	165.4	217.9	226.9	286.2	383.3	580.8	383.3
1996	7.0	92.6	188.2	298.3	322.2	28.1	182.3	392.3	476.0
1997	75.3	0	104.0	230.9	305.3	203.3	285.0	160.2	222.9
1998	44.1	1.8	104.6	104.8	214.6	214.4	506.1	95.6	387.9
1999	86.3	64.4	98.3	119.6	161.7	99.5	412.3	232.0	369.0
2000	4.0	73.0	60.8	170.0	191.8	413.7	294.7	237.9	345.0
2001	18.8	10.1	119.3	394.3	155.7	364.3	216.0	137.4	357.1
2002	0	115	163.5	278.1	199.4	344.9	411.3	491.8	294.8
2003	33.9	13.7	172.0	169.8	226.5	187.6	177.1	142.1	393.3
2004	28.8	28.3	68.4	118.9	250.7	448.9	288.0	403.0	297.6
2005	0	9.8	182.2	119.6	95.5	450.2	458.8	97.0	207.6
2006	33.1	22.3	146.0	117.1	394.0	240.2	462.4	359.2	334.4
2007	15.6	48.2	91.6	183.5	350.2	347.9	354.3	303.3	462.5
2008	10.3	2.8	146.1	160.1	215.6	272.9	413.6	319.7	199.3
2009	14.6	108.6	69.8	157.8	330.5	171.8	175.0	248.3	294.5
2010	15.5	68.6	55.3	321.5	79.6	145.4	91.6	332.2	615.1
2011	0	77.8	87.0	321.5	353.5	430.9	550.8	502.5	409.3

Edo State CROP (tonnes)									
Timescale	**Cassava**	**Rice**	**Cocoyam**	**Melon**	**Rice**	**Groundnut**	**Beans**	**Yam**	**Maize**
1980	457	4.49	3.30	8.05	131.70	6.56	1.79	389	57.90
1981	518	7.90	3.21	6.52	121.30	6.25	0.96	349	62.12
1982	604	5.72	3.56	11.96	141.23	7.45	0.89	385	62.13
1983	702	6.23	3.64	10.23	112.20	7.89	0.79	345	64.23
1984	503	6.15	3.45	12.31	113.40	7.96	0.85	398	62.10
1985	601	6.45	3.56	12.52	121.20	8.96	0.95	378	65.23
1986	524	6.45	3.47	12.64	123.12	8.95	0.74	399	64.52
1987	625	6.32	3.54	12.45	111.11	8.99	0.78	374	63.45
1988	651	6.78	3.54	12.85	96.45	9.21	0.85	398	67.52
1989	456	6.89	3.65	13.45	98.65	9.56	0.74	395	63.85
1990	564	5.23	3.21	12.45	102.32	9.45	0.68	385	62.45
1991	523	5.46	3.14	12.36	89.23	9.42	0.74	374	68.52
1992	456	5.46	4.12	14.25	85.62	9.78	0.95	395	64.56
1993	552	5.89	4.32	13.52	84.65	9.65	0.88	345	64.23
1994	621	5.98	4.12	13.33	87.54	9.45	0.78	385	65.23
1995	654	5.78	5.62	14.25	96.54	8.56	0.85	374	64.52
1996	452	5.99	6.89	17.45	97.65	8.23	0.56	395	68.56
1997	521	5.47	7.52	16.54	85.62	8.45	0.88	398	64.23
1998	532	5.42	8.32	15.42	87.45	8.55	0.89	397	62.85
1999	604	5.32	8.21	16.66	86.23	8.74	0.87	395	61.42
2000	624	4.69	8.95	15.62	87.56	9.52	0.89	398	63.15
2001	596	5.23	9.65	15.61	103.21	9.21	0.88	374	68.52
2002	589	5.45	8.74	16.60	131.45	9.32	0.89	385	62.12
2003	597	5.42	8.95	16.64	142.32	9.12	1.01	375	63.52
2004	599	5.46	8.47	16.66	156.23	9.42	1.21	395	63.45
2005	601	5.61	8.99	16.47	99.65	10.20	0.85	396	68.35
2006	602	5.41	9.21	17.21	95.65	9.12	0.86	385	67.52
2007	685	5.65	10.51	16.45	99.65	8.56	0.92	348	65.55
2008	647	6.23	11.21	14.25	98.56	9.56	0.95	395	62.41
2009	634	6.21	12.30	16.25	94.56	9.65	0.99	365	63.12

2010	602	6.41	12.45	15.56	102.32	9.52	0.98	345	62.54
2011	623	6.52	12.55	16.89	112.03	9.49	0.96	385	61.32

Quantity of fertilizer in metric tonnes

Timescale	tonnage
1980-1981	321
1981-1982	354
1982-1983	364
1983-1984	395
1984-1985	347
1985-1986	369
1986-1987	452
1987-1988	465
1988-1989	421
1989-1990	465
1990-1991	452
1991-1992	415
1992-1993	436
1993-1994	456
1994-1995	478
1995-1996	492
1996-1997	487
1997-1998	499
1998-1999	521
1999-2000	513
2000-2001	542
2001-2002	554
2002-2003	564
2003-2004	586
2004-2005	598
2005-2006	598
2006-2007	599
2007-2008	601
2008-2009	612
2009-2010	614
2010-2011	631

KWARA STATE MONTHLY AVERAGE MAXIMUM TEMPERATURES (ºC)										
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
	1971	31.5	32.2	32.6	32.3	32.0	29.5	28.1	27.6	28.4
	1972	32.8	33.2	33.7	32.5	31.4	29.5	29.1	28.9	29.0
	1973	34.0	34.0	33.7	32.5	33.1	31.2	30.1	29.4	29.2
	1974	31.3	33.3	32.7	31.9	30.6	29.7	28.5	28.7	28.4
	1975	32.7	32.4	32.3	32.1	31.0	29.3	27.6	27.4	28.4
	1976	32.1	31.4	31.2	30.8	31.0	29.6	28.4	28.3	29.2
	1977	32.4	32.8	32.1	31.1	30.3	28.7	27.9	28.4	28.9
	1978	32.1	33.0	33.0	33.0	29.8	28.7	27.1	27.9	28.8
	1979	32.5	32.4	32.6	32.9	30.0	28.6	27.9	27.5	29.2
	1980	32.2	33.3	33.1	33.4	30.9	30.5	28.4	29.1	29.9
	1981	33.3	34.2	33.1	33.0	31.2	27.9	27.8	25.5	28.9
	1982	33.1	33.9	33.1	33.8	30.9	29.2	28.2	27.8	29.1
	1983	33.3	34.2	32.1	31.0	30.0	29.2	28.9	28.7	29.9
	1984	32.2	34.4	33.1	31.2	28.9	29.2	29.4	27.9	29.8
	1985	32.2	34.1	31.9	32.8	32.2	30.3	27.9	28.7	28.2
	1986	33.2	33.1	33.3	33.9	31.6	30.0	29.8	27.8	28.9
	1987	33.0	34.2	33.3	33.2	30.2	28.9	27.9	28.7	28.9
	1988	32.2	32.1	30.9	30.4	28.9	28.8	28.7	29.9	33.2
	1989	32.1	34.2	33.3	32.0	31.2	29.8	27.9	27.8	28.9
	1990	32.1	34.2	33.3	32.0	31.2	29.8	27.9	27.8	28.9
	1991	32.3	33.4	32.8	31.6	31.0	30.3	28.3	28.0	29.2
	1992	32.5	33.9	35.2	32.5	31.2	30.2	27.6	28.5	29.1
	1993	33.3	33.3	24.2	32.6	31.2	30.0	28.0	28.6	31.0
	1994	31.9	33.4	33.2	32.8	31.5	29.8	29.0	28.3	29.4
	1995	33.2	33.5	32.6	33.1	32.1	30.0	28.4	28.5	29.2
	1996	32.9	33.2	33.2	32.1	31.3	29.5	28.7	28.1	28.5
	1997	33.1	35.1	32.8	33.2	32.6	29.4	29.0	29.0	30.0
	1998	33.1	35.3	35.0	34.6	32.5	31.0	29.0	28.9	29.2
	1999	32.0	33.2	33.0	32.1	31.4	30.2	28.1	29.1	28.9
	2000	32.0	3.40	34.6	32.8	31.8	29.6	28.4	27.6	28.3
	2001	32.7	33.6	34.3	32.6	31.9	29.4	28.6	27.7	28.8
	2002	32.9	33.7	33.8	32.8	32.3	30.3	28.8	28.6	29.3
	2003	32.4	33.6	33.9	32.0	32.3	29.5	29.2	29.3	29.8
	2004	32.5	33.5	32.8	32.4	31.2	29.6	28.4	28.3	29.2
	2005	33.2	33.4	33.4	32.9	31.1	29.4	28.3	28.6	29.5
	2006	32.5	33.8	33.3	33.9	31.4	30.7	29.1	28.8	28.6
	2007	33.6	34.7	35.0	32.5	31.2	30.2	27.6	28.5	29.1
	2008	33.7	35.5	33.4	32.9	31.7	30.0	28.5	28.9	29.1
	2009	33.7	33.7	33.7	32.7	31.8	30.5	29.0	28.9	30.1

KWARA STATE MONTHLY AVERAGE MINIMUM TEMPERATURES (ºC)										
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
	1971	21.8	22.9	22.9	23.0	23.0	22.0	21.7	21.5	21.8
	1972	22.5	23.1	23.4	23.2	23.5	22.3	22.7	22.0	22.3
	1973	23.7	25.1	24.5	24.3	23.4	22.9	22.6	22.0	22.2
	1974	22.2	23.4	23.9	23.2	22.9	22.4	22.4	21.8	22.1
	1975	20.7	22.8	23.9	23.2	23.2	22.6	22.0	21.4	21.8
	1976	22.2	22.6	23.8	22.6	22.7	22.8	22.8	22.1	21.9
	1977	22.4	24.0	23.3	23.3	22.9	22.6	21.6	16.0	21.3
	1978	22.3	24.8	23.2	23.4	22.5	21.6	21.1	20.8	20.9
	1979	21.7	22.9	23.6	23.7	22.8	22.8	22.8	22.1	21.9
	1980	23.9	24.4	24.6	24.8	23.9	23.7	22.6	22.5	22.7
	1981	22.9	23.8	24.5	22.6	21.7	21.9	21.6	22.7	22.6
	1982	23.0	22.9	24.5	23.6	23.8	22.5	21.6	21.7	22.5
	1983	19.9	23.6	25.5	24.6	24.2	22.6	21.7	21.6	22.5
	1984	23.3	23.9	25.1	23.8	22.9	22.2	21.8	21.9	22.5
	1985	23.0	23.9	24.8	24.8	22.7	22.5	22.2	22.7	19.9
	1986	23.1	23.9	23.7	24.9	23.3	22.5	22.2	21.6	21.7
	1987	23.9	24.8	24.5	25.6	23.7	23.3	22.9	22.7	22.8
	1988	23.8	24.6	24.7	24.6	23.8	23.3	22.2	22.8	22.9
	1989	19.9	22.8	23.7	23.9	23.7	24.4	23.2	22.6	22.8
	1990	23.9	23.7	24.6	23.9	24.7	23.6	23.3	22.4	21.9
	1991	23.7	25.2	25.2	24.1	23.0	23.9	23.3	23.0	23.1
	1992	21.4	24.4	26.0	25.0	24.5	23.1	23.1	22.6	23.7
	1993	22.0	24.4	24.2	24.8	23.9	23.3	23.0	23.0	22.8
	1994	23.1	24.5	28.9	25.1	24.1	23.1	22.8	22.8	23.1
	1995	23.1	24.1	22.3	24.4	23.6	21.7	20.9	22.8	22.7
	1996	24.3	24.5	24.9	24.3	24.1	23.5	23.1	22.9	23.4
	1997	24.7	23.9	24.8	24.3	24.2	23.6	22.8	22.9	23.6
	1998	22.6	26.0	26.5	26.7	25.2	24.0	23.8	23.0	23.3
	1999	24.1	24.5	25.2	24.5	24.4	23.9	23.1	23.0	23.2
	2000	24.7	23.7	25.8	25.8	24.9	23.4	23.0	22.9	23.2
	2001	24.4	24.9	26.0	24.8	24.5	23.5	23.4	23.0	22.6
	2002	24.0	24.9	25.6	25.2	24.6	23.6	23.7	23.4	23.2
	2003	23.7	25.6	25.8	25.0	25.0	23.0	23.2	23.4	23.7
	2004	24.3	24.6	25.0	24.7	24.1	23.0	22.9	23.0	22.6
	2005	22.6	25.7	25.3	25.3	24.6	23.7	23.3	22.9	24.0
	2006	25.2	25.8	23.2	23.4	22.5	21.6	21.1	20.8	20.9
	2007	23.4	24.5	25.2	24.9	24.2	23.4	22.9	22.9	23.1
	2008	23.6	24.8	25.0	25.2	23.9	23.7	23.4	23.6	23.7

KWARA STATE MONTHLY AVERAGE RELATIVE HUMIDITY, %									
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
	1981	70	74	75	75	82	89	87	83
	1982	41	73	75	78	83	87	85	84
	1983	72	69	76	69	74	78	78	78
	1984	80	77	77	84	86	82	86	85
	1985	77	79	79	80	81	83	87	81
	1986	79	80	78	78	79	85	86	89
	1987	71	76	80	75	81	86	86	83
	1988	62	62	78	79	82	82	87	86
	1989	79	71	74	80	84	85	89	83
	1990	78	79	78	81	84	85	89	86
	1991	59	74	79	77	83	85	88	84
	1992	58	74	74	77	83	87	84	83
	1993	74	75	76	80	83	84	83	85
	1994	73	79	80	79	82	85	88	89
	1995	83	82	82	81	82	87	89	88
	1996	79	68	77	82	97	86	85	86
	1997	65	75	74	77	82	84	85	83
	1998	80	77	76	82	82	86	89	85
	1999	79	52	69	77	80	88	85	86
	2000	81	72	74	81	84	87	87	87
	2001	68	79	78	82	84	88	89	85
	2002	83	82	78	81	80	88	84	83
	2003	79	77	74	85	87	87	87	86
	2004	66	82	81	82	85	90	89	84
	2005	84	80	79	79	86	87	89	86
	2006	53	77	76	79	82	89	87	87
	2007	62	70	79	79	85	88	86	88
	2008	78	82	81	84	85	87	89	85
	2009	69	79	81	75	85	85	90	85
	2010	79	83	85	83	85	86	84	87

KWARA STATE CROP YEILD (tonnes)									
	Time scale	**Cassava**	**Rice**	**Groundnut**	**Guinea Corn**	**Millet**	**Maize**	**Beans**	**Yam**
	1980	320	43.44	49.30	152.00	21.49	96.34	5.06	902
	1981	420	56.12	44.46	146.64	14.54	97.89	5.33	1041
	1982	400	54.62	45.45	152.32	34.52	99.95	4.94	908
	1983	452	56.45	43.56	113.23	35.55	96.78	6.85	980
	1984	463	66.54	47.34	145.98	34.55	98.57	4.95	756
	1985	421	62.32	45.23	154.32	36.45	95.67	5.56	768
	1986	432	65.23	43.44	147.32	34.52	96.75	6.85	843
	1987	412	64.56	47.83	144.32	36.45	98.45	4.75	945
	1988	452	63.12	45.65	154.33	36.45	98.88	5.32	877
	1989	468	66.52	47.23	155.55	36.66	96.76	5.21	820
	1990	489	64.52	36.45	165.55	35.34	97.57	5.32	1001
	1991	475	64.23	43.23	154.34	36.33	86.65	5.22	934
	1992	410	68.98	43.33	145.54	35.34	89.99	4.74	956
	1993	421	62.31	45.45	145.65	34.45	89.90	5.32	945
	1994	451	65.21	46.71	155.55	35.47	91.21	4.90	951
	1995	432	72.13	45.45	145.32	35.54	92.23	5.11	845
	1996	415	78.52	46.66	145.34	35.55	95.45	5.45	865
	1997	461	73.12	45.34	155.34	36.21	93.34	4.75	856
	1998	423	72.12	46.34	154.32	34.12	94.44	5.11	877
	1999	412	71.23	43.54	155.32	35.66	92.32	4.94	845
	2000	452	71.41	41.12	144.56	35.44	90.03	5.22	768
	2001	389	71.23	40.12	150.21	35.34	91.15	4.98	798
	2002	376	72.52	41.12	151.21	34.44	92.12	5.01	786
	2003	395	71.12	43.32	154.54	35.42	91.23	5.12	820
	2004	345	72.12	45.34	151.23	34.34	87.96	5.21	810
	2005	345	73.21	44.45	150.98	35.35	89.76	5.10	890
	2006	352	71.32	43.23	153.32	35.12	83.45	4.75	920
	2007	374	74.34	43.33	153.33	34.56	87.94	4.33	901
	2008	356	75.67	45.52	153.23	33.54	87.74	4.42	856
	2009	345	75.78	43.33	152.21	36.45	88.76	4.46	885
	2010	355	76.21	44.44	152.23	35.34	86.77	4.55	896
	2011	365	76.34	44.54	152.31	35.44	89.12	4.75	894

Quantity of fertilizer in metric tonnes

Timescale	tonnes
1980-1981	543
1981-1982	532
1982-1983	532
1983-1984	489
1984-1985	478
1985-1986	545
1986-1987	478
1987-1988	453
1988-1989	489
1989-1990	491
1990-1991	489
1991-1992	482
1992-1993	478
1993-1994	481
1994-1995	502
1995-1996	501
1996-1997	512
1997-1998	521
1998-1999	531
1999-2000	521
2000-2001	532
2001-2002	543
2002-2003	546
2003-2004	553
2004-2005	561
2005-2006	564
2006-2007	567
2007-2008	583
2008-2009	541
2009-2010	566
2010-2011	571

KOGI STATE MONTHLY AVERAGE MAXIMUM TEMPERATURES (^{O}C)										
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
	1971	33.7	36.5	36.7	36.5	34.0	31.0	29.9	29.7	29.9
	1972	34.8	36.4	35.4	33.0	33.1	30.8	31.6	30.4	31.2
	1973	35.8	37.8	38.1	37.6	32.0	31.6	30.3	30.2	30.8
	1974	33.7	36.6	37.9	34.3	32.1	31.5	30.4	30.3	30.7
	1975	33.1	35.4	36.6	34.9	32.2	31.7	24.9	29.5	30.5
	1976	34.4	36.0	36.2	35.4	32.1	31.2	30.0	29.6	31.1
	1977	34.7	36.9	37.4	35.6	32.0	31.4	31.0	30.3	30.5
	1978	34.8	37.4	36.5	33.4	32.2	31.4	29.4	30.3	30.3
	1979	35.3	36.7	36.6	35.1	32.7	31.8	30.9	30.6	31.5
	1980	35.7	37.1	38.0	35.8	32.3	32.7	30.7	30.2	30.8
	1981	34.4	37.5	37.3	36.3	32.8	32.1	29.9	30.3	30.9
	1982	34.7	36.0	36.7	35.3	32.9	32.1	30.1	30.1	30.9
	1983	33.2	38.1	38.7	37.4	34.7	31.0	30.8	30.4	31.0
	1984	35.3	37.7	37.5	35.7	33.0	31.8	31.0	31.1	30.9
	1985	35.8	36.6	39.4	35.1	33.6	31.1	29.9	30.6	31.6
	1986	34.8	36.9	36.1	35.3	32.7	31.5	30.1	31.0	30.2
	1987	35.9	37.0	37.2	38.3	35.8	32.7	31.9	31.2	31.5
	1988	34.8	37.0	37.0	35.9	33.8	31.8	29.9	29.8	30.6
	1989	33.6	36.2	37.5	37.3	32.7	31.3	30.3	29.9	30.5
	1990	35.2	36.2	38.5	36.2	33.2	31.7	30.1	30.5	30.8
	1991	34.6	37.4	36.5	34.4	32.0	32.0	30.2	29.8	31.0
	1992	33.8	37.2	37.3	36.0	33.1	30.7	30.2	29.9	30.2
	1993	33.9	36.8	36.8	36.4	33.8	32.0	30.9	30.5	31.1
	1994	34.5	36.9	38.2	34.7	32.8	31.7	30.3	30.0	31.0
	1995	34.3	36.7	36.9	35.2	33.3	31.5	30.8	30.4	31.1
	1996	35.5	36.9	37.7	35.2	33.5	31.9	30.6	29.7	30.1
	1997	35.2	36.4	36.4	33.1	32.9	31.3	30.3	31.0	31.1
	1998	35.1	38.5	39.1	38.0	34.3	32.3	31.0	30.6	30.8
	1999	35.6	36.4	37.2	35.9	32.7	31.5	30.6	30.7	30.3
	2000	35.3	35.9	38.3	35.6	32.1	31.0	30.7	30.1	31.3
	2001	35.3	37.1	38.4	36.2	34.4	31.8	30.7	29.9	30.3
	2002	34.2	37.2	37.8	34.9	33.4	32.2	30.9	30.3	30.7
	2003	34.6	36.8	37.3	35.6	32.0	31.6	30.3	30.2	30.8
	2004	34.7	36.9	37.4	35.7	32.1	31.7	30.4	30.3	30.7
	2005	34.8	37.4	36.5	33.4	32.2	31.4	29.4	30.3	30.3
	2006	35.3	36.7	36.6	35.1	32.7	31.8	30.9	30.6	31.5
	2007	34.8	36.9	37.2	35.6	33.1	31.6	30.4	30.3	30.8
	2008	34.8	37.0	37.4	35.7	33.2	31.7	30.5	30.5	30.9
	2009	34.9	37.2	38.4	34.7	33.0	31.5	30.8	30.5	31.1
	2010	35.9	37.7	38.2	36.9	33.5	32.6	30.6	30.6	31.0

KOGI STATE MONTHLY AVERAGE MINIMUM TEMPERATU (ºC)										
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	1971	20.5	23.4	25.4	25.3	24.2	22.9	22.3	22.3	22.2
	1972	20.3	24.1	25.0	24.2	24.1	22.6	23.1	22.7	22.7
	1973	23.1	25.0	26.0	25.8	24.3	23.6	23.0	22.6	22.3
	1974	19.8	23.6	25.8	24.3	23.5	23.6	22.4	22.9	22.4
	1975	17.0	23	25.5	24.6	23.7	22.8	22.2	22.3	22.2
	1976	19.7	24.6	25.3	24.8	23.3	22.6	22.4	22.1	22.6
	1977	21.6	23.2	25.2	26.4	24.6	23.3	23.0	22.9	22.7
	1978	18.6	25.6	25.2	24.8	23.4	23.3	22.8	23.0	22.7
	1979	18.9	24.0	25.8	25.1	23.6	23.4	23.2	23.4	23.0
	1980	21.7	24.4	25.5	25.7	24.1	24.2	23.2	23.0	22.9
	1981	18.7	22.3	25.4	25.1	23.5	23.0	22.2	22.6	22.3
	1982	20.7	23.4	24.5	25.2	24.1	23.5	22.4	22.3	22.4
	1983	16.8	23.9	24.5	26.3	24.6	23.0	22.6	22.0	22.5
	1984	18.4	23.3	25.9	23.3	22.8	22.3	22.5	22.3	22.6
	1985	23.6	20.7	24.8	24.7	23.7	22.8	22.3	23.0	22.2
	1986	20.8	24.7	25.0	24.6	23.5	23.0	22.3	21.9	21.9
	1987	19.5	24.7	25.4	26.4	25.4	23.8	23.1	23.2	23.3
	1988	21.2	24.5	26.8	25.8	24.7	23.5	22.8	23.1	23.1
	1989	14.1	19.1	24.8	25.4	23.2	22.7	22.2	22.3	22.1
	1990	21.6	21.9	23.5	25.7	24.7	23.8	23.0	22.0	23.0
	1991	21.0	26.0	25.9	27.7	24.6	24.1	23.2	23.3	23.0
	1992	18.0	20.1	26.0	26.1	24.3	23.1	22.9	22.8	22.5
	1993	18.6	21.8	24.4	25.5	24.7	23.6	23.3	23.0	22.8
	1994	21.4	23.5	26.6	25.2	24.3	23.5	23.3	22.9	23.6
	1995	18.4	22.7	26.1	25.7	24.7	23.4	23.5	23.0	23.3
	1996	21.5	25.9	26.5	25.5	24.7	23.7	23.1	23.0	23.0
	1997	22.3	19.3	25.6	24.6	24.4	23.5	23.1	23.5	23.0
	1998	19.8	25.3	26.3	27.7	25.3	24.0	23.9	23.4	23.3
	1999	21.7	25.3	26.3	25.5	24.3	23.3	23.1	22.9	22.6
	2000	21.6	21.5	23.6	25.3	24.8	23.0	23.5	22.7	23.2
	2001	19.6	22.6	26.6	25.9	25.1	24.0	23.6	23.6	23.3
	2002	19.4	23.9	27.0	25.7	25.1	23.9	23.9	23.4	23.4
	2003	22.2	25.5	26.8	26.2	25.8	24.0	23.4	23.9	23.5
	2004	21.4	24.8	26.6	25.9	24.6	23.9	23.5	23.6	22.9
	2005	19.9	26.6	27.6	26.6	25.1	24.0	24.0	23.7	23.7
	2006	25.2	23.9	24.5	26.8	24.5	23.9	24.0	23.3	23.2
	2007	22.2	24.2	24.1	25.3	22.9	22.1	20.9	21.8	20.6
	2008	22.1	21.9	23.8	23.7	22.9	22.2	21.9	21.8	21.6
	2009	22.2	22.9	23.8	23.5	23.2	21.9	20.9	20.8	21.7
	2010	21.8	26.4	27.3	26.8	25.6	24.9	23.4	23.9	23.6

KOGI STATE MONTHLY AVERAGE RELATIVE HUMIDITY, %								
1981	55	55	62	68	78	82	85	85	87
1982	58	54	61	72	78	79	83	79	84
1983	42	51	50	65	72	81	81	83	82
1984	52	50	61	67	77	79	81	81	82
1985	71	44	63	69	75	81	83	80	82
1986	60	64	66	70	77	79	83	82	84
1987	57	65	63	61	71	77	81	85	82
1988	56	59	63	67	74	73	79	77	76
1989	32	29	49	51	69	73	77	78	77
1990	49	38	50	68	77	80	84	84	81
1991	47	51	56	64	74	74	79	80	77
1992	39	32	50	59	68	74	74	75	77
1993	36	50	48	60	68	72	74	76	75
1994	50	44	52	65	71	74	78	80	76
1995	42	45	55	64	72	75	79	81	77
1996	55	52	51	62	68	74	75	79	78
1997	53	34	51	70	70	75	74	76	77
1998	42	41	42	54	68	74	76	75	77
1999	52	52	54	57	69	75	77	77	77
2000	49	36	41	62	68	71	75	77	75
2001	43	36	49	58	65	73	77	77	77
2002	37	43	51	63	69	71	76	79	78
2003	51	49	51	58	60	74	75	66	70
2004	47	41	43	60	70	73	74	76	74
2005	39	50	50	57	68	73	73	70	74
2006	83	80	76	80	88	90	92	92	92
2007	77	71	74	84	90	91	92	93	92
2008	57	47	63	68	77	79	81	82	80
2009	57	56	52	63	74	77	78	83	83
2010	57	54	59	70	77	84	83	80	81

KOGI MONTHLY TOTAL RAINFALL, mm									
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1971	1.0	0	10.9	28.7	151.3	154.8	264.7	448.6	241.9
1972	0	42.9	86.5	126.3	384.2	153.0	79.2	138.5	156.5
1973	0	0	3.9	65.8	161.1	75.0	72.3	205.6	211.2
1974	0	0	1.5	122.9	111.3	226.1	299.4	55.1	176.5
1975	0	3.3	40.9	192.5	137.7	93.7	240.8	100.8	293.0
1976	0	43.6	40.6	58.2	212.9	164.6	128.0	71.9	121.2
1977	0	4.0	6.4	6.6	132.2	141.4	153.7	129.3	231.6
1978	0	0	42.2	256.8	226.5	129.8	165.4	74.4	281.8
1979	0	0	109.1	114.1	149.1	161.1	95.2	152.6	179.5
1980	0	6.4	2.9	83.9	212.2	43.3	194.3	195.5	276.4
1981	0	0	20.8	80.3	94.7	226.7	285.9	237.3	121.3
1982	0	3.6	25.7	194.5	97.7	75.3	122.3	91.7	157.9
1983	0	0	47.5	61.8	99.6	193.3	120.0	172.0	125.4
1984	0	0	39.3	43.1	150.0	195.6	160.1	232.6	195.9
1985	0	0	57.4	41.3	131.7	175.9	110.8	83.6	287.8
1986	27.4	17.7	48.4	103.2	151.7	114.2	217.0	105.1	401.0
1987	0	42.0	59.6	22.7	148.9	139.7	157.9	331.3	140.9
1988	8.6	75.3	17.3	82.9	121.3	261.2	423.5	121.2	164.7
1989	0	0	13.1	47.9	228.8	164.0	301.1	289.9	248.2
1990	0	0	0	80.7	133.0	132.7	213.1	274.0	175.6
1991	0	0	60.4	159.8	238.4	231.1	205.7	329.3	208.1
1992	0	0	2.7	86.3	251.6	146.6	131.6	151.6	245.2
1993	0	33.4	16.5	81.5	190.6	135.9	110.8	82.9	218.1
1994	0.8	0	12.4	152.7	186.4	135	154.7	397.8	178.9
1995	0	0	88.7	112.4	188.9	93.9	301.4	201.4	80.4
1996	0	10.3	0.3	168.8	108.2	107.5	164.8	235.6	322.3
1997	1.8	0	41.9	169.3	116.3	304.1	76.1	126.6	303.3
1998	0	0	0	70.9	98.2	227.9	169.9	107.9	206.4
1999	0	6.9	23.1	74.1	211.0	395.3	156.1	427.2	253.8
2000	0	0	0	162.6	97.2	155.2	97.2	190.1	216.6
2001	0	0	4.0	112.0	77.3	125.1	198.3	157.9	282.1
2002	0	0	2.9	162.2	79.6	93.2	325.9	278.0	196.4
2003	0	15.3	9.4	38.5	92.7	180.9	271.4	53.3	163.7
2004	0	0	3.4	157.5	246.0	168.4	225.5	78.6	252.9
2005	0	32.7	0	93.4	134.3	170.6	60.9	132.9	143.5
2006	12.4	19.3	40.9	61.8	370.0	62.1	303.0	352.8	290.6
2007	1.4	8.6	27.1	103.8	306.8	184.2	226.2	224.9	185.6
2008	0	0	21.8	162.6	163.7	166.3	258.2	278.9	169.5
2009	10.1	0	5.0	265.5	108.4	205.5	221.9	367.9	240.9
2010	0	0	2.2	65.1	114.7	104.4	136.5	133.1	140.1

KOGI STATE CROP YIELD (tonnes)								
Time scale	**Cassava**	**Rice**	**Groundnut**	**Guinea Corn**	**Millet**	**Maize**	**Beans**	**Yam**
1980	1228	89.18	16.67	63.13	3.24	123.89	10.05	913
1981	1435	93.43	18.45	63.23	0.98	132.45	12.43	956
1982	1234	113.42	23.45	64.34	1.79	142.34	13.34	1023
1983	1345	123.34	34.56	63.34	2.34	142.32	13.45	1034
1984	1345	133.23	56.45	64.34	3.23	144.23	13.33	1211
1985	1432	132.23	45.54	65.23	1.24	134.98	13.34	1234
1986	1567	154.32	45.67	61.34	2.45	141.23	13.35	1254
1987	1234	135.23	45.27	63.23	3.12	146.45	14.44	1245
1988	1567	145.45	34.54	70.5	2.23	146.54	14.56	1312
1989	1654	142.34	40.12	71.23	2.78	151.23	14.67	1356
1990	1665	134.56	39.56	71.09	2.33	162.34	15.56	1236
1991	1674	145.45	41.23	68.89	3.32	152.34	13.56	1312
1992	1720	144.68	43.23	64.45	2.88	155.12	14.44	1345
1993	1789	134.54	42.13	66.45	3.12	156.45	14.52	1445
1994	1845	153.23	45.43	63.32	2.74	153.23	14.32	1435
1995	1770	154.45	39.98	62.34	2.31	154.34	14.43	1345
1996	1882	152.32	39.99	64.45	2.95	156.23	14.61	1321
1997	1856	156.43	40.01	65.31	2.43	151.23	14.98	1435
1998	1912	156.34	42.05	72.02	3.13	145.54	14.67	1323
1999	1943	155.43	43.08	71.34	2.23	155.21	15.21	1342
2000	1956	156.72	41.34	73.33	2.56	145.56	16.23	1267
2001	1965	156.66	44.54	73.04	2.78	151.23	15.99	1378
2002	1985	157.71	41.32	74.23	2.55	134.45	16.01	1325
2003	1975	156.34	42.32	74.13	2.78	147.45	17.04	1330
2004	1994	157.34	42.22	74.56	3.15	161.23	16.45	1245
2005	2012	154.88	43.21	73.34	3.12	154.45	15.65	1321
2006	2307	157.88	43.34	72.34	3.23	154.34	14.54	1367
2007	2413	161.21	42.32	74.43	2.99	148.91	15.57	1397
2008	2513	160.31	42.34	73.55	3.04	151.23	14.98	1321
2009	2449	161.32	42.45	74.54	3.56	156.34	15.09	1290
2010	2517	162.22	43.23	75.55	3.71	153.45	16.01	1312
2011	2523	163.56	43.23	75.63	3.65	155.45	15.99	1299

Quantity of fertilizer in metric tonnes

Timescale	tonnes
1980-1981	465
1981-1982	564
1982-1983	456
1983-1984	608
1984-1985	654
1985-1986	654
1986-1987	654
1987-1988	675
1988-1989	645
1989-1990	645
1990-1991	680
1991-1992	657
1992-1993	680
1993-1994	678
1994-1995	668
1995-1996	678
1996-1997	689
1997-1998	657
1998-1999	645
1999-2000	686
2000-2001	675
2001-2002	677
2002-2003	656
2003-2004	689
2004-2005	690
2005-2006	719
2006-2007	734
2007-2008	734
2008-2009	735
2009-2010	754
2010-2011	765

Appendix B

Tables used to Analyse Environmental Forcing Agents

Maximum Average Temperature (ºC) **Note: -Bold font = increasing temperature and normal font = negative**				
State	Zone	Geographical location	R^2	P
Enugu	Derived savannah and Humid Forest	Central	**12%**	0.02
Kano	Sudan savannah and Northern Guinea savannah	Central North	**7%**	0.09
Ogun	Derived savannah and Humid Forest	South West	**11%**	0.06
Edo	Derived savannah and Humid Forest	Central South	**40%**	<0.01
Kwara	Derived savannah and Southern guinea savannah	Central West	**34%**	<0.01
Kogi	Derived savannah	Central South	**10%**	0.04
Benue	Derived savannah	Central East	**30%**	<0.01
Niger	Northern and southern Guinea savannah	Central/North West	**3%**	0.08

Minimum Average Temperature (ºC) **Note:-Bold font = increasing temperature and normal font = negative**				
State	Zone	Geographical location	R^2	P
Enugu	Derived savannah and Humid Forest	Central	**24%**	<0.01
Kano	Sudan savannah and Northern Guinea savannah	Central North	**20%**	<0.01
Ogun	Derived savannah and Humid Forest	South West	**34%**	<0.01
Edo	Derived savannah and Humid Forest	Central South	**33%**	<0.01
Kwara	Derived savannah and Southern guinea savannah	Central West	**44%**	<0.01
Kogi	Derived savannah	Central South	**2%**	0.42
Benue	Derived savannah	Central East	**20%**	<0.01
Niger	Northern and southern Guinea savannah	Central/North West	**8%**	0.07

Precipitation Note: -Bold font = increasing precipitation and normal font = negative				
State	Zone	Geographical location	R^2	P
Enugu	Derived savannah and Humid Forest	Central	**0%**	0.56
Kano	Sudan savannah and Northern Guinea savannah	Central North	**50%**	<0.001
Ogun	Derived savannah and Humid Forest	South West	**11%**	0.06
Edo	Derived savannah and Humid Forest	Central South	**12%**	0.03
Kwara	Derived savannah and Southern Guinea savannah	Central West	**10%**	0.06
Kogi	Derived savannah	Central South	**3%**	0.27
Benue	Derived savannah	Central East	**6%**	0.14
Niger	Northern and southern Guinea savannah	Central/North West	**2%**	<0.01

Humidity Note: -Bold font = increasing humidity and normal font = negative				
State	Zone	Geographical location	R^2	P
Enugu	Derived savannah and Humid Forest	Central	**20%**	<0.01
Kano	Sudan savannah and Northern Guinea savannah	Central North	**13%**	0.05
Ogun	Derived savannah and Humid Forest	South West	**2%**	0.06
Edo	Derived savannah and Humid Forest	Central South	**5%**	<0.01
Kwara	Derived savannah and Southern Guinea savannah	Central West	**26%**	0.01
Kogi	Derived savannah	Central South	**0%**	0.94
Benue	Derived savannah	Central East	**24%**	<0.01
Niger	Northern and southern Guinea savannah	Central/North West	**21%**	<0.01

Appendix C

Tables used to analyse Crop Yield

Beans				
Note: -Bold font = positive increasing crop yield and normal font = negative or decreasing trend				
State	Zone	Geographical location	R^2	P
Enugu	Derived savannah and Humid Forest	Central	**14%**	0.03
Kano	Sudan savannah and Northern Guinea savannah	Central North	**6%**	0.20
Ogun	Derived savannah and Humid Forest	South West	**-**	-
Edo	Derived savannah and Humid Forest	Central South	**0%**	0.93
Kwara	Derived savannah and Southern Guinea savannah	Central West	29%	<0.01
Kogi	Derived savannah	Central South	**61%**	<0.01
Benue	Derived savannah	Central East	0.01	0.56
Niger	Northern and southern Guinea savannah	Central/North West	**47%**	<0.01

Yam				
Note:-Bold font = increasing temperature and normal font = negative				
State	Zone	Geographical location	R^2	P
Enugu	Derived savannah and Humid Forest	Central	**4%**	0.03
Kano	Sudan savannah and Northern Guinea savannah	Central North	**-**	-
Ogun	Derived savannah and Humid Forest	South West	**0%**	0.81
Edo	Derived savannah and Humid Forest	Central South	**0%**	0.88
Kwara	Derived savannah and Southern Guinea savannah	Central West	5%	0.20
Kogi	Derived savannah	Central South	**36%**	<0.01
Benue	Derived savannah	Central East	**6%**	0.56
Niger	Northern and southern Guinea savannah	Central/North West	**20%**	<0.01

Rice **Note:-Bold font = increasing temperature and normal font = negative**				
State	Zone	Geographical location	R^2	P
Enugu	Derived savannah and Humid Forest	Central	**10%**	0.10
Kano	Sudan savannah and Northern Guinea savannah	Central North	71%	<0.01
Ogun	Derived savannah and Humid Forest	South West	53%	<0.01
Edo	Derived savannah and Humid Forest	Central South	4%	0.35
Kwara	Derived savannah and Southern Guinea savannah	Central West	**71%**	<0.01
Kogi	Derived savannah	Central South	**68%**	<0.01
Benue	Derived savannah	Central East	9%	<0.01
Niger	Northern and southern Guinea savannah	Central/North West	0%	0.82

Melon **Note: -Bold font = increasing temperature and normal font = negative**				
State	Zone	Geographical location	R^2	P
Enugu	Derived savannah and Humid Forest	Central	**13%**	0.10
Kano	Sudan savannah and Northern Guinea savannah	Central North	0	0
Ogun	Derived savannah and Humid Forest	South West	**21%**	<0.01
Edo	Derived savannah and Humid Forest	Central South	**70%**	<0.01
Kwara	Derived savannah and Southern Guinea savannah	Central West	0	0
Kogi	Derived savannah	Central South	0	0
Benue	Derived savannah	Central East	0	0
Niger	Northern and southern Guinea savannah	Central/North West	**10%**	0.08

Cocoyam **Note: -Bold font = increasing temperature and normal font = negative**				
State	Zone	Geographical location	R^2	P
Enugu	Derived savannah and Humid Forest	Central	**10%**	0.10
Kano	Sudan savannah and Northern Guinea savannah	Central North	0	0
Ogun	Derived savannah and Humid Forest	South West	0	0.75
Edo	Derived savannah and Humid Forest	Central South	**89%**	<0.01
Kwara	Derived savannah and Southern Guinea savannah	Central West	0	0
Kogi	Derived savannah	Central South	0	0
Benue	Derived savannah	Central East	0	0
Niger	Northern and southern Guinea savannah	Central/North West	0	0

Groundnut **Note: -Bold font = increasing temperature and normal font = negative**				
State	Zone	Geographical location	R^2	P
Enugu	Derived savannah and Humid Forest	Central	**70%**	<0.01
Kano	Sudan savannah and Northern Guinea savannah	Central North	**77%**	<0.01
Ogun	Derived savannah and Humid Forest	South West	0	0
Edo	Derived savannah and Humid Forest	Central South	**50%**	<0.01
Kwara	Derived savannah and Southern Guinea savannah	Central West	8%	0.12
Kogi	Derived savannah	Central South	**19%**	<0.01
Benue	Derived savannah	Central East	**19%**	<0.01
Niger	Northern and southern Guinea savannah	Central/North West	71%	<0.01

Maize **Note: -Bold font = increasing temperature and normal font = negative**				
State	Zone	Geographical location	R^2	P
Enugu	Derived savannah and Humid Forest	Central	**40%**	<0.01
Kano	Sudan savannah and Northern Guinea savannah	Central North	58%	<0.01
Ogun	Derived savannah and Humid Forest	South West	**10%**	0.08
Edo	Derived savannah and Humid Forest	Central South	**2%**	0.43
Kwara	Derived savannah and Southern Guinea savannah	Central West	66%	<0.01
Kogi	Derived savannah	Central South	**36%**	<0.01
Benue	Derived savannah	Central East	7%	<0.01
Niger	Northern and southern Guinea savannah	Central/North West	0%	0.95

Cassava **Note: -Bold font = increasing temperature and normal font = negative**				
State	Zone	Geographical location	R^2	P
Enugu	Derived savannah and Humid Forest	Central	**30%**	<0.01
Kano	Sudan savannah and Northern Guinea savannah	Central North	0	0
Ogun	Derived savannah and Humid Forest	South West	0	0.69
Edo	Derived savannah and Humid Forest	Central South	**14%**	<0.01
Kwara	Derived savannah and Southern guinea savannah	Central West	29%	<0.01
Kogi	Derived savannah	Central South	**92%**	<0.01
Benue	Derived savannah	Central East	**2%**	<0.01
Niger	Northern and southern Guinea savannah	Central/North West	**70%**	<0.01

Millet **Note: -Bold font = increasing temperature and normal font = negative**				
State	Zone	Geographical location	R^2	P
Enugu	Derived savannah and Humid Forest	Central	0	0
Kano	Sudan savannah and Northern Guinea savannah	Central North	**53%**	<0.01
Ogun	Derived savannah and Humid Forest	South West	0	0
Edo	Derived savannah and Humid Forest	Central South	**0**	0
Kwara	Derived savannah and Southern Guinea savannah	Central West	**13%**	0.04
Kogi	Derived savannah	Central South	**32%**	<0.01
Benue	Derived savannah	Central East	50%	<0.01
Niger	Northern and southern Guinea savannah	Central/North West	**9%**	0.08

Guinea corn **Note:-Bold font = increasing temperature and normal font = negative**				
State	Zone	Geographical location	R^2	P
Enugu	Derived savannah and Humid Forest	Central	0	0
Kano	Sudan savannah and Northern Guinea savannah	Central North	**77%**	0.05
Ogun	Derived savannah and Humid Forest	South West	0	0
Edo	Derived savannah and Humid Forest	Central South	0	0
Kwara	Derived savannah and Southern Guinea savannah	Central West	**8%**	0.13
Kogi	Derived savannah	Central South	**67%**	<0.01
Benue	Derived savannah	Central East	**40%**	<0.01
Niger	Northern and southern Guinea savannah	Central/North West	40%	<0.01

Appendix D

Frequency Tables detailing Famers, Public and Government Questionnaires Responses

1.

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	95	41.9	41.9	41.9
	Female	132	58.1	58.1	100.0
	Total	227	100.0	100.0	

2.

Age group

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18-25	53	23.3	23.3	23.3
	26-35	51	22.5	22.5	45.8
	36-45	66	29.1	29.1	74.9
	46-55	45	19.8	19.8	94.7
	56+	12	5.3	5.3	100.0
	Total	227	100.0	100.0	

3.

Academic qualification

	Frequency	Percent	Valid Percent	Cumulative Percent
High school/diploma	52	22.9	22.9	22.9
Degree	47	20.7	20.7	43.6
Masters	25	11.0	11.0	54.6
None	103	45.4	45.4	100.0
Total	227	100.0	100.0	

4.

Employment status

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Employed	86	37.9	37.9	37.9
	Self-employed	109	48.0	48.0	85.9
	Unemployed	32	14.1	14.1	100.0
	Total	227	100.0	100.0	

5.

Time in employment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<5	88	38.8	38.8	38.8
	6-10	44	19.4	19.4	58.1
	11-15	64	28.2	28.2	86.3
	16-20	21	9.3	9.3	95.6
	20+	10	4.4	4.4	100.0
	Total	227	100.0	100.0	

6.

Work travel distance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<5	63	27.8	27.8	27.8
	6-10	48	21.1	21.1	48.9
	11-15	57	25.1	25.1	74.0
	16-20	31	13.7	13.7	87.7
	20+	28	12.3	12.3	100.0
	Total	227	100.0	100.0	

7.

Tenure

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Owner operator	85	37.4	37.4	37.4
	Tenant	95	41.9	41.9	79.3
	Hired labour	40	17.6	17.6	96.9
	Other	7	3.1	3.1	100.0
	Total	227	100.0	100.0	

8.

Number of dependents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	55	24.2	24.2	24.2
	1-3	113	49.8	49.8	74.0
	4-6	48	21.1	21.1	95.2
	7+	11	4.8	4.8	100.0
	Total	227	100.0	100.0	

9.

Farmer's organisation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	177	78.0	78.0	78.0
	Yes	50	22.0	22.0	100.0
	Total	227	100.0	100.0	

10.

Funding for agriculture

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Government	75	33.0	33.0	33.0
	State	88	38.8	38.8	71.8
	Private	44	19.4	19.4	91.2
	N/A	20	8.8	8.8	100.0
	Total	227	100.0	100.0	

11.

Agriculture

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	71	31.3	31.3	31.3
	Yes	156	68.7	68.7	100.0
	Total	227	100.0	100.0	

12.

Livestock

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	121	53.3	53.3	53.3
	Yes	106	46.7	46.7	100.0
	Total	227	100.0	100.0	

13.

Forestry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	189	83.3	83.3	83.3
	Yes	38	16.7	16.7	100.0
	Total	227	100.0	100.0	

14.

Non_farm

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	171	75.3	75.3	75.3
	Yes	56	24.7	24.7	100.0
	Total	227	100.0	100.0	

15.

Charity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	209	92.1	92.1	92.1
	Yes	18	7.9	7.9	100.0
	Total	227	100.0	100.0	

16.

Business

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	182	80.2	80.2	80.2
	Yes	45	19.8	19.8	100.0
	Total	227	100.0	100.0	

17.

Media

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	68	30.0	30.0	30.0
	Yes	159	70.0	70.0	100.0
	Total	227	100.0	100.0	

18.

Energy

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	207	91.2	91.2	91.2
	Yes	20	8.8	8.8	100.0
	Total	227	100.0	100.0	

19.

Environmental organisations

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	178	78.4	78.4	78.4
	Yes	49	21.6	21.6	100.0
	Total	227	100.0	100.0	

20.

Government

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	183	80.6	80.6	80.6
	Yes	44	19.4	19.4	100.0
	Total	227	100.0	100.0	

21.

Family

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	202	89.0	89.0	89.0
	Yes	25	11.0	11.0	100.0
	Total	227	100.0	100.0	

22.

Unaware

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	222	97.8	97.8	97.8
	Yes	5	2.2	2.2	100.0
	Total	227	100.0	100.0	

23.

Trust media

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A lot	145	63.9	63.9	63.9
	A little	58	25.6	25.6	89.4
	Not at all	15	6.6	6.6	96.0
	Nil	9	4.0	4.0	100.0
	Total	227	100.0	100.0	

24.

Trust energy suppliers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A lot	77	33.9	33.9	33.9
	A little	94	41.4	41.4	75.3
	Not at all	39	17.2	17.2	92.5
	Nil	17	7.5	7.5	100.0
	Total	227	100.0	100.0	

25.

Environmental

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A lot	81	35.7	35.7	35.7
	A little	100	44.1	44.1	79.7
	Not at all	29	12.8	12.8	92.5
	Nil	17	7.5	7.5	100.0
	Total	227	100.0	100.0	

26.

Trust government

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A lot	55	24.2	24.2	24.2
	A little	113	49.8	49.8	74.0
	Not at all	38	16.7	16.7	90.7
	Nil	21	9.3	9.3	100.0
	Total	227	100.0	100.0	

27.

Trust family

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A lot	104	45.8	45.8	45.8
	A little	82	36.1	36.1	81.9
	Not at all	22	9.7	9.7	91.6
	Nil	19	8.4	8.4	100.0
	Total	227	100.0	100.0	

28.

Climate change affecting Nigeria?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	126	55.5	55.5	55.5
	No	60	26.4	26.4	81.9
	Don't know	41	18.1	18.1	100.0
	Total	227	100.0	100.0	

29.

Cause for climate change

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Anthropogenic	44	19.4	19.4	19.4
	Natural factors	94	41.4	41.4	60.8
	Anthropogenic & natural factors	66	29.1	29.1	89.9
	Don't know	23	10.1	10.1	100.0
	Total	227	100.0	100.0	

30.

International groups

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	107	47.1	47.1	47.1
	Yes	120	52.9	52.9	100.0
	Total	227	100.0	100.0	

31.

Environmental groups

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	143	63.0	63.0	63.0
	Yes	84	37.0	37.0	100.0
	Total	227	100.0	100.0	

32.

Government

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	152	67.0	67.0	67.0
	Yes	75	33.0	33.0	100.0
	Total	227	100.0	100.0	

33.

Business & industry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	194	85.5	85.5	85.5
	Yes	33	14.5	14.5	100.0
	Total	227	100.0	100.0	

34.

Individuals

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	201	88.5	88.5	88.5
	Yes	26	11.5	11.5	100.0
	Total	227	100.0	100.0	

35.

Q20 (a) We can all do our bit to reduce climate change

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	98	43.2	43.2	43.2
	Fully agree	83	36.6	36.6	79.7
	Fully disagree	12	5.3	5.3	85.0
	Partly disagree	23	10.1	10.1	95.2
	Nil	11	4.8	4.8	100.0
	Total	227	100.0	100.0	

36.

Q20 (b) People should be encouraged to reduce their energy consumption

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	68	30.0	30.0	30.0
	Fully agree	101	44.5	44.5	74.4
	Fully disagree	28	12.3	12.3	86.8
	Partly disagree	19	8.4	8.4	95.2
	Nil	11	4.8	4.8	100.0
	Total	227	100.0	100.0	

37.

Q20 (c) Climate change is inevitable

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	60	26.4	26.4	26.4
	Fully agree	110	48.5	48.5	74.9
	Fully disagree	19	8.4	8.4	83.3
	Partly disagree	25	11.0	11.0	94.3
	Nil	13	5.7	5.7	100.0
	Total	227	100.0	100.0	

38.

Q20 (d) Climate change is a natural phenomenon

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	52	22.9	22.9	22.9
	Fully agree	118	52.0	52.0	74.9
	Fully disagree	22	9.7	9.7	84.6
	Partly disagree	23	10.1	10.1	94.7
	Nil	12	5.3	5.3	100.0
	Total	227	100.0	100.0	

39.

Q20 (e) Climate change will improve Nigerian weather

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	61	26.9	26.9	26.9
	Fully agree	81	35.7	35.7	62.6
	Fully disagree	49	21.6	21.6	84.1
	Partly disagree	23	10.1	10.1	94.3
	Nil	13	5.7	5.7	100.0
	Total	227	100.0	100.0	

40.

Q20 (f) I would only take action if everyone else does

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	51	22.5	22.5	22.5
	Fully agree	80	35.2	35.2	57.7
	Fully disagree	57	25.1	25.1	82.8
	Partly disagree	27	11.9	11.9	94.7
	Nil	12	5.3	5.3	100.0
	Total	227	100.0	100.0	

41.

Q20 (g) It is already too late to do anything about climate change

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	55	24.2	24.2	24.2
	Fully agree	70	30.8	30.8	55.1
	Fully disagree	71	31.3	31.3	86.3
	Partly disagree	18	7.9	7.9	94.3
	Nil	13	5.7	5.7	100.0
	Total	227	100.0	100.0	

42.

Q20 (h) Climate change is something which frightens me

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	64	28.2	28.2	28.2
	Fully agree	79	34.8	34.8	63.0
	Fully disagree	44	19.4	19.4	82.4
	Partly disagree	26	11.5	11.5	93.8
	Nil	14	6.2	6.2	100.0
	Total	227	100.0	100.0	

43.

Q20 (i) I am uncertain as to whether climate change is really happening

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	69	30.4	30.4	30.4
	Fully agree	72	31.7	31.7	62.1
	Fully disagree	46	20.3	20.3	82.4
	Partly disagree	27	11.9	11.9	94.3
	Nil	13	5.7	5.7	100.0
	Total	227	100.0	100.0	

44.

Q20 (j) Developing countries are to blame for climate change

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	59	26.0	26.0	26.0
	Fully agree	81	35.7	35.7	61.7
	Fully disagree	46	20.3	20.3	81.9
	Partly disagree	27	11.9	11.9	93.8
	Nil	14	6.2	6.2	100.0
	Total	227	100.0	100.0	

45.

Q20 (k) Radical changes to society are needed to reduce climate change

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	53	23.3	23.3	23.3
	Fully agree	83	36.6	36.6	59.9
	Fully disagree	53	23.3	23.3	83.3
	Partly disagree	24	10.6	10.6	93.8
	Nil	14	6.2	6.2	100.0
	Total	227	100.0	100.0	

46.

Q20 (l) The evidence for climate change is unreliable

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	61	26.9	26.9	26.9
	Fully agree	69	30.4	30.4	57.3
	Fully disagree	46	20.3	20.3	77.5
	Partly disagree	36	15.9	15.9	93.4
	Nil	15	6.6	6.6	100.0
	Total	227	100.0	100.0	

47.

Q20 (o) People are too selfish to do anything about climate change

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	66	29.1	29.1	29.1
	Fully agree	76	33.5	33.5	62.6
	Fully disagree	44	19.4	19.4	81.9
	Partly disagree	27	11.9	11.9	93.8
	Nil	14	6.2	6.2	100.0
	Total	227	100.0	100.0	

48.

Increase in rainfall

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very concerned	137	60.4	60.4	60.4
	Concerned	48	21.1	21.1	81.5
	Neither concerned nor unconcerned	17	7.5	7.5	89.0
	Not very concerned	10	4.4	4.4	93.4
	Unconcerned	6	2.6	2.6	96.0
	Very unconcerned	9	4.0	4.0	100.0
	Total	227	100.0	100.0	

49.

Decrease in rainfall

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very concerned	69	30.4	30.4	30.4
	Concerned	66	29.1	29.1	59.5
	Neither concerned nor unconcerned	27	11.9	11.9	71.4
	Not very concerned	14	6.2	6.2	77.5
	Unconcerned	13	5.7	5.7	83.3
	Very unconcerned	38	16.7	16.7	100.0
	Total	227	100.0	100.0	

50.

Increase in runoff

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very concerned	57	25.1	25.1	25.1
	Concerned	68	30.0	30.0	55.1
	Neither concerned nor unconcerned	34	15.0	15.0	70.0
	Not very concerned	20	8.8	8.8	78.9
	Unconcerned	10	4.4	4.4	83.3
	Very unconcerned	38	16.7	16.7	100.0
	Total	227	100.0	100.0	

51.

Increase in groundwater

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very concerned	77	33.9	33.9	33.9
	Concerned	62	27.3	27.3	61.2
	Neither concerned nor unconcerned	46	20.3	20.3	81.5
	Not very concerned	16	7.0	7.0	88.5
	Unconcerned	12	5.3	5.3	93.8
	Very unconcerned	14	6.2	6.2	100.0
	Total	227	100.0	100.0	

52.

Increase in drought

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very concerned	51	22.5	22.5	22.5
	Concerned	70	30.8	30.8	53.3
	Neither concerned nor unconcerned	36	15.9	15.9	69.2
	Not very concerned	23	10.1	10.1	79.3
	Unconcerned	13	5.7	5.7	85.0
	Very unconcerned	34	15.0	15.0	100.0
	Total	227	100.0	100.0	

53.

Decrease in drought

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very concerned	42	18.5	18.5	18.5
	Concerned	65	28.6	28.6	47.1
	Neither concerned nor unconcerned	35	15.4	15.4	62.6
	Not very concerned	28	12.3	12.3	74.9
	Unconcerned	15	6.6	6.6	81.5
	Very unconcerned	42	18.5	18.5	100.0
	Total	227	100.0	100.0	

54.

Increase in rain

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A lot	144	63.4	63.4	63.4
	A little	63	27.8	27.8	91.2
	Quite a little	15	6.6	6.6	97.8
	Neither a lot or little	1	.4	.4	98.2
	Not at all	2	.9	.9	99.1
	Nil	2	.9	.9	100.0
	Total	227	100.0	100.0	

55.

Decrease in rain

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A lot	95	41.9	41.9	41.9
	A little	93	41.0	41.0	82.8
	Quite a little	35	15.4	15.4	98.2
	Neither a lot or a little	1	.4	.4	98.7
	Not at all	2	.9	.9	99.6
	Nil	1	.4	.4	100.0
	Total	227	100.0	100.0	

56.

Increase in runoff

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A lot	94	41.4	41.4	41.4
	A little	111	48.9	48.9	90.3
	Not at all	21	9.3	9.3	99.6
	Nil	1	.4	.4	100.0
	Total	227	100.0	100.0	

57.

Decrease in runoff

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A lot	97	42.7	42.7	42.7
	A little	94	41.4	41.4	84.1
	Not at all	36	15.9	15.9	100.0
	Total	227	100.0	100.0	

58.

Increase in groundwater

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A lot	86	37.9	37.9	37.9
	A little	111	48.9	48.9	86.8
	Not at all	30	13.2	13.2	100.0
	Total	227	100.0	100.0	

59.

Decrease in groundwater

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A lot	93	41.0	41.0	41.0
	A little	101	44.5	44.5	85.5
	Not at all	33	14.5	14.5	100.0
	Total	227	100.0	100.0	

60.

Decline in surface water quality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A lot	117	51.5	51.5	51.5
	A little	83	36.6	36.6	88.1
	Not at all	27	11.9	11.9	100.0
	Total	227	100.0	100.0	

61.

Decline in groundwater quality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A lot	87	38.3	38.3	38.3
	A little	97	42.7	42.7	81.1
	Not at all	43	18.9	18.9	100.0
	Total	227	100.0	100.0	

62.

Increase in flood

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A lot	110	48.5	48.5	48.5
	A little	85	37.4	37.4	85.9
	Not at all	32	14.1	14.1	100.0
	Total	227	100.0	100.0	

63.

Increase in drought

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A lot	87	38.3	38.3	38.3
	A little	99	43.6	43.6	81.9
	Not at all	41	18.1	18.1	100.0
	Total	227	100.0	100.0	

64.

Q23 (a) Flood protection

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Implemented	138	60.8	60.8	60.8
	Planned	46	20.3	20.3	81.1
	Needed	43	18.9	18.9	100.0
	Total	227	100.0	100.0	

65.

Q23 (b) Drought protection

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Implemented	118	52.0	52.0	52.0
	Planned	63	27.8	27.8	79.7
	Needed	46	20.3	20.3	100.0
	Total	227	100.0	100.0	

66.

Q23 (c) Coastal protection

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Implemented	107	47.1	47.1	47.1
	Planned	59	26.0	26.0	73.1
	Needed	61	26.9	26.9	100.0
	Total	227	100.0	100.0	

67.

Q23 (d) Natural retention of flood water

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Implemented	87	38.3	38.3	38.3
	Planned	94	41.4	41.4	79.7
	Needed	46	20.3	20.3	100.0
	Total	227	100.0	100.0	

70.

Q23 (e) Restricting development in risk areas

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Implemented	51	22.5	22.5	22.5
	Planned	121	53.3	53.3	75.8
	Needed	55	24.2	24.2	100.0
	Total	227	100.0	100.0	

71.

Q23 (f) Improved standards for development

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Implemented	71	31.3	31.3	31.3
	Planned	106	46.7	46.7	78.0
	Needed	50	22.0	22.0	100.0
	Total	227	100.0	100.0	

72.

Q23 (g) Improved forecasting and monitoring information

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Implemented	49	21.6	21.6	21.6
	Planned	119	52.4	52.4	74.0
	Needed	59	26.0	26.0	100.0
	Total	227	100.0	100.0	

73.

Q23 (h) Improved insurance schemes against flooding

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Implemented	62	27.3	27.3	27.3
	Planned	116	51.1	51.1	78.4
	Needed	49	21.6	21.6	100.0
	Total	227	100.0	100.0	

74.

Q23 (i) Increased supply of water

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Implemented	62	27.3	27.3	27.3
	Planned	108	47.6	47.6	74.9
	Needed	57	25.1	25.1	100.0
	Total	227	100.0	100.0	

75.

Q23 (j) Economic instruments such as water pricing

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Implemented	68	30.0	30.0	30.0
	Planned	87	38.3	38.3	68.3
	Needed	72	31.7	31.7	100.0
	Total	227	100.0	100.0	

76.

Q23 (k) Restriction of water use

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Implemented	49	21.6	21.6	21.6
	Planned	95	41.9	41.9	63.4
	Needed	83	36.6	36.6	100.0
	Total	227	100.0	100.0	

77.

Q23 (l) Measures to improve water balance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Implemented	49	21.6	21.6	21.6
	Planned	99	43.6	43.6	65.2
	Needed	79	34.8	34.8	100.0
	Total	227	100.0	100.0	

78.

Q23 (m) Drought protection

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Implemented	54	23.8	23.8	23.8
	Planned	97	42.7	42.7	66.5
	Needed	76	33.5	33.5	100.0
	Total	227	100.0	100.0	

79.

Q23 (n) New or revised legislation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Implemented	73	32.2	32.2	32.2
	Planned	89	39.2	39.2	71.4
	Needed	65	28.6	28.6	100.0
	Total	227	100.0	100.0	

80.

Q23 (o) Economic incentives or financial mechanisms

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Implemented	71	31.3	31.3	31.3
	Planned	91	40.1	40.1	71.4
	Needed	65	28.6	28.6	100.0
	Total	227	100.0	100.0	

81.

Q23 (p) Awareness raising or campaigns

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Implemented	78	34.4	34.4	34.4
	Planned	85	37.4	37.4	71.8
	Needed	64	28.2	28.2	100.0
	Total	227	100.0	100.0	

82.

Q23 (q) Others (please specify)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Implemented	65	28.6	28.6	28.6
	Planned	96	42.3	42.3	70.9
	Needed	66	29.1	29.1	100.0
	Total	227	100.0	100.0	

83.

When will farmers feel the impact of Climate Change?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Already	139	61.2	61.2	61.2
	Next 10 years	45	19.8	19.8	81.1
	Next 25 years	18	7.9	7.9	89.0
	Next 50 years	7	3.1	3.1	92.1
	More than 100 years	3	1.3	1.3	93.4
	Never	15	6.6	6.6	100.0
	Total	227	100.0	100.0	

84.

Q25 (a) Can we do our bit to reduce climate change

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	124	54.6	54.6	54.6
	Fully disagree	56	24.7	24.7	79.3
	Disagree	21	9.3	9.3	88.5
	Partly disagree	12	5.3	5.3	93.8
	Nil	14	6.2	6.2	100.0
	Total	227	100.0	100.0	

85.

Q25 (b) People should be encouraged to reduce their energy consumption

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	130	57.3	57.3	57.3
	Fully disagree	54	23.8	23.8	81.1
	Disagree	16	7.0	7.0	88.1
	Partly disagree	12	5.3	5.3	93.4
	Nil	15	6.6	6.6	100.0
	Total	227	100.0	100.0	

86.

Q25 (c) Climate change is inevitable

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	116	51.1	51.1	51.1
	Fully disagree	73	32.2	32.2	83.3
	Disagree	14	6.2	6.2	89.4
	Partly disagree	10	4.4	4.4	93.8
	Nil	14	6.2	6.2	100.0
	Total	227	100.0	100.0	

87.

Q25 (d) Climate change is a natural phenomenon

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	100	44.1	44.1	44.1
	Fully disagree	64	28.2	28.2	72.2
	Disagree	32	14.1	14.1	86.3
	Partly disagree	18	7.9	7.9	94.3
	Nil	13	5.7	5.7	100.0
	Total	227	100.0	100.0	

88.

Q25 (e) Climate change will improve Nigerian weather

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	87	38.3	38.3	38.3
	Fully disagree	75	33.0	33.0	71.4
	Disagree	33	14.5	14.5	85.9
	Partly disagree	19	8.4	8.4	94.3
	Nil	13	5.7	5.7	100.0
	Total	227	100.0	100.0	

89.

Q25 (f) I would only take action if everyone else does

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	93	41.0	41.0	41.0
	Fully disagree	68	30.0	30.0	70.9
	Disagree	31	13.7	13.7	84.6
	Partly disagree	22	9.7	9.7	94.3
	Nil	13	5.7	5.7	100.0
	Total	227	100.0	100.0	

90.

Q25 (g) It is already too late to do anything about climate change

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	103	45.4	45.4	45.4
	Fully disagree	62	27.3	27.3	72.7
	Disagree	38	16.7	16.7	89.4
	Partly disagree	10	4.4	4.4	93.8
	Nil	14	6.2	6.2	100.0
	Total	227	100.0	100.0	

91.

Q25 (h) Climate change is something which frightens me

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	103	45.4	45.4	45.4
	Fully disagree	60	26.4	26.4	71.8
	Disagree	31	13.7	13.7	85.5
	Partly disagree	18	7.9	7.9	93.4
	Nil	15	6.6	6.6	100.0
	Total	227	100.0	100.0	

92.

Q25 (i) I am uncertain as to whether climate change is really happening

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	96	42.3	42.3	42.3
	Fully disagree	62	27.3	27.3	69.6
	Disagree	38	16.7	16.7	86.3
	Partly disagree	13	5.7	5.7	92.1
	Nil	18	7.9	7.9	100.0
	Total	227	100.0	100.0	

93.

Q25 (j) Developing countries are to blame for climate change

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	98	43.2	43.2	43.2
	Fully disagree	53	23.3	23.3	66.5
	Disagree	44	19.4	19.4	85.9
	Partly disagree	14	6.2	6.2	92.1
	Nil	18	7.9	7.9	100.0
	Total	227	100.0	100.0	

94.

Q25 (k) Radical changes to society are needed to reduce climate change

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	108	47.6	47.6	47.6
	Fully disagree	61	26.9	26.9	74.4
	Disagree	30	13.2	13.2	87.7
	Partly disagree	12	5.3	5.3	93.0
	Nil	16	7.0	7.0	100.0
	Total	227	100.0	100.0	

95.

Q25 (l) The evidence for climate change is unreliable

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	101	44.5	44.5	44.5
	Fully disagree	48	21.1	21.1	65.6
	Disagree	39	17.2	17.2	82.8
	Partly disagree	25	11.0	11.0	93.8
	Nil	14	6.2	6.2	100.0
	Total	227	100.0	100.0	

96.

Q25 (m) People are too selfish to do anything about climate change

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Partly agree	96	42.3	42.3	42.3
	Fully disagree	64	28.2	28.2	70.5
	Disagree	37	16.3	16.3	86.8
	Partly disagree	17	7.5	7.5	94.3
	Nil	13	5.7	5.7	100.0
	Total	227	100.0	100.0	

97.

Prevent pollution

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	10	4.4	4.4	4.4
	Yes	217	95.6	95.6	100.0
	Total	227	100.0	100.0	

98.

Respect the earth

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	42	18.5	18.5	18.5
	Yes	185	81.5	81.5	100.0
	Total	227	100.0	100.0	

99.

Unity with nature

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	55	24.2	24.2	24.2
	Yes	172	75.8	75.8	100.0
	Total	227	100.0	100.0	

100.

Protect the environment

		Frequency	Percent	Valid Percent	Cumulative Percent
	Yes	158	69.6	69.6	100.0
	Total	227	100.0	100.0	

101.

Experienced drought

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	86	37.9	37.9	37.9
	Yes	141	62.1	62.1	100.0
	Total	227	100.0	100.0	

102.

Experienced flood

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	81	35.7	35.7	35.7
	Yes	146	64.3	64.3	100.0
	Total	227	100.0	100.0	

103.

Experienced lack of water

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	118	52.0	52.0	52.0
	Yes	109	48.0	48.0	100.0
	Total	227	100.0	100.0	

104.

Experienced soil erosion

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	112	49.3	49.3	49.3
	Yes	115	50.7	50.7	100.0
	Total	227	100.0	100.0	

105.

Experienced cyclones

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	207	91.2	91.2	91.2
	Yes	20	8.8	8.8	100.0
	Total	227	100.0	100.0	

106.

Experienced lack of labour

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	151	66.5	66.5	66.5
	Yes	76	33.5	33.5	100.0
	Total	227	100.0	100.0	

107.

Experienced infertile soil

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	94	41.4	41.4	41.4
	Yes	133	58.6	58.6	100.0
	Total	227	100.0	100.0	

108.

Experienced lack of knowledge

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	116	51.1	51.1	51.1
	Yes	111	48.9	48.9	100.0
	Total	227	100.0	100.0	

109.

Experienced pests & disease

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	72	31.7	31.7	31.7
	Yes	155	68.3	68.3	100.0
	Total	227	100.0	100.0	

Appendix E

Questionnaires

Farmer Knowledge, Attitude, Practice and Perception of Climate Change in Nigeria

My name is Kelechi and I am a PhD student in the UK undertaking research on the evaluation of climate change adaptation and public perception of climate change in Nigeria. The information you give in this questionnaire will be confidential and all participants will remain anonymous. I appreciate your time and thank you for your assistance.

Q1. What is your gender?
- Male ☐
- Female ☐

Q2. What is your age?
- 18 - 25 ☐
- 26 - 35 ☐
- 36 - 45 ☐
- 46 - 55 ☐
- 56 - + ☐

Q3. What is your highest academic qualification?
- High School / Diploma ☐
- First Degree ☐
- Masters ☐
- PhD ☐
- None ☐

Q4. What is your employment status?
- Employed ☐
- Self-employed ☐
- Unemployed ☐

Q5. How long have you been employed?
- Less than 5 years ☐
- 6 - 10 years ☐
- 11 - 15 years ☐
- 16 - 20 years ☐
- More than 20 years ☐

Q6. How far do you travel to work each day?
- Less than 5 miles ☐
- 5 - 10 miles ☐
- 10 - 15 miles ☐
- 15 - 20 miles ☐
- More than 20 miles ☐

Q7. What is your tenure status?
- Owner operator ☐
- Tenant ☐
- Hired labour ☐
- Other (please specify):

____

Q8. How many dependents do you have?
- None ☐
- 1 - 3 people ☐
- 4 - 6 people ☐
- 6 people of more ☐

Q9. Are you a member of a farmer's organisation?

Yes ☐
No ☐ - Go to Q10

Q10. Which organisation are you a member of?

____

Q11. Who is funding agricultural practises in your state?

Government ☐
State ☐
Private ☐
Not applicable ☐

Q12. What are your main sources of income? - *You may tick more than one.*

Agriculture ☐
Livestock ☐
Forestry products ☐
Non-farm income ☐
Charity ☐
Business ☐

Q13. What do you think about climate change is?

____

Q14. How did you hear about climate change?

Media (TV, radio, newspapers, magazines, internet) ☐
Energy suppliers ☐
Environmental organisations ☐
Government, local councils ☐
Family and friends ☐
I have not heard ☐

Q15. How much do you trust the following?

	A lot	A little	Not at all
Media	☐	☐	☐
Energy suppliers	☐	☐	☐
Environmental organisations	☐	☐	☐
Government, local councils	☐	☐	☐
Family and friends	☐	☐	☐

Q16. Do you think climate change is already affecting Nigeria?

Yes ☐
No ☐ - Go to Q18
Do not know ☐

Q17. In what way do you think climate change is affecting Nigeria

____

Q18. What do you think is the major cause of climate change:

Anthropogenic factors ☐
Natural factors ☐
Both ☐
Do not know ☐

Q19. Who do you think should take responsibility for tackling climate change?

International groups (e.g. UN, IPCC)	☐
Environmental organisations (e.g. Friends of the Earth)	☐
Government	☐
Local business and industry	☐
Individuals	☐

Q20. Please indicate whether you agree or disagree with the following statements:

	Tick (box)	Partly Agree/	Fully Agree/	Partly disagree /	Fully disagree
We can all do our bit to reduce climate change	☐	☐	☐	☐	☐
People should be encouraged to reduce their energy consumption					
Climate change is inevitable					
Climate change is a natural phenomenon					
Climate change will improve Nigerian weather					
I would only take action if everyone else does					
It is already too late to do anything about climate change					
Climate change is something which frightens me					
I am uncertain as to whether climate change is really happening					
Developing countries are to blame for climate change					
Radical changes to society are needed to reduce climate change					
The evidence for climate change is unreliable					
People are too selfish to do anything about climate change					

Q21. How concerned are you about the following? - *1 is very concerned, 6 is unconcerned.*

	1	2	3	4	5	6
Increase in rainfall	☐	☐	☐	☐	☐	☐
Decrease in rainfall	☐	☐	☐	☐	☐	☐
Increase in runoff	☐	☐	☐	☐	☐	☐
Decrease in runoff	☐	☐	☐	☐	☐	☐
Increase in groundwater level	☐	☐	☐	☐	☐	☐
Decrease in groundwater level	☐	☐	☐	☐	☐	☐
Increased drought	☐	☐	☐	☐	☐	☐
Decreased chance of drought	☐	☐	☐	☐	☐	☐

Q22. What effect do you think climate change will have on the following?

	A lot	A little	Not at all
Increase in rainfall	☐	☐	☐
Decrease in rainfall	☐	☐	☐
Increase in runoff	☐	☐	☐
Decrease in runoff	☐	☐	☐
Increase in groundwater discharge	☐	☐	☐
Decrease in groundwater discharge	☐	☐	☐
Decline in surface water quality	☐	☐	☐
Decline in groundwater quality	☐	☐	☐
Increase risk of flood	☐	☐	☐
Increase risk of drought	☐	☐	☐

Q23. Please indicate which of the following have been implemented, planned, or are needed in your area:

	Implemented	Planned	Needed
Flood protection	☐	☐	☐
Drought protection			
Coastal protection			
Natural retention of flood water			
Restricting development in risk areas			
Improved standards for development			
Improved forecasting and monitoring information			

Improved insurance schemes against flooding
Increased supply of water
Economic instruments such as water pricing
Restriction of water use
Measures to improve water balance
Drought protection
New or revised legislation
Economic incentives or financial mechanisms
Awareness raising or campaigns
Others (please specify):

Q24. When do you think Nigerian farmers will start feeling the effects of climate change?

- We are already feeling the effects ☐
- In the next 10 years ☐
- In the next 25 years ☐
- In the next 50 years ☐
- In the next 100 years ☐
- In more than 100 years ☐
- Never ☐

Q25. Please indicate whether you agree or disagree with the following statements:

Tick (box)	Partly Agree/	Fully Agree/	Partly disagree /	Fully disagree
	☐	☐	☐	☐

My local area is likely to be affected by climate change
Climate change will mostly affect developing countries
Climate change is likely to have a big impact of farmers
I am reducing my energy use to help tackle climate change
I am prepared to pay more for energy efficient products
The place I live is unique and distinctive
I feel like I belong to a community
If I were to move, I would like to farm in a similar place
This area allows me to live and farm the way I want to
I am very concerned with environmental issues
Being environmentally friendly is important to me
I identify with the aims of tackling climate change
People are too selfish to do anything about climate change

Q26. Do you abide by any of the following principles?	Yes	No
Preventing pollution, protecting natural resource	☐	☐
Respecting the earth, harmony with other species	☐	☐
Unity with nature, fitting into nature	☐	☐
Protecting the environment, preserving nature	☐	☐

Q27. Have you personally experienced any of the following in the last year?

- Droughts ☐
- Flooding ☐
- Lack of water ☐
- Soil erosion ☐
- Cyclones ☐
- Shortage of labour ☐
- Infertile soil ☐
- Lack of techniques or knowledge ☐
- Pests, disease ☐

Q28. Do you have any other concerns related to climate change?

____

Public Perception of Climate Change in Nigeria

My name is Kelechi and I am a PhD student in the UK undertaking research on the evaluation of climate change adaptation and public perception of climate change in Nigeria. The information you give in this questionnaire will be confidential and all participants will remain anonymous. I appreciate your time and thank you for your assistance.

Q1. What is your gender?

Male ☐
Female ☐

Q2. What is your age?

18 - 25 years ☐
26 - 35 years ☐
36 - 45 years ☐
46 - 55 years ☐
56 - 65 years ☐
65 + years ☐

Q3. What is your highest academic qualification?

High School / Diploma ☐
First Degree ☐
Masters ☐
PhD ☐
None ☐

Q4. What is your employment status?

Employed ☐
Self-employed ☐
Unemployed ☐ - Go to Q7

Q5. How long have you been employed?

Less than 5 years ☐
6 - 10 years ☐
11 - 15 years ☐
16 - 20 years ☐
More than 20 years ☐

Q6. How far do you travel to work each day?

Less than 5 miles ☐
5 - 10 miles ☐
10 - 15 miles ☐
15 - 20 miles ☐
More than 20 miles ☐

Q6B. How do you normally travel?

Bus ☐ Train ☐ Car ☐ Bicycle ☐ Walk ☐

Q7. What do you think climate change is?

____

Q8. Have you heard about climate change, and if so, how?

Media (TV, radio, newspapers, magazines, internet)	☐
Energy suppliers	☐
Environmental organisations	☐
Government, local councils	☐
Family and friends	☐
Unaware	☐

Q9. How much do you trust the following?

	A lot	A little	Not at all
Media	☐	☐	☐
Energy suppliers	☐	☐	☐
Environmental organisations	☐	☐	☐
Government, local councils	☐	☐	☐
Family and friends	☐	☐	☐

Q10. Do you think climate change is something already affecting Nigeria?

Yes ☐

No ☐ - Go to Q12

Q11. In what way do you think climate change is affecting Nigeria

____

Q12. What do you think is the major cause of climate change?

Human factors	☐
Natural factors	☐
Both	☐

Q13. Who do you think should take responsibility for tackling climate change?

International groups (e.g. UN, IPCC)	☐
Environmental organisations (e.g. Friends of the Earth)	☐
Government	☐
Local business and industry	☐
Individuals	☐
No action is needed	☐

Q14. Please indicate whether you agree or disagree with the following statements:

	Agree	Disagree
We can all do our bit to reduce climate change	☐	☐
People should be encouraged to reduce their energy consumption	☐	☐
Climate change is inevitable	☐	☐
Climate change is a natural phenomenon	☐	☐
Climate change will improve Nigerian weather	☐	☐
I would only take action if everyone else does	☐	☐
It is already too late to do anything about climate change	☐	☐
Climate change is something which frightens me	☐	☐
I am uncertain as to whether climate change is really happening	☐	☐
Developing countries are to blame for climate change	☐	☐
Big changes to society are needed to reduce climate change	☐	☐
The evidence for climate change is unreliable	☐	☐
People are too selfish to do anything about climate change	☐	☐
No Action is needed	☐	☐

Q15. How concerned are you about the following? - *1 is very concerned, 5 is unconcerned.*

	1	2	3	4	5
Employment	☐	☐	☐	☐	☐
Environment	☐	☐	☐	☐	☐
Health	☐	☐	☐	☐	☐
Education	☐	☐	☐	☐	☐
Cost of Living	☐	☐	☐	☐	☐
Crime	☐	☐	☐	☐	☐

Q16. How concerned are you about the following? - *1 is very concerned, 5 is unconcerned*

	1	2	3	4	5
Air pollution	☐	☐	☐	☐	☐
Food security	☐	☐	☐	☐	☐
Drought	☐	☐	☐	☐	☐
Waste disposal	☐	☐	☐	☐	☐
Water pollution	☐	☐	☐	☐	☐
Sea level rise and storms	☐	☐	☐	☐	☐
Energy security	☐	☐	☐	☐	☐

Q17. Which of the following do you think contributes most to climate change?

Landfill ☐
Transport ☐
Industry ☐
Other (please specify):

____

Q18. Have you noticed any changes which you consider to be linked to climate change?

Yes ☐

No ☐ - Go to Q20

Q19. Please briefly describe these changes:

____

Q20. Does or will climate change impact your life?

Yes ☐

No ☐ - Go to Q22

Q21. Please describe these impacts:

____

Q22. Do you think that reducing greenhouse gas emissions, especially CO_2 will help solve the problem of climate change?

Yes ☐

No ☐

Q23. Do you think that making lifestyle changes will help reduce the impacts of climate change?

Yes ☐

No ☐

Q24. Would you be prepared to make changes to your lifestyle to help reduce climate change, even if it cost you time and money?

Yes ☐

No ☐ - Go to Q26

Q25. Please give brief details of the changes you would be prepared to make and the cost per week you would be prepared to pay:

____

Q26. Do you have any other comments?

____

____

Government Perception of Climate Change

My name is Kelechi and I am a PhD student in the UK undertaking research on the evaluation of climate change adaptation and public perception of climate change in Nigeria. The information you give in this questionnaire will be confidential and all participants will remain anonymous. I appreciate your time and thank you for your assistance.

Demographic

Q1. What is your gender?

- Male ☐
- Female ☐

Q2. What is your age?

- 18 - 25 ☐
- 26 - 35 ☐
- 36 - 45 ☐
- 46 - 55 ☐
- 56 - + ☐

Q3. What is your highest academic qualification?

- High School / Diploma ☐
- First Degree ☐
- Masters ☐
- PhD ☐

Q4(a). Which business/organisation do you work for?

____

Q4(b). Which department do you work for?

____

Q5. How long have you been employed?

- Less than 5 years ☐
- 6 - 10 years ☐
- 11 - 15 years ☐
- 16 - 20 years ☐
- More than 20 years ☐

Q6. How far do you travel to work each day?

- Less than 5 miles ☐
- 5 - 10 miles ☐
- 10 - 15 miles ☐
- 15 - 20 miles ☐
- More than 20 miles ☐

Q7. What do you think climate change is?

____

Q8. How have you heard about climate change?

Media (TV, radio, newspapers, magazines, internet)	☐
Energy suppliers	☐
Environmental organisations	☐
Government, local councils	☐
Family and friends	☐

Q9. How much do you trust the following?

	A lot	A little	Not at all
Media	☐	☐	☐
Energy suppliers	☐	☐	☐
Environmental organisations	☐	☐	☐
Government, local councils	☐	☐	☐
Family and friends	☐	☐	☐

Q10. Do you think climate change is something already affecting Nigeria?

Yes ☐

No ☐

Q11. In what way do you think climate change is affecting Nigeria

____

Q12. What do you think is the major cause of climate change:

Anthropogenic factors	☐
Natural factors	☐
Both	☐

Q13. Who do you think should take responsibility for tackling climate change?

International groups (e.g. UN, IPCC)	☐
Environmental organisations (e.g. Friends of the Earth)	☐
Government	☐
Local business and industry	☐
Individuals	☐

Q14. Please indicate whether you agree or disagree with the following statements:

	Agree	Disagree
We can all do our bit to reduce climate change	☐	☐
People should be encouraged to reduce their energy consumption	☐	☐
Climate change is inevitable	☐	☐
Climate change is a natural phenomenon	☐	☐
Climate change will improve Nigerian weather	☐	☐
I would only take action if everyone else does	☐	☐
It is already too late to do anything about climate change	☐	☐
Climate change is something which frightens me	☐	☐
I am uncertain as to whether climate change is really happening	☐	☐
Developing countries are to blame for climate change	☐	☐
Radical changes to society are needed to reduce climate change	☐	☐
The evidence for climate change is unreliable	☐	☐
People are too selfish to do anything about climate change	☐	☐

Q15. How much do you think climate change will affect the following?

	A lot	a little	Not at all
Coastal zones	☐	☐	☐
Urban areas	☐	☐	☐
Lowland areas	☐	☐	☐
Agricultural areas	☐	☐	☐
Industrial areas	☐	☐	☐
Military areas	☐	☐	☐
Airports and harbours	☐	☐	☐

Q16. What impacts do you think climate change will have?

	A lot	A little	Not at all
Reduced water availability/stores	☐	☐	☐
Pressure on drainage/sewers	☐	☐	☐
Increase in need for irrigation	☐	☐	☐
Impact on hydropower	☐	☐	☐
Increased flooding	☐	☐	☐
Infrastructure damage	☐	☐	☐
Loss of land	☐	☐	☐
Increase in drought	☐	☐	☐

Q17. What do you think is the most major concern in Nigeria

	Yes	No
Flooding	☐	☐
Litter	☐	☐
Drought	☐	☐
Hole in the ozone layer	☐	☐
Poor waste management	☐	☐
Climate change	☐	☐
Deforestation	☐	☐
Traffic/congestion	☐	☐
Pollution	☐	☐
Animal extinction	☐	☐

Q18. Please indicate which of the following have been implemented, planned, are needed in your organisation:

	Implemented	Planned	Needed
Flood protection	☐	☐	☐
Drought protection	☐	☐	☐
Coastal protection	☐	☐	☐
Natural retention of flood water	☐	☐	☐
Restricting development in risk areas	☐	☐	☐
Improved standards for development	☐	☐	☐
Improved forecasting and monitoring information	☐	☐	☐
Improved insurance schemes against flooding	☐	☐	☐
Increased supply of water	☐	☐	☐
Economic instruments such as water pricing	☐	☐	☐
Restriction of water use	☐	☐	☐

Measures to improve water balance	☐	☐	☐
Drought protection	☐	☐	☐
New or revised legislation	☐	☐	☐
Economic incentives or financial mechanisms	☐	☐	☐
Awareness raising or campaigns	☐	☐	☐
Others (please specify):	☐	☐	☐

____

Q19: Is your organisation involved in any climate change adaptation initiative action?

Yes ☐

No ☐ - Go to Q21

Q20: Who is involved and which organisation are you involved in

Institution (name of organisation, government, department):

____

Ownership (public, private or non-government organisation):

____

Key stakeholders (public, private sector organisations, communities, individuals):

____

Q21. Do you have any other comments?

____

____