PERCEPTION OF CLIMATE CHANGE AND ADAPTATION STRATEGIES OF LIVESTOCK AND CROP FARMERS IN IMO STATE, NIGERIA

BY

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CERTIFICATION

This is to certify that this research work entitled "Perception of Climatic and Adaptation Strategies of Livestock and Crop farmers in Imo State, Nigeria'' was carried out by Osuala, Ogechi Mercy. With Reg No. 20094705018, a post graduate student of the Department of Agricultural Economics has satisfactorily completed the requirement for the award of degree of Masters of Science in Agricultural economics. The work embodied in this thesis except where duly acknowledged, is original and has not been previously published or submitted in part or full for any other Diploma or degree of this or any other university.

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This work is dedicated to my late son, Osuala David

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ABSTRACT

This study analyzed the perception of climate change and adaptation strategies of livestock and crop farmers in Imo State. The specific objectives of the study included to; identify the socioeconomic characteristics of livestock and crop farmers, identify the various forms of climate change conditions perceived by livestock and crop farmers, determine the perceived effects of climate change on livestock and crop farmers, identify the various adaptations and coping strategies adopted by livestock and crop farmers, and determine the factors that influence the adaptation measures to perceived climate change adopted by the livestock and crop farmers. Hypotheses tested were; there was no significant difference in the net returns of livestock and crop farmers in the study area; crop farmers socioeconomic characteristics did not significantly affect their uptake of adaptation to climate change; and livestock farmers' socioeconomic characteristics did not significantly affect their uptake of adaptation measures to climate change. Data were collected with structured questionnaire from 72 and 120 proportionately livestock and crop farmers, respectively, from Imo State. Data were analyzed using descriptive statistics and multinomial logit model. Mean farm size was 890 birds, 11 goats and 0.91 hectares for poultry, goat and crop farmers, respectively. Most (69.4%) of the livestock farmers and majority (89.2%) of the crop farmers reported that their perceived form of climate change was high temperature/heat. Most (74.2%) of the crop farmers perceived the effect of climate change as poor soil fertility, while most (73.6%) of the livestock farmers indicated reduced productivity as the perceived effect of climate change. Planting improved crop varieties and intensive management system were adopted by most of the crop and livestock farmers, respectively, as adaptation measures to climate change. Factors that influence the adaptation measures to climate change by livestock farmers were age, gender, level of education, farmers' experience, and farm income, while the factors that influenced change by crop farmers were gender, access to credit, crop mixture, and level of education. Hypotheses one and two were rejected with respect to the significant socioeconomic variables and accepted as regards the non-significant socioeconomic variables of the crop and livestock farmers. Climate in Imo State is really changing and affecting crop and livestock farmers negatively in their production activities which they have tried to cushion through various adaptation strategies. There is therefore, need to encourage the farmers to adapt to climate change through enlightenment campaigns which may be organized by the government through the mass media, print media or the churches and other public functions.

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Agriculture places heavy burden on the environment in the process of providing humanity with food and fiber, while climate is the primary determinant of agricultural productivity (Apata *et al.,* 2009).The effectiveness of rainfall for crop and livestock production is a function of the temperature values which affect evaporation and transpiration, (Rudolf and Harman, 2009).

Smith and Skinner (2002) asserted that climate played a dominant role in agriculture having a direct impact in the productivity of physical production factors, for example the soil moisture and fertility. Adverse climate effects can influence farming output at any stage from cultivation through the final harvest. Even if there is sufficient rain, its irregularity can affect yields adversely if rains fail to arrive during the crucial growing stage of the crop (Molua *etal.*, 2007).Interest in this issue has motivated a substantial body of research on climate change and agriculture (Lobell *et al.*, 2008). Climate change is expected to influence crop and livestock production, hydrologic balance, input supplies and other components of agricultural systems. However, the nature of these bio physical effects and the human responses to them are complex and uncertain. It is evident that climate change will have a strong impact on Nigeria particularly in the area of agriculture (Apata *et al.,* 2009).Crop growth, soil water availability, soil fertility, pests and diseases and rise in sea level could be some effects of climate change. Higher concentration of carbon dioxide in the atmosphere is expected to create a gradient that could facilitate increased intake of

CO2 and therefore increase rate of photosynthesis. This will be expected to produce higher yield of crops (Eze *et al.,* 2006).

Nigeria like all the countries of Sub-Saharan Africa is highly vulnerable to the impact of climate change (NEST., 2004; IPCC, 2007 and Apata *et a.l*, 2009).Though climate change is a threat to agriculture and non-agricultural socio–economic development, agricultural production activities are generally more vulnerable to climate change than other sectors.(Kula Suriya *et al.*, 2006).

Ole *et al,* (2009) asserted that analysis of 9000 farmers in African countries predicted that fall in farm revenues with current climate scenarios. Also, Butt *et al*,(2005)predicted that future economic losses has increased the risk of hunger due to climate change. It seems clear that the combination of high climate variability, poor infrastructure, poverty, drought, excess rainfall, poor livestock health, reduced crop yields, low productivity and range of other problems associated with climate variability constitutes important challenges for Africa generally and Nigeria in particular(Adger *et al.,* 2007).

Agriculture is frequently limited by the seasonality and magnitude of moisture availability. Agricultural production is severely limited in many humid tropical regions like South-east Nigeria by a wide range of weeds, pests and diseases that flourish in consistently warm and moist climate. The growth of some crops and varieties, which require long hours of daylight to reach maturity, is also limited by the invariable day lengths of the tropics. Nigeria is engulfed within the theatre of natural processes. Over 70% of these events are related to extreme weather and climate events including droughts, floods, extreme temperatures, thunder, desertification and high lake and oceanic waves among others (United Nations Office for Outer Space Affairs, 2002).

Whenever they occur, they are often associated with many severe impacts such as destruction of property, displacement of people, loss of lives and disruption of many socio-economic activities. On the other hand, current scientific knowledge points towards a discernible change in global climate with associated regional impacts. These, therefore, underscore the importance of climate change in Nigeria, as virtually most of her socio economic activities are widely sensitive to climate variability.

Agriculture is potentially the most vulnerable of all human and economic activities in nature. The effect of climatic change is felt more in developing countries where technology generation, innovation and adoption have been slow to counteract the adverse effects of varying environmental conditions. For example, inappropriate management of agro-ecosystem compounded by severe climatic events such as recurrent droughts have made the dry land increasingly vulnerable and prone to rapid degradation and desertification (Treror, 2001). Even in the high rainfall areas, increased probability of extreme events can cause increased nutrient losses due to run-off and water logging.

A warm climate will also influence pests and diseases dynamics causing crop and livestock losses. Improved adoption of adjustment strategy, particularly in areas where climate variability is large, holds the key to improving food security for the global production. Agricultural crops and cropping systems have been developed for an adaptation to these varied regimes of climate, soil, diseases and pests.

Advances in agricultural research for developing country condition will be vital for future food stability in the world poorest countries. Developing countries may not be able to import food to meet needs in the future as a result of lack of fund. Nigeria is a tropical country and is more dependent on agriculture and therefore more vulnerable to climate

change as much as greater populace of Nigeria is reliant on agriculture for their livelihood. With low levels of technology, land degradation, unequal land distribution and rapid population growth, Nigeria is exceeding her capacity to feed herself. Most importantly, farming is the basis for most rural economies like Nigeria, without a strong farming sector, countries have little hope of making the transition to broader based economies. This study will therefore examine the perception of climate change and adjustment strategies of some selected food crops and livestock farmers in Imo State, Nigeria.

1.2 Statement of the Problem.

There is a growing consensus in the scientific literature that in the coming decades, the world will witness higher temperature and changing precipitation levels. The effects of these lead to low/poor agricultural products asevidence has shown that change in climate has already affected crop yields in many countries (IPCC, 2007; Deresa *et al.,* 2008; BNRCC, 2008). This is particularly true in low-income countries, where climate is the primary determinant of agricultural productivity and adaptive capacities are low (SPORE, 2008; Apata *et al.,* 2009).Many African countries, which have their economies largely based on weather-sensitive agricultural production systems like Nigeria, are particularly vulnerable to climate change (Dinar *et al.,* 2006).This vulnerability has been demonstrated by the various prolonged or delayed on set of rains that are currently being witnessed in some parts of Northern region like bronu and yobe states. Thus, for many poor countries like Nigeria that are highly vulnerable to effects of climate change, understanding farmers' perception to climatic variation is crucial, as this will help in designing and recommending appropriate coping strategies.

West Africa is one of the most vulnerable to the vagaries of the climate, as the scope of the impacts of climate variability over the last three to four decades has shown (IPCC, 2007). Recent food crises in countries such as Nigeria (wfp 2011)World food programme.are reminders of the continuing vulnerability of the region to the vicissitude of climatic conditions. This is in large measure due to weak institutional capacity, limited engagement in environmental and adaptation issues, and a lack of validation of local knowledge (SPORE, 2008; BNRCC, 2008; Royal Society, 2005; Adams *et al.*, 1998).Studies on climate change and African culture have focused on its agricultural and biological consequences to the neglect of its economic and social consequences particularly from the perceptive of farmers. Although agricultural production is highly dependent on weather and climate, water availability is adversely affected by these weather and climate related disasters,especially when there is late rain, the end point is farmer's negligence. Failure and occurrences of extreme weather conditions such as flood and drought could lead to crop failure, food insecurity, famine, loss of property and life, mass migration and negative national economic growth. Pests and diseases migrate in response to climate variations and will potentially pose a threat to livestock production and food crops.

Global warming brings about drastic changes in the location of the agro-ecological zones and threatens to destabilize weather pattern, which leads to decrease in production and productivity of livestock. The global average concentration of carbon dioxide in the atmosphere has increased from about 315 parts per million (PPM) to over 350ppm. Other green house gases, which allow sunlight into the earth surface but absorb some of the out goingheat radiation, are also increasing, including methane, chlorofluorocarbon (CFC), and neutrons oxide. This effect of initial warming, which causes greater evaporation, reduction

in livestock productivity and production due to high water losses, which has lowers the income of many livestock farmers unknowingly to the farmers (IPCC, 1996).

Farm production may be distinguished into two basic areas; these are crop and livestock production. Livestock and food crops production in Imo State are inadequate leading to insufficient food to the people. One of the factors contributing to this is low agricultural production. It is however, not known if climatic conditions affect the length of production and if farmers know this. While attention has been focused on the magnitude of human suffering by problems of climate change, the impact on the economy has been equally profound lowering the gross domestic product of a nation, which leads to the loss in real economic growth, thereby lowering the standard of living of the people (IPCC, 1996). One of the greatest effects of climate change is on livestock and food crop production. They are important source of income, employment and exports because it has reduced the national herds of cattle, goats and sheep.Due to the importance livestock and food crops play as a foreign exchange earner, losses may have severe impact on the budgetary and balance of payment situations. Population and employment may also register the effects of a climate disaster as many people will migrate in search of relief, squatter settlements will grow, urban overcrowding and unemployment will increase, additional burdens will be placed on the limited social services and political instability will intensify.

Rough estimates suggest that over the next 50 years or so, climate may likely have a serious threat to meeting global food needs than other constraints on agricultural systems (IPCC, 2007; BNRCC, 2008). Specifically, population, income, and economic growth could all affect the severity of climate change impacts in terms of food security, hunger, and nutritional adequacy. If climate change negatively affects agriculture, human effects

are likely to be more severe in a poorer world. Recently, international tension and concerns are heightening over what the impact of climate will have on the environment and agricultural produce (NEST, 2004; BNRCC,2008; Apata *et al.*, 2009). Also, how agricultural and food-distribution systems will be further stressed up by the shifting of temperature and precipitating belts, especially if changes are rapid and not planned for (NEST, 2004).The cause for concern in this study is how livestock and crops farmers perceive climate change, and their adaptation strategies.

Consequently, attempt was made in this study to investigate perception of climate change and adjustment strategies of selected livestock and food crops farmers. Though some attempts have been made to estimate the impact of climate change on food crop and livestock production at the state, country, regional, or global scale (*Eze et al.*, 2006; Pearce et al, 1996; Mc Carthy *et al.*, 2001; Parry *et al*, 2004; Nkomo *et al.*, 2006; Stern, 2007; *Deresa et al.*, 2008; BNRCC, 2008; *Apata et al.*, 2009). However, these attempts fail to provide critical insight in terms of perception of climate change and future adaptation strategies, insights from these studies help to appreciate the extent of the problem.

It is now known that one of the factors contributing to low domestic production of livestock and food crops is adverse climatic conditions. It is, however, not known if climatic condition affects the length of production and if farmers knew this. It is in the light of these problems that the study is aimed at investigating the perception of climatic change and adaptation strategies of selected livestock and crop farmers in Imo State.

Although a similar study by Nwajiuba (2006), concentrated on perception and adaptation by poultry farmers, no attention was given to the perception of climate change on livestock

and food crops farmers .There is also a serious neglect on the adjustment strategies. Therefore, this study is designed to take care of these neglects.

1.3 Objectives of the Study

The broad objective of the study was to determine perception of climate change and adaptation strategies of selected livestock and crops farmers in Imo State, Nigeria.

The specific objectives were to;

i. identify the socio- economic characteristics of selected livestock and crop farmers,
ii. identify the various types of climate conditions perceived by farmers in the study area,
iii. determine the perceived effect of climatic change on selected livestock and crops farmers,
iv. identify the various adaptations and coping strategies adopted by selected livestock and crops farmers.
v. determine the factors that influence the adaptation measures to perceived climate change adopted by the selected livestock and crops farmers in the study area.

1.4 Hypotheses of the study.

In the light of forgoing objectives, the following null hypotheses were tested:

i. crop farmers' socioeconomic characteristics do not significantly affect their use of adaptation measures to climate change, and

ii. livestock farmers' socioeconomic characteristics do not significantly affect their use of adaptation measures to climate change.

1.5 **Significance of the study**.

This study is significant in terms of the creation of awareness on climate change and adjustment strategies of selected livestock and food crop farmers in Imo state. The most important myth concerning extreme climatic conditions is that nothing can be done to prevent them or to respond effectively once they have started.

This study is important for sustenance of agricultural growth and development in Nigeria especially in the aspect of reduction of financial losses during natural disasters thereby sustaining the farmer's income and output level. It will serve as a warning signal to farmers as it will help in interpreting and giving adequate notice to them in order to begin response and reduce severity of the extreme weather condition(s) for various individuals, and specifically research students and climatologists, this study will serve as a source of data. It will also contribute to the literature on the issues of climate change and adjustment strategies. All these together will improve agricultural productivity and put farmers in a better financial position as to meet up with farming challenges.

It will help in assisting policy makers in making reasonable policies that will reduce the drastic effects of climatic change on agriculture, as it will serve as a source of data to them. It will equally help government to improve upon the schemes or design ameliorative measures on complementary programmes to sustain agriculture and prevention of major losses during periods of extreme climatic conditions and agricultural crops and cropping systems that will be developed and adapted to the extreme weather condition. Nigeria as a whole will be put on a better stable economic state of food self sufficiency when

agricultural output is on the proper level. Apart from the country that will benefit from this study, through improved policies on the adjustment strategies, the farmers, research students and the academic community will benefit from the outcome of the research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Theoretical Literature.

2.1.1 Concept of adaptation to climatic change.

Adaptation is one of the policy options to climate change that is influencing development practice (IPCC, 2007, Tanner and Mitchell, 2008). Adaptation to climate change refers to adjustments to practices, processes and systems to minimize current and/or future adverse effects of climate change and take advantage of available opportunities to maximize benefits (Eriksen *et al.*, 2011; Pouliolte *et al.*, 2009; Smitters and Smit, 2009). Adaptations can either be planned or autonomous with the latter being done without awareness of climate change predictions but based on experience and prevailing conditions (Smitters and Smit, 2009).

Adaptation does not occur without influence from other factors such as socio-economic, cultural, political, geographical, ecological and in stitutional that shape the human environment interactions (Eriksen *et al.,* 2009). Adaptation to climate change is needed both in the short term and long term basis (Adger *et a.l,* 2003, Eriksen*et al.*, 2011; Pittock and Jones, 2009). The adaptation theory posits that social, economic, ecological and institutional systems as well as individuals can and do adapt to changing environment (Smithers and Smit, 2009). The extent of sustainable adaptation depends on the adaptive capacity, knowledge, skills, robustness of livelihoods and alternatives, as well as resources and institutions accessible to enable effective adaptation (IPCC, 2007a).The adaptive

capacity is influenced by factors such as knowledge about climate change, assets, access to appropriate technology, institutions, policies and perceptions (Adger *et al.*, 2003; IFAD, 2008). Smithers and Smit, (2009) contend that environmental perceptions are among key elements influencing adoption of adaptation strategies. Actions that follow perceptions of climate change are informed by different processes such as perception of risk associated with climate change, resource endowments, and cultural values, institutional and political environment and there is no guarantee that having perceptions that climate change has or is occurring would prompt effective adaptation responses (Weber, 2010).

2.1.2 Key concepts and definitions.

The United Nations frame work convention on climate change (UNFCCC) defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. It generally refers to longer term changes in means or in climate variability itself, and often specifically to change resulting from human activities for example global warning due to the burning of fossil fuels (IPCC, 1997).

Climate – is usually defined as the "average weather", or more rigorously, as the statistical description of the weather in terms of the mean and variability of relevant quantities over periods of several decades (typically three decades as defined by world meteorological organization). These quantities are most often surface variables such as temperature, precipitation, and wind, but in a wider sense the "climate" is the description of the state of the climate system (IPCC, 1997).

Climate variability – The weather represents variability in the atmospheric conditions on a daily and weekly basis. The term climate variability generally refers to variations of the climate system, which includes oceans and the land surface as well as the atmosphere, over months, years and decades. This encompasses predictability, i.e. an inherent uncertainty. The rainy season is a predictable occurrence, but the amount, timing and distribution of the rains is uncertain (HellMuth *etal.*, 2009).

Adaptation – is the ability to respond and adjust to actual or potential impacts of changing climate conditions in ways that moderate harm or take advantage of any positive opportunities that the climate may afford. It includes policies and measures to reduce exposure to climate variability for extremes, and the strengthening of adaptive capacity. Adaptation can be anticipatory, where systems adjust before the initial impacts take place, or it can be reactive, where change is introduced in response to the onset of impacts (IISD, 2003).

Adaptation to climate change – it is the process through which people reduce the adverse effects of climate variability on their health and well-being, and take advantage of the opportunities that their climatic environment provides (Burton, 1992).

The term adaptation means any adjustment, whether passive, reactive or anticipatory, that is proposed as a means for ameliorating the anticipated adverse consequences associated with climate change (Stakhi, 1993 quoted in Smit *et al.*, 2000).

Adaptability refers to the degree to which adjustments are possible in practices, processes, or structures of systems to projected or actual change in climate. Adaptation can be spontaneous or planned, and can be carried out in response to or in anticipation of changes in conditions (IPCC, 1996).

Adaptive capacity – is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damage, to take advantage of opportunities, or to cope with the consequences (IPCC, 2001). Thus the adaptive capacity of a system or a community describes its ability to modify its characteristics or behaviors so as to cope better with change in external conditions. Adaption to climate change is crucial in order to reduce the impacts of climate change that are happening at present time and increase resilience to future impacts.

Climate change mitigation – An anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and enhancing greenhouse gas sinks (IPCC, 2007).

Climate change perception-Perception is the process of attaining awareness or understanding of sensory information. It is the awareness of sensation registered on the sense organs and interpreted by the mind. The word "Perception'' comes from the Latin words perceptio, percepio and means" receiving, collecting, and action of taking possession, apprehension with the mind of senses." Farmers learn and adopt new innovations in many ways (Madison, 2007).

Based on their perception and observations from neighbours, success stories and practice, farmers tend to update and try to adapt to the adverse effects of weather changes. However, this depends on the resources in their hands and opportunities in accessing extension services, credit as well as inputs.

Two steps are involved in climate change adjustment: First perceiving change and then deciding whether or not to adopt a particular measure (Madison, 2007). Whenever they have the opportunity, farmers tend to adopt new variety of measures or technologies in

response to the perceived change of weather conditions. The supports from extension workers, information gained and technologies available to them will highly influence their adjustment and response capacity. For instance, farmers use water conservation techniques whenever the rainfall patterns change and amounts of rain are reduced. In such situations, they different crop varieties that have short maturity duration with adjustment of planting dates (Madison, 2007).

2.2.Empirical Literature

2.2.1 Perception of changes in climatic conditions

Nwajiuba *et al.*, (2006) revealed that 60% of the respondents' perceived temperature as increasing, which was the majority, 33.33% perceived temperature as not changing while the remaining 6.67% perceived it as decreasing for a period of ten years. The data of mean annual temperature for a period of ten years (1996-2005) obtained from NRCRI, Umudike revealed that temperature had increased with a range of 0.96^0c and a slight mean deviation of 0.003^0c. The highest annual mean temperature was recorded in 2000. Therefore, farmer's perception that temperature had increased for a period of ten years was in accordance with the result of NRCRI, Umudike. Crop farmers also showed the same trend in perception of rising temperature.

Fifty-three percent of poultry farmers perceived rainfall as increasing, 40% perceived rainfall as unchanging, while the remaining 6.67% perceived it as decreasing for a period of ten years. Rainfall data obtained from NRCRI, Umudike revealed that rainfall had decreased with a mean of 89.19cm and a slight negative mean deviation of 1.9068cm. The highest annual rainfall mean was recorded in 1996. Therefore, farmer's perception that rainfall has increased for a period of ten years was not in accordance with the result from

NRCRI, Umudike. This was also the case with crops farmers. Data on number of rainy days increased for a period of ten years with a mean of 2.0 days. The highest mean annual rainy days was recorded in 2005 with a value of 12.30 days. The farmers therefore perceived increased number of rainy days as increase in rainfall. That is to say, it is not in aggregate volume per annum but frequency/number of rainy days per annum that seems of interest to farmers. Also, the result from NRCRI showed that the least mean annual temperature was recorded in the same year when the highest temperature had a negative relationship with rainfall. Fifty-five percent of poultry farmers perceived humidity as increasing, 35.56% saw humidity as not changing while the remaining 8.89% said humidity had decreased for a period of 10 years. But, the data from NRCRI, Umudike, on annual means of relative humidity showed that it had decreased with a range of 3.75%. This implied that farmers did not correctly perceive this. Therefore, farmer's perception that relative humidity increased over a period of ten years was not in agreement with the result from NRCRI, Umudike. The highest annual relative humidity was recorded in 1996 which is the same year with the highest rainfall. It is the same year (1996) that the least annual temperature mean was recorded implying that temperature decreased with increasing relative humidity while rainfall increases with increasing relative humidity.

The many(48.89%) of the respondents perceived the duration of sunshine as increasing, 46.67% of the farmers perceived sunshine duration as not changing while 4.44% perceived sunshine as decreasing. The data of sunshine duration for a period of ten years (1996-2005) obtained from NRCRI, Umudike, revealed that sunshine duration had increased with mean of 0.68 hour. The highest annual sunshine duration mean was that of 1999 with a value of 4.56 hours. Therefore, farmer's perception that sunshine duration had increased was in agreement with the result from NRCRI, Umudike. This perception tallied with that of

temperature, but the highest annual mean sunshine duration was recorded in 1999 while that of annual mean temperature was recorded in 2000 – a year later. This meant that temperature and sunshine duration are positively related.

Onyeneke (2010) and Onyeneke *et al.,* (2012) in their result stated that, the respondents in all the communities perceived that climate change was evidenced in short rainy season (Orori,81%,Umuorsu,74%,Umukara,80%,Umueli 86%, and Umuobasi 77%).Recent studies have shown that precipitation decreased in the humid region of west Africa, including southern Nigeria, since the beginning of the century, is about 10-25 or about 2-5 per decade (FME,2003).All the respondents in the study villages, Orori 70%,Umuorsu 70%,Umukaram 83%, Umueli 73%, and Umuobasi 79% perceived thermal discomfort and occasional heat waves as evidence of climate change. This fact is corroborated by Duruji (2005) who asserted the worldwide temperature have climbed more than 1 over the past century and that the 1990s were the hottest decade on record globally.

Onyeneke and Madukwe, in their study on barriers to adaptation to climate change stated that 50% of the farmers lacked information on appropriate adaptation options, Lack of finance was reported by 35% of the farmers, shortage of labour was reported by 35% of the farmers, shortage of land wasindicated by 5% of the farmers, while poor access to market was indicated by 5% of the farmers.

2.2.2 **Effects of changes in rainfall and temperature on crop yields**.

Crop growth, soil water availability, soil fertility, pests and diseases and rise in sea level could be some effects of climate change. Higher concentration of carbon dioxide in the atmosphere is expected to create a gradient that could facilitate increased intake of Co_2 and

therefore increased rate of photosynthesis. This will be expected to produce higher yields of crops.

A significant effect of climate change due to increased levels of Co_2 would be reflected in the production of food crops namely cassava, yam, cowpeas, wheat, soy beans, rice and potatoes (Adejuwon, 2004). Also, expected changes in crop development and phonology can cause shortening or lengthening of crop cycle that could lead to decreases or increases in productivity, Structural changes in the carbohydrate status of plants can also occur. This may affect nutritional value, taste and storage quality of fruits and vegetables. Increases in Co_2 can lower crop water requirements by reducing transpiration per unit leaf area.

High temperatures may result in accelerated physiological development, leading to early maturation and reduced yield. It also may accelerate the rate at which plants release Co_2 in the process of respiration leading to less than optimal condition for growth. When temperatures exceed the optimal for biological processes, crops often respond negatively with a steep drop in net growth and yield (Fischer *et al*, 2002, Peters and Ekpoh, 1994). Also, if night time temperature minima rise more than do daytime maxima as is expected from green house warming projections, heat stress during the day may be less severe than otherwise, but increased night-time respiration may reduce potential yields.

According to IPCC (2001a) water demand by and water supply to crop plants will be modified to the detriment of crop yield as global warming progressed with the same level of perceptible water, higher temperature will reduce the relative humidity, and increase the sink strength of the atmosphere. As a result, more water will be withdrawn from the soil through evaporation and less optimal functioning of the plant since flowering, pollination and grain filling will be hindered by moisture stress.

The high rate of chemical and biochemical action as well as the abundance of micro organic activity in tropical soils arose from the low organic contents of its soils. For instance, when a dead part of plant or an animal falls on the ground, it is attacked by myriads of insects and worms which bring about an initial break down, producing soluble minerals, which are easily carried away by percolating water. As a result, organic matter is restricted to the surface. Soil fertility depends on the organic matter content which is the main source of nitrogen and nutrients such as calcium, potassium and phosphorus. This process of biodegradation is usually enhanced by high temperatures. Additional application of inorganic materials (Fertilizer) may be needed to counter these processes and take advantage of the potential for enhanced crops growth that can result from increased atmospheric carbon dioxide (Co_2). However major factor responsible for erosion on Nigerian farm include ecosystem disequilibrium, rising population pressure on land and fragile permeable soil when affected by heavy raindrops (Titilola *et al.*, 1996). Soil erosion is aggravated by such factors as the farming system, soil management practices and poverty in soil conservation techniques and the lack of understanding of the need for soil conservation.

The localization and occurrence of pests and diseases are determined by moisture content of the area and its temperature is high under conditions of optimum water supply. Also altered wind patterns may change the spread, location and distribution of pests and diseases that could affect our crops either positively or negatively. Livestock pests and diseases may be similarly affected. The possible increases in pest infestations may bring about greater use of pesticides to control them with its climatic and environmental implications.

2.3 Nature of Climate Change and their Expected Mitigation Strategies.

According to United Nations Office for Outer Space Affairs (2002), extreme weather conditions have occurred and were still occurring in Nigeria and environs. Some of them are:

2.3.1 Floods.

Floods are among the devastating natural hazards in the world, claiming more lives and

causing more property damage than any other natural process. In Nigeria, a percentage of the population is at risk from one form of floods or another. This includes the whole spectrum from the rich urban residents of bar beach in Victoria Island, Lagos to poor farmers and fishermen in Benue and Niger through the coastal regions of Nigeria. Data from remote sensing can be relayed to provide early warning of impending flood conditions. Geographic information system (GIS) and remote sensing are useful for risk analysis and calculation of the various areas that are more at risk of flooding.

A flooding contingency plan can be made based on regional and weather forecasts, geographic information systems, ground stations and satellite imaging. During flooding, timely and detailed situation reports are required by authorities to locate and identify by authorities to locate and identify the affected areas and to implement corresponding damage mitigations. During this period of response or relief, it is essential that information be accurate and timely in order to address emergency situation like search, rescue and relief. Space information can help to augment ground information for real time damage assessment and extending threat to life and property. Space imagery integrated with GIS

can also help in preparing flood recovery plans. Information collected on the mitigations preparedness, response and recovery phases can be integrated into preventing flood project.

2.3.2 Drought

Drought has long been recognized as one of the most insidious causes of human misery. It is today the unfortunate distinction of being the natural disaster that annually claims the most victims. Its ability to cause widespread misery is actually increased while generally associated with semi arid climates, drought can occur in areas that normally enjoy adequate rainfall levels like Nigeria. In the broadest sense, any lack of water for the normal needs of agriculture, livestock, industry or human population may be termed a drought. The cause may be lack of supply, inadequate storage or conveyance facilities, or abnormal demand. Drought, as commonly understood is a condition of climatic dryness that is severe enough to reduce soil moisture and water below the minimum necessary for sustaining plant, animal and human life. Drought is usually accompanied by hot, dry winds and may be followed by damaging floods.

2.3.3Bush fire

Bush fire threat tends to be seasonal. It can be rapid under conditions of high temperatures and high wind, when major fire fronts advance very quickly. Also fragmentation of fire from a front may be carried forward by the wind, starting new fires further ahead. Effects of bush fire can be destructive, especially in loss of building, soil fertility, timber and livestock. Recovery from effects on the environment may take several years. Wild fire occurs almost everywhere in Nigeria where combustible materials are available,

particularly in the dry seasons. Nigeria suffers enormous losses through unnecessary wild fires. A comprehensive study in states in Nigeria indicates that of the 12, 147 hectares of plantations established, 1,122 hectares were affected by fire, while, 1,788.4 hectares were completely destroyed in 1992/93 alone (Arrow, 1996).

These losses amounted to over N20 million and the trend seems to be on the increase. The effect of this to agriculture and human settlement is unimaginable. Satellite remote sensing makes it possible to identify the fires that are hottest. This allows the fire fighters to analyze the conditions of the era and prioritize the fighting efforts.

2.3.4 Land slides

Land slides occur in areas of relatively steep topographic slopes underlain by unstable materials. Slides are often the result of high concentration of soil moisture that lubricates the surface materials. Landslides may cause severe damage of structures and systems. Rivers may be blocked, causing flooding, crops may be affected. Area of crop producing land may be lost altogether when landslides are combined with very heavy rain and flooding, the movement of debris may cause high levels of damages and destruction. Areas that are susceptible landslides can be identified from remotely sensed data by the hummocky appearance that is characteristic of unstable slopes.

People are at risk from disaster, whether natural or not, human beings can take actions that save lives, reduce loses, speed response and reduce human sufferings when they receive accurate warnings on time. Space derived information can provide accurate and warning techniques as better dynamic models and expand the understanding of the causes of disasters. Finally any effort at managing disaster must apply prevention strategies to reduce the impacts of natural and man-made disasters. We cannot decide how many

storms will strike, or how fiercely the winds will blow, or the waters will range, but we can decide the impact they will have on our lives and on the ecosystem. This can be done by adopting disaster management techniques.

2.4 Causes of Climate Change

The earth's climate is dynamic and always changing through a natural cycle (Arrow, 1996). What the world is more worried about is that the changes that are occurring today have been speeded up because of man's activities. These changes are being studied by scientists all over the world who are finding evidence from the rings, pollen samples, ice cores and sea sediments, biotic, cultural, soil pH and soil texture are some environmental factors affecting production in which climatic factors are also induced. The cause of climate change can be divided into two categories, namely, those that are due to natural causes and those that are created by man.

2.4.1 Natural causes.

There are a number of natural factors responsible for climate change. Some of the more prominent ones are continental drift, volcanoes, ocean currents, the earth's tilt, comets, meteorites, tides and waves.

2.4.2 Human causes.

The industrial revolution in the 19^{th} century saw the large scale use of fossil fuels for industrial activities. These industries created jobs, and over the years, people moved from rural areas to the cities. This trend is continuing even today .More and more land that was covered with vegetation have been cleared to make way for houses. Natural resources are

being used extensively for construction, industries, transport and consumption. Our increasing want for material things has increased by leaps and bounds, creating mountains of waste also; our population has increased to an incredible extent.

All these have contributed to a rise in greenhouse gases in the atmosphere. Fossil fuels such as oil, coal and natural gas supply most of the energy needed to run vehicles, generate electricity for industries, households, etc. The energy sector is responsible for about three quarters of carbon dioxide emissions, one fifth of the methane emissions and a large quantity of nitrogen monoxide, which are greenhouse gases but do have an influence on the chemical cycles in the atmosphere that produce or destroy greenhouse gases (Mohia and Lambi, 2007).

2.5 The Effect of Climate Change on Agriculture and General Development.

At the basis of any understanding of climate impacts on agriculture lies the biophysical science. The rate of most biophysical processes is highly dependent on climate variables such as radiation, temperature and moisture that vary regionally. For example, rate of plant photosynthesis depend on the amount of photo synthetically active radiation and levels of atmospheric carbondioxide. Temperature is an important determinant of the rate at which a plant progresses through various phonological stages towards maturity. The accumulation of biomass is constrained by availability of moisture and nutrients to a growing plant (Rosen Weig *et al.*, 1992).

Numerous studies have been examined on the impact of past climatic variations on agriculture using case studies, statistical analysis and simulation models. Such studies have

clearly demonstrated the sensitivity of both temperate and tropical agriculture systems to climatic variations and changes. In the temperate regions, the impacts of climate variability, particularly drought, on fields of grains in North America and the Soviet Union have been of particular concern because of their effects on world food security. In the tropics, drought impacts on agriculture and resulting food shortages have been widely studied, especially when associated with the failure of the monsoon in Asia or the rains in sudano-sahelian Africa. In the temperate regions, climatic variations are associated with economic disruptions, in the tropics; droughts bring famine and wide spread social unrest (Pierce, 1990).

2.5.1 **The impact of droughts on development.**

If drought is allowed to continue without response, the impact on development can be severe. Food shortage may become chronic. The country urban growth may deteriorate. To respond to this, the government must borrow heavily and must divest money from other development schemes in order to meet these needs. All serve to undermine the potential for economic development.

If drought response is treated as only a relief operation, it may wide out years of development especially in rural areas. Agricultural projects in particular are most likely to be affected by drought. For those in agricultural development, drought or the threat of droughts should be considered a part of the overall development equation. A balanced agricultural programme that develops good water resources, addresses the problems of soil erosion, adopts realistic limits on the expansion with comprehensive rage management will contribute to the mitigation of drought impact.

The same philosophy is used to reconstruct the aftermath of drought. Reconstruction should be viewed as an opportunity to accelerate development work. It is an ideal time to introduce improved animal husbandry techniques, range land management, water resources development schemes and erosion control measures.

The most serious impact droughts can be that of creating famine. It should be regarded as a parallel disaster that will have parallel implications in development. Famine induces out migration, when dwindling supplies of food are not replaced, famine can occur. Further accelerating the migration out of the stricken areas to less affected zones. The migration may in itself contribute to spreading the scope of the disaster especially if grazing animals are moved with the people.

2.6 **Adaptation to Climate Change.**

Adaptation is the mechanism to manage risks, adjust economic activity to reduce vulnerability and to improve business certainty. There should therefore be a national adaptation framework which will aid decision makers understand and incorporate climate change into policy and operational decisions across all vulnerable sectors particularly Agriculture (National climate change adaptation framework, 2008). Decision makers require information about projections of climate change, particularly extremes of events, social and economic trends that affect climate change vulnerability, and the social and economic impacts of climate change. Effective decision making will need to be supported by integrated, multidisciplinary assessments of vulnerability to climate change. Farmers can, however, adopt the following adaptation options altered planting dates, change to crops more adaptable to the new climate situation, application of irrigation facilities, changes in the levels of fertilization, changes in agriculture systems, and adopting on farm

adaptation systems such as planting quicker/slower maturing varieties, planting pests and diseases resistant crops, alteration of tillage methods (use minimum or reduced tillage, terracing, ridging, deep ploughing, switch seasons for cropping) there is need to develop decision support tools, pilot adaptation options, inform and encourage adaptation and engage industry in participatory research communication and review since no sector benefits or suffers more than the other where there is climate change (Eze *et al.*, 2006). Government can facilitate adaptation to climate change through water development projects, agricultural extension activities, incentives, subsidies, regulations and provision of insurance.

2.7. **Farmers Coping Strategies in their Farm Business (Crops and Livestock)**

Livestock is generally more adaptable to environmental shocks (climate change) than crops and often more so than keepers themselves. They are mobile, which can increase survivability by moving across diverse natural resources. They may be relatively omnivorous, and thereby able to survive dramatic effects on feedstock of natural or induced environmental change. Native animal varieties in particular are adapted to local environmental change. Native animal varieties in particular are adapted to local environmental risk and use natural resources efficiently. For all these reasons, superior survivability of livestock can actually increase survivability of livestock keepers and poor people keeping livestock, to a significant extent transfer environmental risk to their animals. Otte (2005).A farm keeper should keep fewer livestock so that he or she can manage them better. Also, he or she should establish pasture fields, plant drought tolerant

grass and food and crops for feed, and construct a dike as a reliable source of water rather than walking long distance with livestock.

One traditional adjustment strategy food crops farmers usually practice if there is climatic change such as the occurrence of drought is the conservation of the soil moisture provided by occasional showers. After each shower, farmers quickly plough or hand weeds their fields. These operations reduce moisture losses by evaporation and evapotranspiration, and prepare the soil to absorb the next shower quickly and deeply. When young plants die due to lack of moisture in April, farmers often re-sow the crops in May and June. To compensate loss of crop production, farmers devote more land to crops in the post-drought period Adnan (1993). The important seasonal strategies by food crops farmers include choice of cropping patterns to spread risk involving mixed cropping, cultivating of secondary crops particularly root crops. (Tony, 2009).

The adaptation measures that farmers reported may be profit driven rather climate driven. Despite this missing link, we assume that their actions are driven by climatic factors, as reported by farmers themselves (Maddison, 2006; Nhemachena and Hassan, 2007).From the responses, the researchers delineated seven broad categories of adaptation to climate change.

1. Portfolio diversification: Specific categories encapsulated in this option are using improved crop varieties, intercropping and using different crop varieties that survive in adverse climatic conditions.
2. Soil conservation: Farmers specific adaptation option listed in this category include mulching, planting cover crops, applying fertilizer and organic manure.
3. Changing planting dates: This covers early planting and late planting options.

4. Changing tillage operation: The option in this category are using minimum tillage operations, full tillage operation and digging ridges across slopes in the farm against erosion.
5. Planting trees: This specifically involves planting trees in the farm to serve as shade against harsh temperature.
6. Irrigation: As the name implies, it involves supplying water to farm. The informal type is used here.
7. No adaptation: This term was designed to accommodate the category of farmers who did not use any adaptation method to counteract the negative impact of climate change.

2.7.1Farmer's perception on issues of the business and the environment

The farm is a production sub system in an economy and normally identified as a business ventures. The farming environment is dynamic-always changing. It faces changes in technology, prices, climate, and institutions. These changes affect the performance of an enterprise or enterprises in farm. A successful farmer will be quick to choose the profitable enterprise and will raise the enterprise with efficient allocation of resources. The environment does play an important role in the progress and development or otherwise of the Agricultural sector in particular and the economy as a whole. No business and therefore no farm, exists or operates in a vacuum. Constraints of various kinds-social, legal, national, political and economic, sometimes emanating from forces (especially economic forces) Well beyond national boundaries-constantly affect the freedom of managers, matters such as the way in which prices and costs are influenced by international markets, the prevailing climate for borrowing funds, the effect of legal constraints on the field of employment,

social responsibilities (Oseni *et al.,* 2006). In respect of such questions are pollution and other environmental issues, as well as the influence of purely political considerations on national farming policies and international agreement are just some of the obvious examples of the various influences which combine to create the environment in which farm managers have to work. Few managers will need reminding that the influence of the business external environment are real, usually unavoidable and just have to be lived with. At the end of the day, farmer managers, like all other manager must simply get on and manage effectively.

2.8Farming Systems and How Climate Change has Affected Them.

Farming system designates a set of agricultural activities organized while preserving land productivity, environmental quality and maintaining desirable level of biological diversity and ecological stability. It is defined as the way in which the farm resource arte allocated to the needs and priorities of the farmers in his local circumstances which include

(1) Agro climatic condition such as the quantity, distribution and reliability of rainfall, Soil type and topography temperature e.t.c.

(2) Economic and institutional circumstances like market opportunities, prices, institution and infrastructure facilities and technology. (Lal and Millar, 1990)

2.8.1. Effects of climate change on farming systems.

Climate change has affected the farming systems in diverse ways according to ILRI (1993), and they are as follows:

(i) Shifting cultivation: Shifting cultivation is the characteristic agricultural practices in much of the humid part of West Africa (i.e the equatorial forest zone). This farming system is based on the natural soil fertility and input of manual labour only. There is no input of

capital, technology, manure or fertilizer. It is characterized by short period of cropping (one or three years), alternating with long fallow periods which serve to restore the fertility of the soil. Shifting cultivation in general have only a few domestic animals like goats, sheep, chicken or pigs which are kept near the farm yards. During the fallow period, the fields are not used for grazing. Shifting cultivation is mainly associated with subsistence agriculture. Shifting cultivation is not practiced in land deficit areas like Imo state in this recent time. The length of the fallow period is strongly correlated with the distribution and density of the population (generally less than 10 per km). The shifting cultivator is skilled in adapting cropping practices to the environment in which he is working. Important aspects of adaptation are the selection of the field to be cultivated, the choice of crops, the organization of the inter cropping, mixed cropping, or phased planting and arrangement of short, middle and long term fallows.

(ii) Fallow systems: Fallow farming is usually characterized by clearly defined farm with largely permanent field divisions and more or less permanent farm yards. (Lal and Miller, 1990). Under fallow systems, a regular system of fallow is created which are never permitted to revert to savanna woodland or equatorial forest. After several years of arable cropping, the field can be used for the cultivation of grasses and legumes that are utilized for livestock production. In a bush fallow system in Nigeria, almost all farmers cultivate fields in both the uplands and the valley bottoms. The upland farms are cultivated for about ten years. During the rainy season, the most important upland crops are guinea corn (sorghum), melon, maize, and yam, while on the valley bottoms only rice is cultivated. In the dry season, the valley bottoms are cultivated with cassava, sweet potato, okra, and sugar cane.

A major problem in fallow system is the declining fertility status of the soils' because the fallow period is too short generally and the manure applications are insufficient to maintain the soils natural fertility. Furthermore, fallow farming can cause a degradation of the soil structure, resulting in the sealing of the soil surface and the compaction of subsurface layers. This, in turn leads to increased soil erosion.

(iii) Semi-permanent farming systems: Any intensification of the fallow system results in a further shortening of the fallow period, or, eventually, its absence. The farming system becomes more or less permanent. There are three different types of farming system within permanent farming systems. These are;

(i) permanent cropping of annual crops;

(ii) planting of perennial, especially tree crops, and

(ii) irrigated farm

CHAPTER THREE

METHODOLOGY

3.1 Study Area

This research was conducted in Imo State of Nigeria. Imo State is located between latitude 5^{o} 10' and 6^{o} 35' north of the equator, and longitudes 6^{o} 35', and 7^{o} 31' east of the Greenwich Meridian, and therefore it is found in the tropical rainforest zone (Areola *et al*, 1999).It is situated east of the River Niger and occupies the Imo River Basin. It has a total land mass of 25,289km² (Imo State Directorate of Land, Survey and Urban Planning, 1995). It has a total of 27 Local Governments with its capital as Owerri. The population of the state was recorded as 4.8 million by the National Population Census (NPC) (2006). It shares boundaries with Abia State in the East, Anambra State in the North and Rivers State in the West.

In the North, there is a gradual rise which forms the rolling hills in the Okigwe axis. There are rivers in the state such as Imo, Otamiri and Njaba. Also, some lakes like Oguta Lake in Oguta LGA and Aba-daba Lake in Ihitte/Uboma Local Government Area exist in the state. Vegetatively, Imo State has a mixture of the rich savannah and tropical rain forest.

The climate is made up of two major seasons, the dry season which begins in October and ends in March and the rainy season that commences in April and ends in September. Also a dry spell widely regarded as the "August Break" occurs in August. Average annual rainfall and rain days are recorded to be 1,500mm to 2,2800mm and 148-155days, respectively with mean annual temperature of 20^{0}C (Meteorology Department, 2006).

The relative humidity of about 90% in the rainy season while in the dry season, the state experiences a relative humidity of about 60% (Meteorology Department, 2006). It has an altitude of 122m. The soils are mostly ferralitic and feralsolic. They are reddish yellow in color with P^H of about 5.5 within the top soil. The sandy nature of soils in Imo State makes it prone to erosion. This is a disadvantage to the farmers in the state.

There is an abundance of resources both human and economic in Imo State. Examples of economic resources are cash crops like oil palm and food crops like maize and yam. The mainstay of the people of Imo State is agriculture and civil service. The citizens are relatively literate and farmers practice in small scale. Some of the crops grown in the state are yam, cassava, cocoyam, maize, banana, oil palm, cocoa, oranges and plantain. Livestock include goat, sheep and poultry and are reared sometimes in free range system. Also the presence of Universities and academicians put the state in a good condition for producing sound citizens that can contribute to the economic growth of the state.

3.2 Sample Selection

The study was conducted in Imo State. There are three agricultural zones in the state based on the classification of the State's Agricultural Development Programme (ADP). The zones are Okigwe, Owerri and Orlu, with each zone having little variation in the vegetation and climate. The three zones are subdivided into 27 Local Government Areas (LGAs). Orlu zone experiences heavy erosion, flooding and leaching every year more than others. The simple random and proportionate sampling techniques were used and the categories of farmers sampled were small holder livestock and crops farmers. Two Local Government Areas were randomly selected from each of the three agricultural zones of Imo State. Okigwe zone was represented by Onuimo and Ihitte/Uboma LGAs, Ikeduru and Ngor

Okpala LGAs were selected from Owerri zone, while Orsu and Ohaji/Egbema LGAs represented Orlu zone. In each Local Government Area, two communities were randomly selected making six communities namely; Eziama and Ntu in Ngor Okpala LGA, Obidi Agwa and Egbema in Ohaji/Egbema LGA, and Okwu and Amaimo in Ikeduru LGA. From each community, two villages were randomly selected making a total of 24 villages. These were Umuebi, Umuokoro, Umuogbo, Umuhita, Aro, Mgbala, Abaezi, Aliocha, Umuchima, Owauzo, Umuofor, Obodo, Ezelu Okwe, Umudike, Ezihe, Umuogboanu, Eboeke, Eluama, Amaiheugwu, Amaihenta. The list of food crop and livestock farmers in each selected village was compiled with the assistance of the extension agents located at the local government area and this formed the sampling frame. From this sampling frame, five food crop farmers and three livestock farmers were proportionately selected from each village making a sample size of 120 food crop farmers and 72 livestock farmers. The sample frame was thus 192 farmers. Cassava-based crop enterprise is the major food crop in the area as well as goatry and poultry for livestock production. The researcher concentrated on farmers identified in these operations/activities.

Table 3.2 shows the distribution of the zones, local government areas, communities and villages that were randomly selected.

ZONE	LGA	COMMUNITY	VILLAGES
OKIGWE	Onuimo	Okwe ,	Ezelu Okwe,Umudike
		Umuchi Okwe,	Ezihe,Umu ogboanu
	Ihitte/uboma	Eboeke	Eboeke,Eluama
		Amaihe	Amaihe ugwu, Amaihenta
Owerri	Ikeduru	Okwu	Umuchima, owauzo
		Amaimo	Umuofor,Obodo
	Ngor okpala	Eziama	Umuabi,umuokoro
		Ntu	Umuogbo,Umuhita
Orlu	Ohaji egbeme	Obudi agwa	Aro, mgbala
	Egbema	Abaezi, Aliocha	
	Orsu	Amazu	Umuebe,Umuoka
Anaebu	Amebu eke, Amaebu nkwo		

3.3 Data Collection

Data collection was through primary sources. The primary sources included the use of questionnaire, as well as personal observations by the researcher. Primary data were collected on variables such as age, gender, household size, farming experience, farm size, level of education, perceived effects of climate change, perceived forms of climate change, adaptation strategies on climate change, access to credit, farm income, inputs and prices, flooding, outputs and prices, frequency of rainfall and extension contact. Data collection took place between July and November, 2013.

3.4 Data Analyses

Descriptive statistics such as mean, percentages and frequency distribution were used to achieve objectives i,ii,iii,and iv.

Objective v was realized using the multinomial logit model.

It is assumed that each farmer faced a set of discrete, mutually exclusive choices of adaptation measures. These measures were assumed to depend on a number of climate attributes, socio-economic characteristics and other factors. The multinomial logit model (MNL) for the adaptation choice specified the following relationship on the probabilities of choosing option A and the set of explanatory variables X as in Green (2003)

$$\text{Prob}(Yi=j) = \frac{1}{1+\sum_{j-1}^{j-1} e^{Bj-xi}} \quad . \; i = 0,1\ldots j \quad \text{- - - - - - - - .} \quad 3.1$$

A universal logit model avoids the independence of irrelevant alternative property while maintaining multinomial logit form by making each ratio of probabilities a function of the attributes of all the alternatives. The effects of explanatory variables on the probability marginal effects are usually derived as

$$\delta j = Yi = \frac{\delta P_j}{\delta x_i} = P_j \left[\beta_j - \sum_{k=0}^{j} P_k \beta_k \right] = P_j(X_i \beta_j) \text{ - - - - - - - - - - - - - - - . 3.2}$$

Where,

$\delta_{j1} = Y_1$ =Marginal effects of crop farmers adopting a particular adaptation strategy

j = 1 for crop farmer and 2 for livestock farmer

P_j = Probability of adopting a particular adaptation strategy

Xi = Explanatory variables

β_j =Coefficients to be estimated

The marginal effects measure the expected change in probability of a particular choice being made in respect to a unit change in an explanatory variable (Long, 1997; Greene, 2003; Apata *et al.*, 2010).The signs of the marginal effects and respective coefficients may be different as it depends on the signs and the magnitude of all other coefficients. The explanatory variables were as follows;

For Crop farmers

δ_{j1}=Y1=Marginal effect of crop farmers adopting a particular adaptation strategy.

X_1 = Gender (Dummy variable, 1 for male, 0 for female)

X_2 =Farm size (Ha)

X_3 = Access to credit (Dummy variable, 1 for access, 0 for no access)

X_4 = Age (Years)

X_5 = Crop mixture (Number of crops in mixed cropping)

X_6 = Level of education (Number of years spent in school)

X_7 = Household size (Number of persons)

X_8 = Farming Experience (Years)

X_9 = Annual farm income (₦)

X_{10} = Extension contact (Number of visits per year)

It is expected *apriori* that the coefficients of;

$X_1, X_2, X_3, X_5, X_6, X_8, X_9, X_{10}, >0$; $X_4, X_7<0$

For livestock farmers,

$\delta j2 = Y_2$ = Marginal effect of livestock farmers adopting particular adaptation strategy.

X_1 = Gender (Dummy variable, 1 for male, 0 for female)

X_2 = Age (Years)

X_3 = Educational level (Number of years spent in school)

X_4 = Farming experience (Years)

X_5 = Household size (Number of persons)

X_6 = Extension contact (Number of visits per year)

X_7 = Annual farm income (₦)

It is expected *a priori* that the coefficients of;

$X_1, X_3, X_4, X_6, X_7, >0$; $X_2, X_5< 0$

3.4.1 Test of Hypotheses

Hypotheses i and ii were tested using the t-ratios and chi-squares that were produced in the multinomial logit analysis performed to achieve objective vi. The t-ratios were compared with the t-tabulated values at specified alpha level and n-k degrees of freedom to test the two hypotheses.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socioeconomic Characteristics of Livestock and Crop Farmers

The socioeconomic characteristics of livestock and crop farmers studied included age, marital status, sex, level of education, farming experience, household size, membership of cooperative society, secondary occupation, extension contact, farm size, access to credit, methods of land acquisition and cropping system. Data on these are presented and discussed in this section.

4.1.1 Age

Table 4.1 shows the percentage distribution of livestock and crop farmers by age in the study area.

Table 4.1 Distribution of livestock and crops farmers by age

Age (years)	**Livestock Farmers**		**Crop farmers**	
	Frequency	**%**	**Freq**	**%**
31 – 40	8	11.10	11	9.20
41 – 50	15	20.80	21	17.50
51 – 60	32	44.40	60	50.00
61 – 70	13	18.10	22	18.30
71-- 80	4	5.60	6	5.00
Total	72	100.00120	100.00	
Mean	53.9years		54.5years	

Source: Field Survey Data, 2013

Table 4.1 shows that the mean age of the livestock farmers was 53.9 years while the mean age of the crop farmers was 54.5 years. Many (44.4%) of the livestock farmers and 50% of the crop farmers were within the age group of 51 – 60 years. Also, 20.8% of the livestock farmers were within the age group of 61 – 70 years. Age group of 71-80 years formed the least percentage of 5.6% and 5% of livestock and crop farmers, respectively. This finding did not support the result of Onubuogu *et al*, (2014) and Esiobu (2014) who stated that younger farmers are likely to adopt new innovation faster than the older ones.

4.1.2 Marital status

The distribution of livestock and crop farmers according to marital status is presented in Table 4.2. Result of analysis indicated that majority (87.5%) of the livestock and crop farmers (85%) were married. This finding implies that livestock and crop were mostly produced by married people who possibly are regarded to be more responsible in their respective communities.

Table 4.2 Distribution of livestock and crop farmers by marital status

Marital status	**Livestock Farmers**		**Crop Farmers**	
	Freq	**%**	**Freq**	**%**
Married	63	87.50	102	85.00
Single	9	12.50	18	15.00
Total	72	100.00	120	100.00

Source: Field survey Data, 2013

4.1.3 Sex

The distribution of livestock and crop farmers by sex as presented in Table 4.3.

Table 4.3 Distribution of livestock and crop farmers by sex

Sex	Livestock Farmers		Crop Farmers	
	Freq	%	Freq	%
Male	**43**	**59.70**	**69**	**57.50**
Female	**29**	**40.30**	**51**	**42.50**
Total	**72**	**100.00120**	**100.00**	

Source: Field survey Data, 2013

Table 4.3 shows that most (59.7%) of the livestock and 57.5% of crop farmers were males, while 40.3% and 42.5% of the livestock and crop farmers, respectively were females. This result implies that livestock and crop production in the study area were practiced by both males and females but the males were more involved than the females.

4.1.4 Household size

Table 4.4 shows the percentage distribution of livestock and crop farmers by household size. Table 4.4 shows that most (56.9%) of the livestock farmers and 62.5% of the crop farmers had household size of 5 – 8 persons, while 25% and 20% of livestock and crops farmers respectively had household size of 9 – 12 persons.

The mean household sizes of livestock and crop farmers were nine persons and eight persons, respectively, which imply that the household sizes of the farmers were relatively large and could provide substantial workforce in the farms. This finding supports the result of Tekle Wold *et al.*,(2006) who reported that large house hold size was a proxy forlabour availability, ensure easy adaptation to climate change and reduced the cost of hired labour.

Table 4.4 Distribution of livestock and crop farmers by household size.

Household size (No. of persons)	Livestock farmers		Crop Farmers	
	Freq	%	Freq	%
1 – 4	3	4.20	10	8.30
5 – 8	41	56.90	75	62.50
9 – 12	18	25.00	24	20.00
13 – 16	10	13.90	11	9.00
Total	72	100.00	120	100.00
Mean	9 persons		8 persons	

Source: Field survey Data, 2013

4.1.5 Level of education

The distribution of livestock and crop farmers according to level of education is presented in Table 4.5.

Table 4.5 Distribution of livestock and crop farmers by level of education

Level of Education (No. of years spent in school)	Livestock farmers		Crop farmers	
	Freq	%	Freq	%
0 (No formal education)	3	4.20	9	7.50
1 – 6	11	15.30	20	16.70
7 – 12	10	13.90	66	55.00
13 – 18	41	56.90	15	12.50
19 --25	7	9.70	10	8.30
Total	72	100.00	120	100.00
Mean	12.5 years		9.3 years	

Source: Field survey Data, 2013

This indicates that most (56.9%) of the livestock farmers spent 13–18 years in formal education, while most (55%) of the crops farmers spent 7–12 years in school. Also, 15.3% of the livestock and 16.7% of crops farmers spent 1–6 years in school. Only 4.2% of the livestock farmers and 7.5% of the crops farmers did not go to school. The mean level of education were 12.5 years and 9.3 years for the livestock and crop farmers, respectively. This result implies that most of the farmers went to secondary school but the livestock farmers were more educated than the crop farmers.

This level of education could help the farmers to benefit from agricultural training especially in the production of poultry and goat, management of resource inputs and adoption of livestock and crop technologies which in turn would result in increased production of livestock and crops in the study area.

4.1.6 Farm Size for livestock (Poultry) farmers

The distribution of poultry farmers according to farm size is presented in Table 4.6. Table 4.6 shows that most (59.7%) of the livestock farmers that kept poultry had farm size of 500–800 birds, while 20.8% of them had farm size of 801–1101 birds. Only 1.4% of the livestock farmers that kept poultry had farm size of 2005–2305 birds in the study area.

The mean farm size was 890 birds. These birds were both broilers and layers. This result implies that most of the livestock farmers that kept poultry were small scale farmers. This could be due to the huge amount of capital required to operate large scale poultry farming which the poultry farmers did not have and which they could not easily raise from financial institutions due to inadequate collateral.

Table 4.6 Distribution of poultry farmers according to farm size

Farm size (No. of birds)	**Frequency**	**Percentage**
500 – 800	43	59.70
801 – 1101	15	20.80
1102 – 1402	41	5.60
1403 – 1703	6	8.30
1704 – 2004	3	2.00
2005 - 2305	1	1.40
Total	72	100.00
Mean	890 Birds	

Source: Field survey Data, 2013

4.1.7 Farm size for livestock (Goat) farmers

The percentage distribution of goat farmers according to farm size is presented in Table 4.7.

Table 4.7 Distribution of goat farmers according to farm size

Farm size (No. of animals)	**Frequency**	**Percentage**
8 – 10	26	65.00
11 – 13	4	10.00
14 – 16	5	12.50
17 – 19	3	7.50
20-- 22	2	5.00
Total	40	100.00
Mean	11 goats	

Source: Field survey Data, 2013

Table 4.7 shows that most (65%) of the livestock farmers that reared goats had farm size of 8–10 goats, while 12.5% had farm size of 14–16 goats. Only 5% of the farmers had 20-22goats in their farms. The mean farm size was 11 goats. The farming system that was used in raising the goat was semi free range system This result implies that the livestock farmers that rear goats are small scale farmers.

4.1.8 Farm size for crop farmers

Table 4.8 shows the distribution of crop farmers according to farm size.

Table 4.8 Distribution of crop farmers according to farm size

Farm Size (Hectare)	**Frequency**	**Percentage**
0.1 - 0.5	56	46.70
0.6 – 1.0	30	25.00
1.1 – 1.5	11	9.20
1.6 – 2.0	6	5.00
2.1 – 2.5	7	5.80
2.6 – 3.0	4	3.30
3.1 – 3.5	6	5.00
Total	120	100
Mean	0.91 hectare	

Source: Field survey Data, 2013

Table 4.8 indicates that a larger proportion (46.7%) of the crop farmers had farm size of not more than 0.5 hectare, while 25% had farm size of 0.6–1.0 hectare. Only 5% had farm size of 3.1-3.5 hectares. The mean farm size was 0.91 hectare, which impliedthat most of the crop farmers were small scale operators. This could be due to the environment the crop farmers find themselves where they battle with land fragmentation, inadequate capital, poor extension education and high input costs among other constraints. This finding did not

agree with those of Deressa *et al.,* (2008) and Onubuogu (2014), who noted that large farm size increased agricultural productivity, improves farmers technical, allocative, resources use efficiency as well as easy adaptation to climate change unlike small farm size

4.1.9 Farming experience

The distribution of livestock and crop farmers according to farming experience is presented in Table 4.9.

Table 4.9 Distribution of livestock and crop farmers by farming experience

Farming Experience (years)	**Livestock Farmers**		**Crop Farmers**	
	Freq	**%**	**Freq**	**%**
1 - 10	27	37.50	4	3.30
11 – 15	25	34.70	36	30.00
16 – 20	13	18.10	41	34.20
21 - 25	7	9.70	39	32.50
Total	72	100	120	100
Mean	11.7 years		17.0 years	

Source: Field survey Data, 2013

Table 4.9 shows that 37.5% and 34.7 of the livestock farmers had farming experience of not more than 10 years and 11–15 years, respectively, while 9.7% of the livestock farmers had farming experience of 21-25 years.

Also, 34.2% 32.5% and 30% of the crop farmers acquired farming experience of 16–20 years, 21 and above years, and 11–15 years respectively. Only 3.3% of the crop farmers had farming experience of not more than 10 years.

The mean farming experience of the livestock and crop farmers were 11.7 years and 17 years, respectively, which implied that the farmers acquired enough farming experience to perform effectively in their farming business. The findings agree with Deressa et al.,(2008) that farmers with high years of farming experience would be more efficient, have better knowledge of farming conditions and climatic situation and are thus, expected to adapt effectively and efficient to climate change in the area.

4.1.10 Cooperative society membership

Table 4.10 shows the distribution of livestock and crop farmers according to cooperative membership. Table 4.10 indicated that majority (88.9%) of livestock farmers and 79.2% of crop farmers belonged to farmers' cooperatives, while 11.1% of livestock farmers and 20.8% of crop farmers did not belong to farmers' cooperatives.

Table 4.10 Distribution of livestock and crop farmers by cooperative membership

Cooperative Membership	**Livestock farmers**		**Crop Farmers**	
	Freq	**%**	**Freq**	**%**
Member	64	88.90	95	79.20
Non-member	8	11.10	25	20.80
Total	72	100.00	120	100.00

Source: Field Survey Data, 2013

This result implies that most of the farmers know the importance and benefits associated with membership of cooperative societies and therefore belonged to farmers'' cooperative societies to enjoy such benefits. The farmers who are yet to belong to farmers' cooperatives were either evaluating the cooperative societies or were part-time operators.

4.1.11 Secondary occupation

The distribution of livestock and crop farmers by secondary occupation is presented in Table 4.11.

Table 4.11 Distribution of livestock and crop farmers according to secondary occupation

Secondary Occupation	**Livestock farmers**		**Crop Farmers**	
	Freq	**%**	**Freq**	**%**
Trading	48	66.70	45	37.50
Civil service	10	13.90	28	23.30
Public service	3	4.20	1	19.20
Artisan	9	12.50	24	20.00
Hunting	2	2.70	7	5.80
Gardening	0	0.00	5	4.20
Total	72	100.00	120	100.00

Source: Field Survey Data, 2013

Table 4.11 indicates that most (66.7%) of livestock farmer and 37.5% of crop farmers had trading as secondary occupation, while 12.5% of livestock farmers and 20% farmers were also artisans. Also, 13.9% of livestock farmers and 23.3% of crop farmers were also civil servants. Other types of secondary occupation which the livestock and crops farmers engage in are as shown in Table 4.11.A secondary occupation is any task or activity that employees perform continually or at a certain point in time in addition to their main employment and which is not part of the private sphere. This finding implies that all the

livestock and crop farmers engage in one type of secondary occupation or the other so as to augment their household incomes.

4.1.12 Extension contact

The distribution of livestock and crop farmers by extension contact is presented in Table 4.12. Table 4.12 shows that most (66.7%) of livestock farmers and 65.8% of crops farmers had no extension visits, while 18% of livestock and 15.8% of crops farmers had 1–2 extension visits per annum. Only 2.8% of livestock and 4.2% of crop farmers had 5-6 extension visits per annum.

The mean extension contacts were 0.85 visit and 0.94 visit for the livestock and crop farmers respectively. This finding implies that the livestock and crop farmers in the study area had poor extension contact, and this could lead to low output of their farm enterprises. This finding agrees with those of Knowler and Bradshaw (2007), who noted that adequate extension contact had a positive relationship with the adoption of agricultural technologies since extension agents transfer modern agricultural technologies to farmers to help them counteract the negative impact of climate change in their area.

Table 4.12 Distribution of livestock and crop farmers by extension contact

Extension contact (No. of visits p.a)	**Livestock farmers**		**Crop Farmers**	
	Freq	**%**	**Freq**	**%**
0 (No extension visit)	48	66.70	79	65.80
1 – 2	13	18.00	19	15.80
3 – 4	9	12.50	17	14.20
5 -6	2	2.80	5	4.20

Total	72	100.00	120 100 .00
Mean	0.85 visit		0.94 visit

Source: Field Survey Data, 2013

4.1.13 Access to credit

This distribution of livestock and crop farmers by access to credit facilities is presented in Table 4.13. Table 4.13 shows that most (52.8%) of livestock farmers and 55.8% of crop farmers did not have access to credit facilities, while 47.2% of livestock farmers and 44.2% of crop farmers had access to credit facilities in the study area. This result implies that a larger proportion of the livestock and crop farmers in the study area had no access to credit facilities and therefore don't have enough fund to adopt innovation to expand or improve their farm business.

Table 4.13 Distribution of livestock and crop farmers by access to credit

Access to credit	**Livestock Farmers**		**Crop Farmers**	
	Freq	**%**	**Freq**	**%**
Access	34	47.20	53	44.20
No-Access	38	52.80	67	55.80
Total	72	100.00	120	100.00

Source: Field Survey Data, 2013

4.1.14 Cropping system

The distribution of crop farmers according to cropping system is presented in Table 4.14. Table 4.14 shows that majority (60.8%) of the crop farmers practiced both mixed cropping and sole cropping, while 27.5% and 11.7% of them practiced only mixed cropping or sole cropping systems, respectively.

This finding implies that most of the crop farmers in Imo state practiced both mixed cropping and sole cropping systems. This will make for production of crops that withstand the stress of climate change especially in mixed cropping systems.

Table 4.14 Distribution of crop farmers by cropping system

Cropping system	**Frequency**	**Percentage**
Mixed crop	33	27.50
Sole crop	14	11.70
Both systems	73	60.80
Total	120	100.00

Source: Field Survey Data, 2013

4.1.15 Methods of land acquisition

The distribution of crop farmers according to methods of land acquisition is presented in Table 4.15. Table 4.15 indicates that majority (72.5%) of the crop farmers acquired farmland through inheritance. Also, 31.7%, 25.8%, 21.7%, 10% and 7.5% of the crop farmers acquired farmland through purchase, rent, exchange, pledge and gift respectively.

This result implies that crop farmers in Imo State acquired farm land through various land acquisition methods available to them in their localities and therefore could be a means of

expanding their farm size if they have access to credit. Moreover it could be a climate change adaptation strategy since they have access to land.

Table 4.15 Distribution of crop farmers according to methods of land acquisition

Methods of land	**Frequency***	**Percentage**
Inheritance	87	72.50
Purchase	38	31.70
Exchange	26	21.70
Rent	31	25.80
Pledge	12	10.00
Gift	9	7.50

Source: Field Survey Data, 2013

4.2 Perceived Forms of climate change

The distribution of livestock and crop farmers by perceived forms of climate change is presented in Table 4.16. Table4.16 shows that most (69.4%) of the livestock farmers reported that their perceived form of climate change was high temperature/heat. This was closely followed by 65.3% of livestock farmers and 73.3% of crop farmers that indicated frequency of rainfall as perceived form of climate change. Also, 58.3% of livestock farmers and 58.3% of crop farmers reported increase in sunshine hours as perceived forms of climate change, while erratic rainfall pattern was the perceived form of climate change reported by 36.1% and 43.3% of livestock farmers and crop farmers respectively. Flooding was perceived by 27.8% of livestock farmers and 30.8% of crop farmers as a form of climate change, while 16.7% of livestock farmers and 23.3% of crop farmers perceived

change in relative humidity as form of climate change. This finding implies that there were various forms of climate change as perceived by livestock and crops farmers in Imo State. Also these farmers perceived climate change in different ways.

Table 4.16 Distribution of livestock and crop farmers by perceived forms of climate change

Perceived forms of Climate change	Livestock farmers		Crop Farmers	
	Freq*	%	Freq*	%
Reduced Frequency of rainfall	47	65.30	88	73.30
Erratic rainfall pattern	26	36.10	52	43.30
Flooding	20	27.80	37	30.80
Increase in sunshine hours	42	58.30	70	58.30
Change in relative humidity	12	16.70	28	23.30
High temperature/heat	50	69.40	107	89.2

*Multiple responses were recorded

Source: Filed Survey Data, 2013

4.3 Perceived Effects of Climate Change on Livestock and Crop Farmers

4.3.1 Perceived effect of climate change on crop farmers

The distribution of crop farmers by perceived effect on climate change is presented in Table 4.17. Table 4.17 indicated that most (74.2%), of the crop farmers perceived the effect of climate change as poor soil fertility, while 61.7%, 45.8% and 42.5% reported poor yield, stunted growth, and poor quality of produce as the perceived effects of climate change in the study area.

Table 4.17 Distribution of crop farmers according to perceived effects of climate change

Perceived effects of Climate change on crop production	Frequency*	Percentage
Stunted growth	55	45.80
Poor yield	74	61.70
Soil erosion	30	25.00
Poor soil fertility	89	74.20
Wilting of plants	23	19.20
Poor quality of produce	51	42.50

*Multiple responses were recorded

Source: Field Survey Data, 2013

Other perceived effects of climate change reported by 25% and 19.2% of crop farmers were soil erosion and wilting of plants respectively. This result implies that the crop farmers perceived the effects of climate change in the study area in various forms.

4.3.2 Perceived effects of climate change on livestock farmers

The distribution of livestock farmers according to perceived effects of climate change is presented in Table 4.18.

Table 4.18 showed that most (73.6%) of the livestock farmers indicated reduced productivity as the perceived effect of climate change on livestock production, while 52.8%, 40.3%, and 31.9% of the livestock farmers reported their perceived effects of

climate change on livestock production as shortage of feed, retarded growth and incidence of pests and diseases respectively.

Other perceived effects of climate change on livestock production reported by 26.4% and 23.6% poor quality product and spread of ectoparasites respectively. This finding implies that climate change affects livestock production in various ways as perceived by the sampled livestock farmers in the study area.

Table 4.18 Distribution of livestock farmers according to perceived effects of climate change

Perceived effects of Climate change on livestock production	Frequency *	Percentage
Shortage of feed	**38**	**52.80**
Reduced productivity	**53**	**73.60**
Incidence of pests and diseases	**23**	**31.90**
Retarded growth	**29**	**40.30**
Poor quality product	**19**	**26.40**
Spread of ectoparasites	**17**	**23.60**

*Multiple responses were record

Source: Field Survey Data, 2013

4.4 Adaptation and Coping Strategies Adopted by Crop and Livestock Farmers

4.4.1 Crops farmers' adaptation measures to climate change

The adaptation methods for this study are based on asking farmers about their perception of climate change and the actions they took to counteract the negative impacts of climate change. The adaptation measures that farmers report may be profit driven, rather than climate change driven. Despite this missing link, we assume that their actions are driven by

climatic factors, as reported by farmers themselves (Maddison, 2006; Nhemachena and Hassan, 2007). From the responses, the researcher delineated six broad categories of crop farmers' adaptation to climate change as presented in Table 4.19:

Diversifying into off-farm business: The option in this category is engaging in off-farm business as reported by 15.8% of the crop farmers.

Use of Fertilizer: Farmers' specific adaptation options listed in this category as indicated by 17.5% of the crops farmers included applying fertilizer and organic manure.

Planting improved crop varieties: Specific category encapsulated in this option is using improved crop varieties that survive in adverse climatic conditions as indicated by 22.5% of the crop farmers.

Changing planting dates: This was reported by 18.3% of crop farmers and covered early planting and late planting options.

Harvesting immature crop: This was indicated by 12.5% of crop farmers and specifically involved harvesting immature crop.

Conservation practices: This was reported by 13.3% of the crop farmers and designed to accommodate the category of farmers who practiced conservation practices such as mulching and planting of cover crops.

Table 4.19 Distribution of crop farmers by adaptation strategies to climate change

Adaptation Strategies by crop farmers	Frequency	Percentage
Diversifying into off-farm business	19	15.8
Use of fertilizer	21	17.5
Planting improved crop varieties	27	22.5
Changing planting dates	22	18.3
Harvesting immature crops	15	12.5
Conservation practices	16	13.3
Total	120	100.0

Source: Field Survey Data, 2013

4.4.2 Livestock farmers' adaptation measures to climate change

The adaptation methods for this study are based on asking farmers about their perception of climate change and the actions they take to counteract the negative impacts of climate change. The adaptation measures that farmers report may be profit driven, rather than climate change driven. Despite this missing link, one can assume that their actions are driven by climatic factors, as reported by farmers themselves (Maddison, 2006; Nhemachena and Hassan, 2007). From the responses, the researcher delineated five broad categories of livestock farmers' adaptation to climate change as presented in Table 4.20.

Diversifying into off-farm business: The option in this category is engaging in off-farm business as indicated by 18.1% of livestock farmers.

Intensive management system: This strategy was reported by 43.1% of livestock farmers, and the farmers' specific adaptation options listed in this category included use of veterinary services, storing feeds, and embarking on brood and sale.

Giving the animals water frequently: This coping strategy was indicated by 18.1% livestock farmers, and the specific category encapsulated in this option was giving the animals water frequently to avoid dehydration.

Selling off the animals: This specifically involved selling off the animals.

Use of acclimated breeds: The option in this category is engaging in the use of acclimated breeds this was reported by only 6.9% of livestock farmers. The term was designed to accommodate the category of farmers who did not use any adaptation method to counteract the negative impact of climate change.

Table 4.20 Distribution of Livestock farmers by adaptation strategies to climate change

Adaptation Strategies by livestock farmers	Frequency	Percent
Diversifying into off-farm business	13	18.1
Intensive management system	31	43.1
Giving the animals water frequently	13	18.1
Selling off the animals	10	13.9
Use of acclimated breeds	5	6.9
Total	72	100.0

Source: Field Survey Data, 2013

4.6 Factors that Influence the Adaptation Measures to Perceived Climate Change by Livestock and Crop Farmers

4.6.1 Factors influencing adaptation measures to perceived climate change by crop farmers

The estimation of the multinomial logit model for this study was undertaken by normalizing one category, which is normally referred to as the "reference or base category", and in this analysis, the last category (no adaptation) was the reference category. The results are presented in Table 4.28. The pseudo R^2 had a value of 0.403 (40.3%) implying that the explanatory variables jointly explained 40.3% of the variation in the probability of uptake of the adaptation options. Low pseudo R^2 value was expected in categorical regression models. The estimated marginal coefficients of the multinomial model, along with their respective Wald Chi Square (X^2) values, are presented in the Table 4.26. The goodness of fit Chi Square (X^2) statistics was highly significant ($P<0.00001$), suggesting that the model had a strong explanatory power. This showed that farmers 'socioeconomic characteristics significantly affected the choice of adaptation to climate change.

Therefore, the null hypothesis was rejected while the alternative hypothesis was accepted. The socioeconomic characteristics that were significant with respect to the adaptation options were:

(i) Diversifying into off-farm business: The significant socioeconomic variables for this adaptation option were gender (x_1), farm size (x_2), farmers' access to credit (x_3), crop mixture (x_5), education level (x_6), household size (x_7), farming experience (x_8), and farm income (x_9).

(ii) Soil fertility and conservation. The socioeconomic variables that were significant in this adaptation option were gender (x_1), farmers' access to credit (x_3), crop mixture (x_5), and education level (x_6).

(iii) Planting improved crop varieties. Farmers' access to credit (x_3), education level (x_6), farming experience (x_8), and farm income (x_9) were the significant socioeconomic variables in this adaption option.

Table 4.26 Multinomial logit marginal estimates of the determinants of crops farmers' adaptation options to climate change

Variable	Diversifying into off-farm business		Soil fertility and conservation		Planting improved crop varieties		Changing planting dates		Harvesting immature crops	
	Coeff.	**Wald**	**Coeff.**	**Wald**	**Coeff.**	**Wald**	**Coeff.**	**Wald**	**Coeff.**	**Wald**
X_1	0.418	2.298*	0.139	2.109*	0.169	0.054	0.613	0.630	-0.345	0.175
X_2	0.447	2.752**	0.333	0.377	-0.522	0.945	0.533	1.122	-0.108	0.036
X_3	-0.309	-2.167*	-0.235	-2.153*	-0.437	-2.359*	-0.727	-3.910**	-0.219	-3.075**
X_4	0.047	0.460	-0.068	0.765	-0.039	0.331	-0.095	1.637	-0.084	1.025
X_5	0.436	3.622**	0.109	3.430**	0.387	0.545	0.655	2.405*	0.118	2.037*
X_6	0.052	3.472**	0.234	7.304**	0.155	4.304**	0.156	3.939**	0.090	2.163*
X_7	-0.117	-2.417*	-0.199	1.218	0.087	0.307	-0.006	0.001	-0.231	2.231*
X_8	-0.083	-3.923**	0.041	0.147	-0.034	-3.147**	0.055	0.307	0.083	0.583
X_9	0.000	3.787**	0.000	0.797	0.000	2.029*	0.000	2.136*	0.000	2.501*
X_{10}	0.188	2.218*	-0.576	1.464	-0.257	0.369	-0.186	0.205	-0.507	1.204
Intercept	-2.832	-0.738	-0.839	-0.061	1.727	0.295	0.757	0.056	4.009	1.270
Pseudo R^2			0.403							
Goodness-of-Fit Chi Square			**57452.2****							

Significant at 5% level,*Significant at the 1% level*Significant at 10 %,

Source: Field Survey Data, 2013

(iv) Changing planting dates. Farmers' access to credit (x_3), crop mixture (x_5), education level (x_6), and farm income (x_9) were the significant socioeconomic variables in this adaptation option.

(v) Harvesting immature crop. The significant socioeconomic factors with respect to this adaptation option were farmers' access to credit (x_3), crop mixture (x_5), education level (x_6), household size (x_7), and farm income (x_9).

4.6.2 Factors that Influence Adaptation measures to perceived climate change by livestock farmers

The estimation of the multinomial logit model for this study was undertaken by normalizing one category, which is normally referred to as the "reference or base category", and the results are presented in Table 4.27. In this analysis, the last category (no adaptation) was the reference category. The pseudo R^2 had a value of 0.274 (27.4%) implying that the explanatory variables jointly explained 27.4% of the variation in the probability of uptake of the adaptation options. Low pseudo R^2 values are expected in categorical regression models. The estimated marginal coefficients of the multinomial model, along with their respective Wald Chi Square (X^2) values, are presented in the table 4.27. The goodness of fit Chi Square (X^2) statistics was highly significant ($P<0.00001$), suggesting that the model had a strong explanatory power. The significance of this statistics showed that livestock farmers 'socioeconomic characteristics significantly affected the choice of adaptation to climate change. Therefore the null hypothesis was rejected and the alternative hypothesis was accepted.

Table 4.27. Multinomial logitmarginal estimates of the determinants of livestock farmers' adaptation options to climate change

Variable	Diversifying into off-farm business		Intensive management system		Giving the animals water frequently		Selling off the animals	
	Coeff.	**Wald**	**Coeff.**	**Wald**	**Coeff.**	**Wald**	**Coeff.**	**Wald**
X_1	0.471	3.859**	-0.250	1.692	-0.258	1.537	-0.114	0.315
X_2	-0.145	-2.227*	-0.073	2.376*	-0.209	2.325*	-0.130	0.911
X_3	0.126	3.808**	0.178	3.844**	0.245	2.959**	0.173	2.386*
X_4	0.041	3.093**	0.057	3.219**	0.144	1.023	0.183	2.505*
X_5	-0.230	0.936	-0.277	1.713	-0.123	0.289	-0.177	2.599**
X_6	0.416	0.636	0.157	0.097	0.322	0.354	0.473	0.760
X_7	0.000	3.078**	0.000	2.126*	0.000	2.656**	0.403	2.057*
Intercept	9.843	2.393	6.422	1.206	6.518	2.176	5.292	0.694
Pseudo R^2		0.274						
Goodness-of-Fit Chi Square			2512.65**					

Significant at 5% level,*Significant at the 1% level*Significant at 10 %,

Source: Field Survey Data, 2013

The significant socioeconomic characteristics with respect to adaptation options were:

(i) Diversifying into off-farm business. Gender (x_1), age (x_2), education level (x_3), farmer's experience (x_4) and farm income (x_7) were the significant socioeconomic variables in this adaptation option.

(ii) Intensive management system. The significant socioeconomic variables in this adaptation option were age (x_2), education level (x_3), farmer's experience (x_4), and farm income (x_7).

(iii) Giving the animals water frequently. Age (x_2), education level (x_3), and farm income (x_7) were the significant socioeconomic variables in this adaptation option.

(iv) Selling of the animals. Education level (x_3), farmer's experience (x_4), household size (x_5), and farm income (x_7), were the significant socioeconomic factors with regard to this adaption option.

4.8 Test of Hypotheses

4.8.1 Test of hypothesis i

This hypothesis states that, crop farmers' socioeconomic characteristics do not significantly affect their uptake of adaption measures to climate change.

This hypothesis was tested using the t-ratios that were produced in the multi nominal logit analysis performed to achieve part of objective6 presented in the Table 4.26. The result of analysis showed that coefficient of gender, crop farmers access to credit (X_3), and crop mixture (X_5) were significant for adaptation measures of soil fertility and conservation, while level of education (X_6) was significant for adaptation measure of soil fertility and conservation, planting improved crop verities, and changing planting dates. Therefore, hypothesis i was rejected with respect to gender (X_1), access to credit (X_3), crop mixture (x_5) and level of education (X_6), and accepted with respect to the other socioeconomic characteristics of crop farmers investigated in this study.

4.8.2 Test of Hypothesis ii

This hypothesis states that, livestock farmers' socioeconomic characteristics do not significantly affect their uptake of adaptation measures to climate change.

This hypothesis was tested using the results of t-ratios that emerged in the multinomial logit analysis performed to achieve objective v and presented in Table 4.27. Gender (X_1), farmers' experience (X_4), and farm income (X_7) were significant at 1% level for adaptation measure of diversifying into off-farm business.

The coefficient of age (X_2) was significant at 5% level while the coefficient of level of education (X_3) was significant at 1% level, for adaptation measure of giving the animals water frequently.

The coefficient of farmers' experience (X_4) was significant at 1% also for adaptation measures of intensive management system, while the coefficient of farm income (X_7) was significant at 5% level for adaptation measure of intensive management system.

Therefore, hypothesis ii was rejected with respect to the significant socioeconomic variables, and accepted as regards the non-significant socioeconomic variables.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

This research work determined perception of climate change and adaptation strategies of selected livestock and crop farmers in Imo State. The specific objectives were to; identify the socioeconomic characteristics of livestock and crop farmers, identify the various forms of climate conditions perceived by them, determine the perceived effects of climatic change, identify strategies adopted by the farmers,and determine the factors that influence the adaptation measures to perceived climate change adopted by the farmers.The hypotheses tested in this study were that; crop farmers'socioeconomic characteristics did not significantly affect their uptake of adaptation to climate change; and livestock farmers' socioeconomic characteristics did not significantly affect their uptake of adaptation measures to climate change.

Sample sizes of 72 livestock and 120 crop farmers were randomly selected from Imo State. Data were collected with structured questionnaire between July and November, 2013. Data were analyzed using descriptive statistics (mean, frequency distribution and percentages), and multinomial logit model.

Results of analysis on achievement of objectives and test of hypotheses showed that mean age of the farmers were 53.9 years and 54.5 years for livestock and crop farmers respectively. Mean household size was nine persons and eight persons for livestock and crop farmers, respectively. Mean level of education was 12.5 years and 9.3 years for

livestock and crop farmers, respectively. Mean farm size was 890 birds for poultry farmers, 11 goats for goat farmers, and 0.91 hectare for crop farmers. Mean farming experience was 11.7 years and 17 years for livestock and crops farmers respectively. Mean extension contact was 0.85 visit and 0.95 visit for livestock and crop farmers respectively.

Most (69.4%) of the livestock farmers and majority (89.2%) of the crop farmers reported that their perceived forms of climate change was high temperature/heat. Most (74.2%) of the crop farmers perceived the effect of climate change as poor soil fertility, while most (73.6%) of the livestock farmers indicated reduced productivity as the perceived effect of climate change on livestock production.

Some (22.5%) of the crop farmers and livestock farmers (43.1%) indicated that their adaptation measures to climate change were planting improved crop varieties and intensive management system, respectively.

Factors that influenced the adaptation measures to perceived climate change by livestock farmers were age, gender, level of education, farmers experience and farm income. Factors that influence the adaptation measures to perceived climate change by selected crop farmers were gender, access to credit, crop mixture, and level of education.

Hypotheses i and ii were rejected with respect to the significant socioeconomic variables and accepted as regards the non-significant socioeconomic variables of the crop and livestock farmers.

5.2 Conclusion

This study analyzed the perception of climate change and adaptation strategies of livestock and crop farmers in Imo State.There were various forms of climate change, as perceived by

livestock and crop farmers in Imo State. Crop and livestock farmers perceived the effects of climate change on their production activities in various forms, such as stunted growth, poor yield, soil erosion, poor soil fertility, wilting of plant and poor quality of produce all for crop farmers, for livestock farmers we have shortage of feed, reduced productivity, incidence of pest and disease, retarded growth, poor quality product and spread of ectoparasites

Diversifying into off-farm business was adopted by most of the crop farmers while intensive management system was preferred by livestock farmers as adaptation measures to perceived climate change.

5.3 Recommendations

Following from the findings of this research work, the following recommendations were made;

(i) The study found that the mean farm size of livestock and crop farmers were small, thereby making them smallholder farmers. This could be because of lack of or inadequate resource inputs like capital, and land. There is need for credit to be made available and easily accessible to the farmer at single digit interest rate to enable them acquire needed production inputs to increase production beyond the smallholder scale;

(ii) extension contact was very poor. This could be due to inadequate extension personnel or poor extension delivery system or mechanism in the study area. There is need for the extension service to increase the number of extension agents in the

field and provide them with needed facilities and motivation to discharge their responsibilities to the livestock and crop farmers;

(iii) climate in the study area was really changing and farmers were doing their best to cushion the effects of climate change. There is need to encourage the farmers to adapt to climate change through enlightenment campaigns which may be organized by the government through the mass media, print media or the churches and other public functions; and

(iv) this study found that various socioeconomic factors affected crop and livestock farmers' adaptation strategies to climate change. These socioeconomic variables should be adequately considered by policy makers and programme planners in making policies and planning programmes aimed at improving livestock and cropfarmer's adaptation strategies to perceived climate change in Imo State.

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FEDERAL UNIVERSITY OF TECHNOLOGY,

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DEPARTMENT OF

AGRICULTURAL ECONOMICS

Dear Respondent,

I am a postgraduate student of the above named institution conducting a study on "Perception of Climate Change and Adaptation Strategies of Selected Livestock and Crop Farmers in Imo State".

Kindly provide the needed information in this questionnaire, and your response is for academic purpose only and will be treated confidentially.

Yours sincerely

Osuala Ogechi Mercy

QUESTIONNAIRE ON: Perception of Climate Change and Adaptation Strategies of Selected Livestock and Crop Farmers in Imo State.

SECTION A: GENERAL INTRODUCTION

1. Name of Agricultural Zone: ----------

2. Name of Local Government Area: ----------

3. Name of Community: ----------

4. Name of Village: ----------

5. Type of Farmer (a) Livestock ☐ (b) Crop ☐

6. If you are a Livestock farmer, provide answers to the following questions:

   (a) What type of poultry do you keep? ----------

   (b) What breeds of sheep do you keep? ----------

   (c) What breeds of goat do you keep? ----------

7. If you are a Crop farmer, please provide answers to the following questions:

   (a) What type of crop do you produce? ----------

   (b) Do you produce in mixed cropping or sole cropping? ----------

8. If you are in mixed cropping, how many crops do you have in the crop mixture?

SECTION B: SOCIO-ECONOMIC CHARACTERISTICS

1. Sex: (a) Male ☐ (b) Female ☐

2. What is your approximate age in years? ----------

3. What is the number of years you spent in school? ----------

4. What is your highest educational qualification? ----------

5. Please indicate your marital status (a) Married ☐ (b) Single ☐

   (c) Separated ☐ (d) Divorced ☐ (e) Widowed ☐

6. How many years have you been in farming? ----------

7. How many people do you have in your household? ----------

8. Are you a member of Farmers Cooperative Society? (a) Yes ☐ (b) No ☐

9. What is your major occupation?

   ----

10. What other income generating activity are you engaged in apart from your major occupation? ----------

11. How many times has extension agent visited you in the last one year?

    ----

12. If you are a livestock farmer, how many of these animals do you have?

    (a) Poultry ----------

    (b) Sheep ----------

    (c) Goat ----------

13. If you are a crop farmer, how many hectares of land do you have? ----------

14. Do you have access to credit facility? (a) Yes ☐ (b) No ☐

15. How did you acquire your farmland? (a) Inheritance ☐ (b) Purchase ☐

(c) Rent ☐ (d) Exchange ☐ (e) Pledge ☐ (f) Gift ☐

16. I you rented farmland, how much did you pay as rent? ----------

17. If you borrowed money for farming, how much did you pay as interest?

SECTION C: VARIABLE INPUT

1. Please provide answers on these variable inputs use

Inputs For Crop Farmers	Quantity Used	Unit Price (₦)	Total Amount (₦)
Cassava Cutting			
Seeds			
Fertilizer			
Agro Chemical			
Manure			
Others (Specify)------			
For Livestock Farmers			
Day Old Chicks			
Sheep			
Goat			
Electricity			
Feed			
Kerosene			
Drugs and Medication			
Water			
Broom			

Others (Specify)

---

2. Please indicate in the table below your expenditure on labour input

Farm Operation	Number of People			Hours Worked Per Day			Wage Rate Per Day			Number of Days Worked		
Clearing	AM	AF	C	AM	AF	C	AM	AF	C	AM	AF	C
Ploughing												
Planting												
Weeding												
Fertilizing												
Harvesting												
Assembling												
Others (Specify)												

Keys: AM = Adult Male, AF = Adult Female, C = Children

SECTION D: FIXED INPUTS

1. Please provide on the table below your expenditure on capital inputs

Capital Inputs	Quantity	Unit Price (₦)	Total Amount (₦)	Number of Years of Useful Life
Cutlass				
Hoes				
Spade				
Basket				
Basin				

Wheelbarrow
Head-pan
Store
Feeding Through
Water Troughs
Rake
Protective Wears
Lantern
Bags
Others (Specify)

2. If you constructed your livestock house, how much did you spend?

   ---

3. How much do you spend on veterinary services per annum ----------

SECTION E: FARM OUTPUT

1. Please provide information on the following output

Farm Output	Quantity	Unit Price (₦)	Total Amount (₦)

Old Layer

Broiler

Cockerel

Goat

Sheep

Manure

Others (Specify)

1. ----------

2. ----------

3. ----------

2. What is the distance from your home to market of purchase of inputs?

---

3. How much did you pay as transport to purchase farm inputs?

---

4. What is the distance from your home to the market of sale of farm output?

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5. How much did you pay as transport to sell your farm output?

SECTION F: PERCEPTION OF CLIMATE CHANGE

1. How do you 'perceive' Climate Change in your locality? (a) High ☐

(b) Moderate ☐ (c) Low ☐

2. What do you perceive as forms of Climate Change in your locality?

(a) Frequency of Rainfall ☐

(b) Erratic Rainfall Pattern ☐

(c) Flooding ☐

(d) Increase in Sunshine Hours ☐

(e) Change in Relative Humidity ☐

(f) High Temperature/Heat ☐

(g) Others (Please Specify)

---

3. What are the perceived effects of Climate Change on your crop production?

(a) Stunted Growth ☐

(b) Poor Yield ☐

(c) Soil Erosion ☐

(d) Poor Oil Fertility ☐

(e) Wilting of Plants ☐

(f) Others (Specify) ----------

4. What are the perceived effects of Climate Change on your livestock production?

(a) Shortage of Feed ☐

(b) Reduced Productivity ☐

(c) Incidence of Pests and Diseases ☐

(d) Retarded Growth ☐

(e) Poor Quality Product ☐

(f) Spread of Ectoparasites ☐

(g) Others (Specify) ----------

SECTION G: ADAPTATION STRATEGIES

1. Please list your Adaptation Strategies on perceived Climate Change

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