EFFECT OF WEATHER VARIABILITY ON ARABLE CROP INSURANCE IN OYO STATE, NIGERIA.

BY

AJIBOYE, BABATUNDE OLUSEYI
B.Tech. (Hons) Agricultural Economic and Extension
AAA011592

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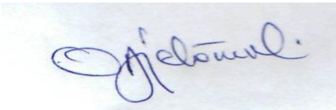
CERTIFICATION

This is project thesis with the title Impact of Climate Change on Crop Insurance in Oyo State Submitted by Ajiboye Babatunde Oluseyi has satisfied the regulation governing the award of degree of Masters of Technology at Ladoke Akintola University of Technology, Ogbomoso



09/04/2014

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Prof. J.O. Ajetomobi Date

Supervisor

……………………. …………………………

Prof. L.O. Olarinde Date

Head of Department

DEDICATION

This research work is dedicated to the Almighty God who has been my shield and exceeding great rewards.

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ABSTRACT

climate change. Agricultural insurance is seen as one of the best strategies to address farm risks and encourage the affected farmers to get back to business and achieve better and quality yields. This study assessed the effect of climate change on crop insurance payout method of the Nigerian Agricultural Insurance Corporation (NAIC). The framework used in this study consists of crop yield models, crop yield variance and the insurance payout estimation methods to be employed to get the affected farmers back to business.

Primary and secondary data were used for this study. Two broad categories of respondents were surveyed to obtain the primary data. A sample of 120 insured and 120 uninsured farmers were randomly selected and interviewed using structured questionnaires. The insured farmers were randomly selected from the insurance policy register of NAIC while the uninsured farmers were selected from the Oyo State Agricultural Development Program (OYSADEP) farmer's register. The secondary data includes climate variables and crop yield data in Oyo State from 1990 to 2010. The data were collected from the Nigerian Meteorological Station (NIMET) and OYSADEP

The results showed that the mean age of the insured and uninsured farmers are 51.5 and 48.2 respectively which is significant at (t = 8.36), education level, year of experience and farm size are significant at (t= 2.19, 6.00 and 3.10 respectively). Changes in climate affects crop yield levels and variability, rainfall and temperature increases are found to increase yield level and variability. On the other hand, rainfall and temperature are individually found to have negative effects on some yield levels and variability. The increase in yield was derived from a significant reduction in rainfall; on the other hand, the decrease in yield was caused by heat stress and the shortening of the growth period induced by the temperature rise. The results also identified that the insured farmers are less productive than the uninsured farmers in term of crop production in the study area. This shows that the insured farmers took an insurance policy as a pre- requisite to obtain credit from the financial

institution which might have been diversified into another thing. An adjusted R^2 indicated the proportion of the variation in output of both insured and uninsured farmers. A value of 93.52% was obtained for the specify function of the insured farmer as compare to 84.38% of the uninsured farmer and 90.66% for the pooled result of the two groups of farmers.

To encourage the uninsured farmers to take an insurance policy to address farm risk and the insured farmers to maximize their insurance cover to improve their productivity, the study therefore simulate a payout method for NAIC to help the farmers address the incidence of yield loss due to climate change incidence and make them more productive and efficient

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1.0 Introduction

1.1 Background to the Study

Mean temperatures in Africa over the last 30 years showed a pronounced upward thread and were above the long term average of the past 100 years. The five warmest years in Africa in the last century all occurs since 1988 and 1995 being the two warmest years (Desanker and Magadza 2001). Since 1968, the average rainfall in West Africa has been decreasing and fluctuating around a notably lower mean (UNEP, 1999). This had led to shortened rainy seasons in many areas thereby aggravating the insufficient water supply available for agricultural production since many West African countries receives less than 500mm of rainfall and thus considered dry lands (UNEP, 2006). In addition, inter-annual rainfall variability is great over most of Africa and for some regions, most notably the Sahel, multi-decadal variability in rainfall has also been substantial.

The rainfall trends of the continent through the 20th century drying up to 2.5% per decade or more in some Western and Eastern parts of the Sahel (Hume et al; 2001). This reduced mean rainfall is expected to persist as a result of climate change. In recent years, the pattern of rainfall has tended towards the extremes, with increasing severity and frequency of drought and floods. Many countries, including Botswana, Burkina Faso, Chad, Ethiopia, Kenya Mauritania Mozambique and Nigeria experiences drought at mean rainfall over the most of the continent. The East African flood of 1988, the Mozambique floods of 2000 and the recent floods in West Africa (Ghana, Benin, Togo and Burkina Faso) in 2007 and recently the devastating floods in Nigeria 2011, which occurs in the Western parts of the country led to loss of much farmland, damage to transport networks, diseases outbreak and loss of human life. The continent already experiences a major deficit in food and animal production in many areas, and potential further declines in soil moistures or inundation of crop lands has been an added burden. One of the ways to address this form of agricultural risk has been the use of agricultural insurance.

The need for a specialized Agricultural insurance company to provide insurance cover to farmers was informed by Government's concern over the vacuum created due to the unwillingness of conventional Insurers to accept Agricultural risks, which they considered too risky. In Nigeria, the implementation of the scheme was thus initially vested in the Nigerian Agricultural Insurance Company limited, which later turned into a Corporation in 1993 by the enabling decree No. 37 of 1993, which was planned by the government to boost agricultural production, but it is constrained by the inability of the average farmer to provide the necessary required rules to purchase an insurance cover.

1.2 Problem statement and research questions

Climate change problem in Nigeria indicate the ways in which climate change has affected crop producing farmers. These include: increased likelihood of crop failure; increase in diseases and mortality of livestock, and/or forced sales of livestock at disadvantageous prices; increased livelihood insecurity, resulting in assets sale, indebtedness, out-migration and dependency on food aid; and downward spiral in human development indicators, such as health and education. Such impacts will further aggravate the stresses already associated with subsistence production, such as isolated location, small farm size, informal land tenure, low levels of technology and narrow employment options.

Most Nigerian Cities are facing major stresses on water availability. Particular stress related to issues of supply scarcity, contamination and salt water infiltration (Enete, 2008; Enete and Ezenwaji, 2011), higher demands, and growing dependency on external supply. The impacts of climate change on health are another area of concern, including air pollution, heat island effects, and spread of disease vectors. The consequences on human settlements due to sea-level rise or coastal and inland flooding are a further concern that could lead to serious disruption in the transportation and infrastructure service (Enete, 2008). Increase in global temperatures, rising energy demands (Enete and Alabi, 2011) and increased heat island effects (Enete and Ijioma, 2011), are identified as other issues of primary concern. It is considered very likely that increasing global temperatures will lead to higher maximum temperatures, more heat waves and fewer cold days over most land areas. Disruption of sensitive ecosystems, loss of biodiversity and food security problems will have been witnessed. Wildfire is dramatically escalating in frequency and extent. Forest could be lost due to frequent and more intense fires (Reid et al., 2007). Other climate change impacts include shifting ranges and seasonal behaviors, changes in growth rates, in the relative abundance of species and in processes like water and nutrient cycling and in the risk of disturbance from fire, insects and invasive species (Johnson and Moghori, 2008).

Adaptation can be both autonomous and planned. Autonomous adaptation is the ongoing implementation of existing knowledge and technology in response to the changes in climate experienced; and planned adaptation is the increase in adaptive capacity by mobilizing institutions and policies to establish or strengthen conditions that are favourable to effective adaptation and investment in new technologies and infrastructure. Autonomous adaptations are highly relevant for smallholder farmers. Mostly located in areas of ecological fragility, they tend to have an extensive knowledge base to draw upon in coping with adverse environmental conditions and shocks. Autonomous adaptation options can be, for example: changing inputs such as crop varieties and/or species and using inputs with increased resistance to heat shock and drought; altering fertilizer rates to maintain grain or fruit quality consistent with the climate; and altering amounts and timing of irrigation and other water management practices; making wider use of technologies to ‘harvest’ water, to conserve soil moisture (e.g. crop residue retention) and to use water more effectively in areas where there is a decrease in rainfall; utilizing water management to prevent water logging, erosion and nutrient leaching in areas where there is an increase in rainfall; altering the timing or location of cropping activities; diversifying income by integrating into farming activities additional activities such as livestock raising; and using seasonal climate forecasting to reduce production risk. However, while many of these measures are effective against a degree of climatic variability, they may become insufficient in the face of accelerating climate change, therefore a longer-term planned approach for adaptation is therefore needed to secure sustainable livelihoods of farmers. It has to incorporate additional information, technologies and investments, infrastructures and institutions and integrate them with the decision-making environment. Insurances, safety nets and cash transfers to reduce vulnerability to shocks are also part of the solution.

Despite the evidence of climate change and the need to adapt to it, there has not been any evidence of change in the payout technique adopted by the Nigerian Agricultural Insurance Corporation; as adaptation need additional financial resources. Unfortunately, financial support for smallholder farmers for implementing adaptation has been too little and too slow in reaching them. Only 500,000 of Nigeria's agricultural producers have access to insurance where only Oyo state has 415,030 farm families (Oysadep 2012). This implies that The Nigerian Agricultural Insurance Corporation has not been able to improve their quality of products, coverage, liberalize insurance market, allow private players to enter and spur competition and restructuring the mode of their payout due to the incidence of climate change and uncertainty.

The research questions that follow the above problem statements are:

1. What are the the socio economic characteristics of insured farmers and uninsured farmers in Oyo state

2. How does climate change and its risk affects food crops production in Oyo state

3. What are the factor(s) affecting farmer's crop insurance decision

4. What are the effect of climate change on payout of agricultural insurance corporation in Oyo State

1.3 Objectives of the Study

The general objective of this study is to evaluate the impact of climate change on crop insurance in Oyo state.

The specific objectives are to;

1. To compare the socio economic characteristics of insured farmers and uninsured farmers in Oyo state

2. To analyze how climate change and its risk affects food crops production in Oyo state
3. To determine the factors affecting farmer's crop insurance decision

4. To estimate the effect of climate change on payout of agricultural insurance corporation in Oyo State

1.4 Hypotheses of the study

Ho_1: There is no significant difference between the socio-economic characteristics of the insured and uninsured farmers in the study area.

Ho_2: There is no structural difference between the production function of the insured and uninsured farmers.

Ho_3: Productivity of the farmers does not have any significant impact on their crop insurance decision.

Ho_4: Climate will not have any significant impact on payout of Agricultural Insurance Corporation in Oyo State.

1.5 Justification of the study

Farmers have a long history of responding to climate variability. Traditional and newly introduced adaptation practices can help farmers to cope with both current climate variability and future climate change. However, the debate about the adaptation of small-scale farmers in Africa to climate change has occurred in the absence of knowledge about existing and potential adaptation practices. Because prevailing ideas about adaptation are vague, conducting focused research on potential adaptation practices and formulating appropriate advice for implementing new practices is difficult, therefore it is pertinent to examine the impact climate change on payout techniques of Agricultural insurance corporation

Even without climate change, there are serious concerns about agriculture in Nigeria because of water supply variability, soil degradation, and recurring drought events. A number of Countries face semi-arid conditions that make agriculture challenging. Further, development efforts have been particularly difficult to sustain. African agriculture has the slowest record of Productivity increase in the world.

Experts are concerned that the agriculture sector in Nigeria will be especially sensitive to future climate change and any increase in climate variability. The current climate is already marginal with respect to precipitation in many parts of Africa. Further warming in these semiarid locations is likely to be devastating to agriculture there. Even in the moist tropics, increased heat is expected to reduce crop yields. Agronomic studies suggest that yields could fall quite dramatically in the absence of costly adaptation measures. The current farming technology is basic, and incomes low, suggesting that farmers will have few options to adapt. Presently, public infrastructure such as roads, long-term weather forecasts, and agricultural research and extension are inadequate to secure appropriate adaptation. Unfortunately, none of the empirical studies of climate impacts in Africa have explored what adaptations would be efficient for either African farmers or African governments. This is a serious deficiency in African impact research, given the importance of efficient adaptation (Mendelsohn 2000).

Although there are well-established concerns about climate change effects in Africa, there is little quantitative information concerning how serious these effects will be. Existing studies cover only a small fraction of Nigeria and few of the African studies include data of actual farmer behavior (adaptation includes responses such as planting dates, harvest dates, use of fertilizer, and crop choice). Hence there is need to examine the impact of climate change in the payout techniques of Nigerian Agricultural Insurance Corporation.In addition, the result of this study will help the government to understand great loss of crop yield as results of climate change variability, and help provide farmers with an effective adaptation measure, and the need to address the payout methods of the Agricultural Insurance policy.

CHAPTER T WO

2.0 REVIEW OF RELATED LITERATURE

2.1 Theoretical Framework

2.1.1 Crop Production and Climate change

Few works have been specific on the effects of climate change on crops production. These are reviewed below:

According to Adeleke and Goh (1980), climate is the average atmospheric conditions of an area over a considerable time. It involves systematic observation, recording and processing of the various elements of climate such as rainfall, temperature, humidity, air pressure, winds, clouds and sunshine before standardization of the climatic means or averages can be arrived at. In a study on crop yield variability as influenced by climate, Chi-Chung *et al*. (2004) submitted that precipitation and temperature are found to have opposite effects on yield levels and variability of corn (maize). Furthermore, they reasoned that more rainfall can cause yield levels to rise, while decreasing yield variance and that temperature has a reverse effect on some crop production. Bancy (2000) study on the influence of climate change on maize production in semi-humid and semi-arid areas of Kenya explained that in order to counter the adverse effects of climate change in maize production, it might be necessary to use early maturing cultivars and practice early planting.

Petit-Maire (1992) predicted more favourable rainfall conditions in the present day Sahel zone. He opined that if the increase in precipitation should be associated with increased rainfall intensity, then a quality and quantity of soil and water resources would decline, for instance through increased run off and erosion, increased land degradation processes and a higher frequency of floods and possibly droughts. Drought is one of the side effects of climate variability. According to Ake *et al*. (2001) it is a creeping phenomenon, characterized by extended period with rainfall below average, prolonged periods of dryness, high temperature and evapotranspiration, very low humidity, and reduced stream flow as well as reservoir water level. Kebbi, Sokoto, Katsina, Kano, Jigawa, Borno, Gombe, Adamawa and Niger are the states prone to drought in Nigeria. Madiyazhagan *et al*. (2004) carried out a study on water and high temperature stress effects on crop production in Australia, they observed that high temperature (greater than 38º C) compounded by water stress occurring at the same time decrease kernel set under dry land environments. Akintola (2011) in a study on the comparative analysis of the distribution of rainy days in different ecological zones observed that the rainy days in the Southern zone show s relatively less variabilities that those in the central (middle belt) and the Northern zones.

Likewise, the distribution in the middle belt shows less variability than those of the Northern zone. He, however, suggested land irrigation as a solution to water inadequacies in the north while flood control measures were advocated for the Southern zone. WMO/UNEP (1996) report, found out that overall global warming is expected to add in one way or other to the difficulties of food production and scarcity. The report also stated that reduced availability of water resources would pose one of the greatest problems to agriculture and food production, especially in the developing countries. Katz and Brown (2002) believed that climate variability is likely to increase under global warming both in absolute and relative terms. Increased intensities of rainfall and increased rainfall totals in mangrove swamp and rain forest zones would increase leaching rates in well drained soils with high infiltration rates and would cause temporary flooding and water saturation hence reduced organic matter decomposition in many soils in level or depressional sites. WM O (1996) report revealed that global rising temperature now estimated to be 0.2º C per decade or 1ºC by 2040 (Mitchell *et al*., 1995) with smallest increase in the tropics (IPCC, 1992) would diminish the yield of some crops, especially if night temperatures are increased. The result posited that higher night temperature might increase dark respiration of plants, diminishing net biomass production. FAO (2005) report stated that climate change may result in shift in the present (agro) ecological zone for over hundreds of kilometers horizontally, and hundreds of metres altitudinally with the hazard that some plants, especially tress and animal species cannot adjust themselves in time. Factors other than climate are known to influence crop yield variability.

Anderson *et al*. (1987) argued that adoption of common high-yielding vanities, uniform planting practices, and common timing of field operations have caused yields of many crops to become more strongly influenced by weather patterns, especially in developing countries. In order to maintain equilibrium between supply of agricultural output and the demand for food by growing population, farmers through the assistance of government will have to adjust and adapt when necessary to the possible changes imposed by changing climate. The ability to adapt to the effects of climate change will vary greatly between countries and regions.

Agriculture is a significant sector of the economy and the source of raw materials used in the processing industries as well as a source of foreign exchange earnings for the country (Mohammed-Lawal and Atte 2006). Since agriculture in Nigeria is mostly rain-fed, it follows therefore that any change in climate is bound to impact its productivity in particular and other socio-economic activities in the country. The impact could, however, be measured in terms of effects on crop growth, availability of soil water, soil erosion, incident of pest and diseases, sea level rises and decrease in soil fertility (Adejuwon 2004). The issue of climate change has become more threatening not only to the sustainable development of socio-economic and agricultural activities of any nation but to the totality of human existence (Adejuwon 2010). As further explained by Adejuwon, the effect of climate change implies that the local climate variability which people have previously experienced and adapted to is changing and this change is observed in a relatively great speed. The threat that climate changes pose to agricultural production does not only cover the area of crop husbandry but also includes livestock and in fact the total agricultural sector. African farmers also depend on livestock for income, food and animal products Nin, Ehui, (Benin 2007).

Climate can affect livestock both directly and indirectly (Adams et al. 1999; Manning and Nobrew 2001). Direct effects of climate variables such as air, temperature, humidity, wind speed and other climate factors influence animal performance such as growth, milk production, wool production and reproduction. Climate can also affect the quantity and quality of feed stuffs such as pasture, forage, and grain and also the severity and distribution of livestock diseases and parasite (Niggol and Mendelsohn 2008). The northeast region of Nigeria is increasingly becoming an arid environment at a very fast rate per year occasioned by fast reduction in the amount of surface water, flora and fauna resources on land (Obioha 2008). Consistent reduction in rainfall leads to a reduction in the natural regeneration rate of land resources (Fasona and Omojola 2005). This makes people to exploit more previously undisturbed lands leading to depletion of the forest cover and increase on sand dunes/Aeolian deposits in the northern axis of Nigeria. Climate change is the most severe problem that world is facing today. It has been suggested that it is a more serious threat than global terrorism (King 2004). The southern area of Nigeria largely known for high rainfall is currently confronted by irregularity in the rainfall and temperature is gradually increasing in the Guinea savannah zone of the country. In addition, the northern zone faces the threat of desert encroachment (FME 2011).

Climate change affects food and water resources that are critical for livelihood in Africa where much of the population especially the poor, rely on local supply system that are sensitive to climate variation. Disruptions of existing food and water systems will have devastating implications for development and livelihood. These are expected to add to the challenges climate change already poses for poverty eradication (De Wit and Stankiewicz 2006). According to Obioha (2009), the sustainability of the environment to provide all life support systems and the materials for fulfilling all developmental aspirations of man and animal is dependent on the suitability of the climate which is undergoing constant changes. The effect of these changes is posing threat to food security in Nigeria.

2.1.2 Climate change and Insurance

The idea of an "insurance-related" scheme to help countries adapt to climate change was first introduced by the Alliance of Small Island States (AOSIS) in 1991. The AOSIS proposal sought to establish a fund with mandatory contributions from industrialized countries to indemnify small-island and low-lying developing nations for losses resulting from sea level rise (Mechler 2005). Although the AOSIS proposal was not strictly an insurance scheme, it motivated formulation of Article 4.8 of the Convention and a number of ensuing proposals for "insurance related" schemes. Whereas the AOSIS insurance proposal addressed the slow onset of sea-level rise, subsequent proposals have turned to sudden-onset weather events and suggest tying assistance to loss reduction measures undertaken in potentially affected countries.

The German watch proposal for an "insurance-related mechanism" (German watch, 2005) builds strongly on AOSIS ideas, but proposes cover for sudden-onset risks, including floods, droughts and windstorms, for public infrastructure. Like the AOSIS proposal, the fund would be capitalized through payments from developed countries. To be eligible for post-disaster indemnity, LDC governments would be required to take specified measures for preventing disaster losses. These “in-kind premiums” would be determined by assessing the country’s risk profile, and claims on the fund would be determined by an index or actual losses. The insurance would be limited to low-probability, high-consequence events. These proposals for global insurance systems rank high on many elements of fairness and efficiency. The German watch proposal satisfies Article 4.8 of the United Nations Framework Convention on Climate Change (UNFCCC) stated criterion of “common but differentiated responsibilities” by targeting governments in need and only “kicking in” when losses exceed what the government can, itself, finance. Moreover, moral hazard is reduced through incentives and direct requirements for risk reduction. There are, however, problems with implementing the schemes. In both the AOSIS and German watch proposals, payouts depend on a loss threshold, which means losses must be measured. This will involve high transaction costs, especially in the less developed countries, where there are no local insurance companies with the expertise to assess claims and help manage risks. In the case of the German watch proposal, a problem arises in determining what kinds of mitigation measures will serve as the entry fee into the scheme. Both proposals raise an important issue concerning the geographical scope of an insurance pool. It should be kept in mind that the number of participants in a global pool could be prohibitively large, even if the pool only covers public infrastructure risks. Perhaps more importantly, it is necessary to build confidence on the part of stakeholders at the local or national levels by working closely together in the initial phases. This does not mean that local or national pools cannot be combined into regional and global structures, but the risks must first be consistently dealt with within the contributory "domains."

Researchers at the International Institute for Applied Systems Analysis (IIASA) also proposed a two-tiered climate change insurance-related mechanism that could meet the intent of Article 4.8. (Linnerooth-Bayer, et al. (2003) and Mechler (2005). The first tier is a global relief fund to cover losses that are either uninsurable or for which cover is unaffordable in poor countries. This tier would be covered by contributions from developed countries, much like that envisaged by AOSIS and German watch, except the fund would be entirely discretionary. Based on the post-disaster needs of developing countries, it would provide discretionary assistance for relief and reconstruction; however, eligibility for post-disaster assistance could be tied to prescribed, stakeholder-led processes for credible efforts at reducing and managing disaster risks. The second tier provides support for insurance initiatives taken by developing countries or regions, themselves. Precedents already exist for donor-supported insurance mechanisms. The World Food Program, for example, is planning to support weather derivatives in Ethiopia (provided by private insurers) to help farmers hedge against drought risks, and the World Bank provides low-interest capital backup to the (public-private)Turkish Catastrophe Insurance Pool (TCIP) to make it affordable to property owners. Such initiatives can be on a local level (e.g. Ethiopian weather derivatives), national level (the TCIP) and regional level (e.g., a regional pool has been proposed for the Caribbean states). Moreover, the pools could be combined through reinsurance or financial derivatives to diversify and spread risks globally. The second tier of the IIASA proposal takes the form of a global insurance facility, which would support these kinds of initiatives by providing capital backups in the form of reinsurance, by subsidizing premiums or by providing technical assistance. The insurance pools could cover only climate-related risks or, alternatively, all hazards. The latter would provide more diversification and thus lower requirements for capital backup. However, the private sector is more reluctant to insure geo-hazards because of added difficulties in risk assessment.

In combination, the two tiers of the IIASA scheme promote many criteria of fairness, efficiency and practicality. The first tier might be considered fair insofar as it assigns financial responsibility for a portion of developing country disaster losses to the developed world. The second tier can potentially promote efficient insurance systems (although any form of subsidies distorts market prices). Finally, the recent initiatives and experience with donor-supported insurance systems demonstrate that the scheme is practical in terms of its implementation.

2.1.3 How would an insurance scheme be funded and what are the benefits?

The United Nations Framework Convention on Climate Change (UNFCCC) pined that Insurance-related mechanisms in developed countries are financed mainly through policy holder premiums. In some insurance systems policy holders pay risk-based premiums, but many include government subsidies or cross-subsidies within the system, such as the National Flood Insurance Program in the United States or the French all-hazards system that is backed by the public sector. Most policy holders face deductible structures that, in theory, should encourage them to reduce risks for the insured assets. In practice, this link is weak due to the high costs associated with monitoring risk reduction efforts. Often there is moral hazard, which is the relaxation of risk reduction efforts after purchasing financial protection. The benefits of creating a fund to support insurance strategies in developing countries are numerous. By subsidizing or providing capital backup for risk transfer programs, developing country governments will rely less on debt financing and international donations, and assured funds for repairing critical infrastructure will attract foreign investment. Donor support will also provide poor households, businesspersons and farmers with access to affordable means to spread risks spatially and temporally, which will secure their livelihoods and improve their creditworthiness and most importantly, by making this assistance contingent on requirements or incentives for prevention and appropriate adaptation measures, pre-disaster assistance can ultimately reduce the human and economic toll disasters take on the poor.

2.1.4 The Nigerian Agricultural Insurance Cooperation

Nigerian Agricultural Insurance Corporation was established in 1987 to provide risk cover to Nigerian farmers. Nigerian Agricultural Insurance Corporation (NAIC) is sole legally mandated supplier of agricultural insurance.

The vision is to remain the pioneer and leader in the country's Agro-investment risk management and the preferred choice for general insurance and the mission is to be at the centre stage of the country's efforts towards a planned and sustained growth in Agriculture aimed at self sufficiency in food and fiber products, optimum foreign exchange earnings and mass gainful employment, by providing insurance cover to farmers who invest their resources in Agriculture against some perils, in a well harmonized manner that will encourage investments in Agriculture, since any loss arising from the insured perils will be indemnified, in a timely and professional manner that will put the farmer back to business.

Prior to the establishment of NAIC, Nigerian farmers suffered various losses on their investment and had no means of going back to production. The frustration made them to move into cities in droves in search of easy means of livelihood. This situation led to depletion of farming populace, which was a serious threat to food security. The Federal Government was disturbed by the ugly trend, hence the establishment of NAIC to address the need of farmers.

The need for a specialized Agricultural Insurance Company to provide insurance cover to farmers was informed by Government's concern over the vacuum created due to the unwillingness of conventional Insurers to accept Agricultural risks, which they considered too risky. This led to the establishment of the Nigerian Agricultural Insurance Scheme on 15th of November, 1987.The implementation of the Scheme was initially vested in the Nigerian Agricultural Insurance Company Limited, which was later incorporated in June, 1988 but later turned into a Corporation in 1993 by the enabling Act 37 of 1993. Nigerian Agricultural Insurance Corporation is therefore a wholly-owned Federal Government of Nigeria insurance company set up specifically to provide Agricultural risks insurance cover to Nigerian farmers.

Risks in Agricultural undertakings are more widely spread and far-reaching than in most other enterprises. This is because they go beyond all the well-known and researched entrepreneurial hazards and uncertainties of the modern business world. Such hazards include the vagaries of nature, inclement weather conditions, pests and diseases along with flood and fire outbreaks. All of these impact very seriously on the success or failure of any agricultural enterprise. Therefore, any nation with a clear vision for boosting its agricultural production so as to meet the food needs of its populace and industries must of necessity put in place mechanisms that would reduce these risks and uncertainties to a bearable minimum.

The need, therefore, for a mechanism that functions specially to keep the farmers in business cannot be over-emphasized, hence the necessity for an agricultural insurance scheme in Nigeria. The broad objective of the Nigerian Agricultural Insurance Scheme (NAIC) is to protect the Nigerian farmer from the effects of natural hazards by introducing measures which shall ensure a prompt payment of appropriate indemnity (compensation) sufficient to keep the farmer in business after suffering a loss.

The Scheme is specially designed to:

- Promote agricultural production since it would enhance greater confidence in adopting new and improved farming practices and at the same time bring about greater investments in the agricultural sector of the Nigerian economy, thereby increasing the total agricultural production;
- Provide financial support to farmers in the event of losses arising from natural disasters;
- Increase the flow of agricultural credit from lending institutions to the farmers;
- Minimize or eliminate the need for emergency assistance provided by Government during period of agricultural disasters

The Nigerian Agricultural Insurance scheme aims at:

(i) Provision of premium subsidy of up to 50% chargeable on selected crop and livestock insurance policies. The perils under cover under the crop sector are fire, lightning, windstorm, flood, droughts, pests and diseases. For livestock the perils covered are death or injury caused by accidents, disease, fire lightning, storm and flood.

(ii) General Insurance coverage of equipments, assets and other properties which form part of the total farm investments at competitive commercial rates

(iii) Re-insurance services

(iv) Provision of extension services to insured farmers and insured projects

(v) Payment of indemnity to insured farmers/clients after having suffered an insured loss

(vi) Encouraging institutional lenders to lend more to agriculture through provision of added security to agricultural lending of commercial banks.

The risks covered are

(a) In the case of crops, damage or loss caused by fire, or lightning, or windstorm, or flood, or drought, or pests, or invasion of farm by wild animal; and

(b) In the case of livestock, death or injury caused by accident, or disease, or fire, or lightning, or storm, or flood. A person insured under the Scheme must satisfy the conditions relating to good husbandry as may be laid down, from time to time, by the Corporation.

The rate of insurance premium payable under the Scheme by farmers shall be such percentage of the sum assured as the Corporation may, from time to time, determine having regard to the pure risk premium, reserve premium and administrative loading.

The Corporation shall subsidize the premium payable under subsection (1) of this section at such rate not exceeding 50 per cent as it may, from time to time, determine.

This subsidy on premium referred to in subsection (2) of the law shall - Be paid to the Corporation by the Federal Government and the respective State Governments in the proportion of 37.5 per cent and 12.5 per cent respectively; and for a particular year, be paid within the first quarter of the following year and where a State Government defaults in its payment to the Corporation, the Federal Government shall cause the amount to be deducted from funds due to the defaulting State and remitted direct to the Corporation.

(a) in the case of crops, on approved input cost up to the time the loss occurred but if some crops were salvaged then, less the value of the crops actually harvested;

(b) in the case of livestock, on a valuation table to be prepared by the Corporation for each class of stock; and

(c) In the case of crops, livestock and other agricultural items specified, from time to time, by the corporation, on agreed value of the crops, livestock or item.

A farmer shall not qualify for indemnity under this Decree unless

(a) the insurance cover was obtained before the damage or loss occurred;

(b) he has a valid insurance cover at the time of damage or loss;

(c) he followed laid down practice for crop and livestock production;

(d) the cause of damage or loss was one of the risks covered by the insurance policy;

(e) the notification of the damage or loss was made within the stipulated time; and

(f) He has satisfied such other conditions as the Corporation may, from time to time, specify.

The Corporation shall bear losses up to 200 per cent of its premium income in each class of insurance covered under section 7 of this Decree and the Federal Government shall pay for all losses above 200 per cent of the premium income.

Participating Farms

A farmer may take out an insurance cover under the Scheme but where the farmer is also a beneficiary of an agricultural loan or credit from the Government, a bank or other financial institution (in this Decree referred to as "lending institution") he shall take out an Insurance cover under the Scheme.

Remittance of premiums by Lending Institutions etc.

(1) A lending Institution shall subject to the provisions of this Decree and other Directives that may be given by the Board deduct the Insurance premium due from the loan or credit at source and remit same to the Corporation not later than 30 days from the date of disbursement of part or the whole of the loan or credit

(2) A lending which fails to comply with the provisions of subsection (1) of this section shall pay the premium which is due from and payable by the farmer under that subsection and the amount of the premium so unpaid shall

(a) Notwithstanding any other enactment, be a first charge on the property of the lending institution; and

(b) be a debt due to the Corporation and the Corporation may sue for and recover from the lending institution the amount in any court of competent jurisdiction.

(3) In an action brought under subsection (2)(b) of this section, the production by the Corporation of a certificate signed by the Managing Director setting out the name of the defendant and the amount of the premium due shall be sufficient evidence of the amount so due and sufficient authority for the court to give judgment for the said amount

2.2 Review of the present methods of Agricultural insurance policy

One common risk management technique to address agricultural loss is traditional indemnity insurance. Agricultural risks are often addressed by agricultural insurance (such as crop and livestock insurance), flood insurance, and property and casualty insurance for natural disasters such as hurricanes and earthquakes. In developed countries, especially Western countries, agricultural insurance is commonly available. Farmers in economically developed countries such as the United States, often manage such risks through crop insurance, which is which is substantially subsidized (by as much as 60 percent in the U.S.) by their governments (Dismuskes et al., 2004). However, according to a USAID report on the potential for developing a weather indexed product in developing countries, this is especially true for small farmers, whose income, farm size, and remote location make traditional crop insurance products unworkable.

However, traditional agricultural insurance, like crop insurance is not readily available in many developing countries for the following reasons: Traditional agricultural insurance often requires government support, because correlated risks create the potential for large financial losses that private industry is unwilling to accept. This government support is often lacking in developing countries. Without government support the cost of insurance is likely unfeasible for small farmers (USAID, 2006). The cost of the insurance can be economically unfeasible for insurers because of the smaller farm lots and lower limits of liability (and subsequent lower premiums). The loss adjustment costs related to proving a loss can easily be larger than the premium for the risks. Moreover, it is costly to control moral hazard and adverse selection, especially for small-scale firms. For all reasons, and others, another risk management technique, index insurance, holds promise especially for agricultural risks in developing countries A Normalized Difference Vegetation Index (NDVI) constructed from data from satellite images which indicate the level of vegetation available for livestock to consume in northern Kenya. When values (which typically range from 0, 1 to 0.7) fall below a certain threshold, the insurance is triggered. A farmer in Peru purchases and area-based yield insurance and receives a payment, if the area (such as a county or district) yield falls below an established trigger yield. Individual livestock herders in Mongolia purchase policies from private insurance companies that pay out when local area mortality rates for livestock exceed specified "trigger" percentages up to a maximum exhaustion point

These examples illustrate different ways in which index insurance can be designed with varying triggers for initiating payouts. The Fundamentals of Index Insurance

The main difference between index insurance and traditional agriculture insurance is that loss estimates for the former is based on an index or a parametric trigger for the loss rather than the individual loss of each policyholder as is the case with the latter (Skees et al., 2007). Examples of index insurance used in agriculture include: A Malawi index-based crop insurance which measures the amount of rain recorded at local meteorological stations. The insurance pays off farmers loans in whole or in part in case of severe drought. Payouts are automatically made to the bank if the index hits the specified contract threshold at the end of the contract.

(a) **Using Index Insurance**

Index insurance may not be an appropriate tool in some circumstances where there is great variance between the index and individual losses. This would be the case in crop loss where the losses of an individual farmer may vary dramatically from the indemnity payout based on the index insurance trigger. This potential mismatch is called *basis risk*. Basis risk occurs when realized losses do not correlate well with the index (KFW report, 2007).

There are three types of basis risk: spatial basis risk (difference in outcomes between the physical places where a loss event occurs and where the index is measured), temporal basis risk (due to the timing of the loss event, the consequences of lack of rainfall may be worse), loss specific basis risk (losses are poorly related to the index). Careful consideration of contract design and better data may help mitigate the incidence of basis risk.

(b) Agricultural insurance products

Agricultural insurance products can be classified into three main groups based on the method of determining how claims are calculated.

Type of Agricultural, Insurance Product and Payouts Availability

I) Indemnity Based Agricultural Insurance *(insurance payouts based on the actual loss at the insured unit level)*

1. Named Peril Percentage of Damage Widespread

2. Multiple Peril Yield Loss Widespread

II) Index based Agricultural Insurance *(insurance payouts based on an index measurement)*

3. Area-Yield Index Area-yield

4. Crop Weather Index Insurance Weather Index payout scale

5. Livestock Mortality Index Insurance payout scale.

6. Forestry Fire Index Insurance (Ignition focus/ burnt area payout scale)

III) Crop Revenue Insurance *(insurance payouts based on yield measurement and crop prices)*

6. Crop Revenue Insurance (CRI) Yield and Price Loss Limited to USA

Source: World Bank, 2009

(c) Indemnity based agricultural insurance products

Indemnity based insurance products determine claim payment based on the actual loss incurred by the policy holder. If an insured event occurs, an assessment of the loss and a determination of the indemnity are made at the level of the insured party. The classification is often divided into two subclasses—*named peril* and *multiple peril* agricultural insurance. *Named peril agricultural insurance products (Damage-based products)* Named peril (damage based), as the name suggests, provides indemnity against those adverse events that are explicitly listed in the policy. This subclass has a number of distinctive features:

• The sum insured is agreed at the inception of the contract and may be based on production costs, or on the expected crop revenue;

• The loss is determined as a percentage of the damage incurred by the insured party as established by a loss adjuster as soon after the damage occurs;

• The indemnity is calculated as the product of the percentage of the damage and the sum insured;

• Deductibles and franchises are normally applied to reduce the incidence of false claims and to encourage improvements in risk management.

Named peril is a popular type of insurance and accounts for a significant portion of the agricultural premiums worldwide. From the perspective of the insured parties, it appeals where firms are located in areas frequently subjected to one of the perils covered; from the insurer's point of view it is suitable to situations where the damages caused by the named perils are both measurable and have sudden impact (Vedenov and Barnett, 2004).

Named peril agricultural insurance products account for a considerable proportion of agricultural insurance worldwide. Named peril insurance contracts are used extensively to protect against hail damage and are used in horticulture and floriculture in addition to crops and fruit but are also used in livestock, bloodstock aquaculture, forestry and greenhouses insurance (world bank 2009).

(d) Multiple peril agricultural insurance products (yield-based products)

Multiple perils (yield based) (MPCI) provides insurance against all perils that affect production unless specific perils have been explicitly excluded in the contract of insurance.

Under this type of insurance, the sum insured is defined in terms of the expected yield to the producer. Cover is normally set in the range of 50 percent to 70 percent of the expected yield. In turn, the expected yield is determined on the basis of the actual production history of the producer or the area in which the producer operates. The sum insured can be based on the future market price of the guaranteed yield if the producer has an insurable interest or alternatively, if the producer has taken a loan to finance the crop, the sum insured may be based on the amount of the loan if the financier has an insurable interest in the crop (Brown, R.A 2009).

The calculation of the payout is based on the extent to which the actual yield falls short of the guaranteed yield at the agreed price or as the shortfall in yield as a percentage of the guaranteed yield applied to the sum insured. An example of an indemnity calculation is provided in this subclass of insurance offers comprehensive cover to the producers but comes at significantly higher cost compared with named peril insurance. Rates for MPCI insurance contracts offered to individual producers range between 5 percent and 20 percent of the sum insured, depending on the crop, the region where the crop is located and the level of coverage. The premium reflects not only the additional cover but the costs of minimizing the chances of adverse selection and moral hazard through risk inspections, enforcing sales deadlines and overall monitoring of the insured. The cost generally makes this form of cover unattractive to marginal or small producers (Brown, R.A,1999)

(e) Named peril crop insurance

The traditional named peril crop insurance product is hail insurance. Insurance companies offer hail insurance for crops and fruits as well as for horticulture and floriculture production. Hail insurance can be offered on a standalone basis or in combination with other perils like fire, freeze, and/or wind as additional risks. The main feature of this type of crop insurance is that the insurance claim is calculated by measuring the percentage of damage in the field soon after the damage occurs. The percentage damage measured in the field, less a deductible expressed as a percentage, is applied to the pre-agreed sum insured. Under this type of insurance, the sum insured is defined on an agreed basis, based on the production costs or on the expected crop revenue. Where damage cannot be measured accurately immediately after the loss, the assessment may be deferred until later in the crop season. The quantity of the deductibles and franchises depends on how vulnerable the crop is to hail damage and the prevalence of hail within the growing area. Insurance on annual crops, considered to be of moderate risk, is offered at rates of between 3% and 5% of the sum insured subject to a non-deductible franchise of 6%. If the crop or the growing areas are considered to be high risk, the premium can be as high as 10% with deductibles of 20% (Downton. 2003).

(f) Multiple peril crop insurance (MPCI)

Coverage under MPCI is expressed in terms of a guaranteed yield which is between 50% and 70% of expected yield having regard to the nature of the crop and the region in which it is being grown. Payout under the policy is initiated where the yield of the producer falls short of the guaranteed yield in the policy. If the producer has an insurable interest, the payout will be the shortfall in yield at a value that is agreed in the policy. If the producer has financed the crop externally and the financier has an insurable interest, the payout accrues to the financier and will be the product of the short fall in the yield and the amount of the loan that was granted. Premium for this type of insurance ranges between 5% and 20% of the sum insured (depending on the type of the crop), the region in which it will be grown and the level of coverage being sought (Eakin, H. 2005).

(g) Crop revenue insurance

In guaranteeing the policy holder a certain level of revenue, the insurer protects the holder from declines in yield and also adverse movements in crop prices. The guaranteed yield is determined as a percentage of the producer's past production, and the guaranteed price can be either the future market price for the crop for the month of harvest or the strike price of a base price option. If the actual yield received by the producer, which is given by the product of the actual yield and the spot market price at the time of harvest, is less than the guaranteed amount, the insurer will pay the difference (Kinsey, 2007)

(h) Area yield index insurance

The insurance contract defines an area referred to as the "insured unit" .The insurer constructs an index based on a guaranteed yield for the insured unit, normally in the range of 50% to 90% of the expected yield. The insurer pays out if the actual yield of the insured crop in the insured unit falls below the guaranteed yield, irrespective of the actual yield of the particular policyholder. The payout is determined as the product of the shortfall in production in the insured unit and the sum insured. Payment is normally made six months after the crop is harvested (Hanks, J., and J. T. Ritchie, 1991)

(i) Weather index insurance products

The product is designed around the construction of an index that is highly correlated with loss experiences. The most common index in agriculture is rainfall. Typically, an insurer will offer a contract that will specify the index (for example, rainfall), over what period and where it will be measured, the threshold, the sum insured and any indemnity limits. If the rainfall is less than the index at the specified measurement point and over the period specified in the contract, the insurer will payout under the contract irrespective of the actual losses of the policyholder. The quantity of the payout is determined according to the provisions of the contract. A simple payout may be the total sum insured under the contract. More commonly, contracts are written sothat the proportion of the sum insured that is paid out is determined by how far the actual production observed in the insured unit deviates from the index (Osgood et al, 2009)

This product can be used at the micro, or macro levels. At the micro level, a producer will insure his/her production based on the measurement of rainfall at a weather station close to his/her farm. Theme so level insurance may attract a financier who has provided crop finance to producers in a certain geographic area and wishes to mitigate his/her credit risk against the possibility of drought in the area. At the macro level, a country wishing to lessen the possibility of famine through the failure of a staple crop as a consequence of drought may be attracted to this insurance, where the index is based on the country and the weather observations are made at stations throughout the country (Osgood et al, 2009)

(j) Livestock insurance

Livestock insurance provides insurance products to cover horses, mares, colts, fillies and foals; bulls, cows and heifers; swine; sheep, goats and dogs and occasionally wild animals. It is a relatively small segment of the market accounting for 4% of the total agricultural insurance premium written worldwide in 2008. The protection offered under livestock products includes against losses arising from death, injury and loss of function as a result of accidents, natural causes, fire, lightning, acts of God and acts of individuals other than the owner. Cover is extended to forced slaughter of livestock on humanitarian grounds. Additional coverage can generally be purchased for veterinary expenses, transport and non-epidemic diseases.

The sum insured is based on the market value of the animal and can be reduced based on the animal's age. Premium rates range from 1.5 percent to 10 percent of the sum insured based on the type of animal, its age, location and the functions it performs. Deductibles range from no deductible to ten percent (Fraser, E.D.G, 2007)

Traditionally, epizootic diseases have been a standard exclusion under livestock policies although some companies have begun to offer cover on a very selective basis. Epizootic insurance coverage is offered to the governments of countries that can demonstrate superior sanitary conditions and effective controls to prevent particular diseases entering the country. Where it is offered, the insurance covers business interruption and the costs to government of slaughtering animals to curtail outbreaks of the relevant diseases.

Livestock mortality index insurance is a relatively new form of livestock insurance that was introduced into Mongolia. It has potential in countries where livestock production is exposed to catastrophic losses (Wehrhahn, R. 2009).

(k) Bloodstock insurance

Bloodstock insurance provides cover for high value animals, mainly equines. It is also a minor business line accounting for 3 percent of the agricultural premium written worldwide in 2008. Animals are either insured on an individual basis or collectively such as where a stable of horses is insured. The insured events include mortality, disability, infertility, medical treatment and surgery. The sum insured is based on the market value of the animal. The market value is determined by the prizes that the animal has won or the present value of the future prizes that it potentially will win. Any matter that adversely affects the animal's capacity to win prizes will affect its market value and can result in over insurance. To deal with the potential moral hazard, it is common practice amongst bloodstock insurers to insure high-value animals for only a portion of their market value.

Premium rates vary in the range of 0.5 to 10 percent. Claims are normally subject to a deductible of 10 percent. Aquaculture insurance provides cover for producers involved in breeding and raising aquatic fauna and growing aquatic flora. In addition to flatfish, aquaculture encompasses molluscs, crustaceans and commercial seaweed cultivation. Although it is a small segment of the market with 1 percent of written premiums for the worldwide agricultural insurance market in 2008, it is expected to develop rapidly as aquaculture becomes more important in the face of dwindling natural fish supplies.

Cover is offered on a named peril or all risks basis. Cover is for loss of stock. Covered perils include meteorological events, acts of God, diseases, pollution, predator attacks, collision, oxygen depletion, changes in pH and salinity, theft and escape. Both offshore cage systems and inshore pond cultures are covered (Mills E, 1996).

The sum insured is defined by the value of the stocks insured and it is customary to set a maximum aggregate limit per site. Premium rates range between 3 percent and 10 percent of the sum insured and deductibles range between 15 percent and 30 percent each and every loss, both depending on the species, location and the conditions in which the stocks are kept.

Aquaculture insurance is a very specialized field with complex insurance contracts reflecting the complexities of the production processes. Underwriting which involves risk assessment and frequently underwater inspections requires specific expertise, as does loss assessment, which is frequently outsourced to firms that specialize in the activity (Fraser, E.D.G, 2007)

(l) Forestry insurance

Forestry insurance is also a small segment of the overall agricultural insurance market accounting for about 1 percent of the premiums written worldwide in 2008. It protects standing timber stocks against fire, lightning, explosion and aircraft impact. Coverage can be extended to damage caused by wind, windstorms, volcanic eruption, flood, hail, freezing and the weight of ice and snow. Fire fighting expenses and debris removal are also covered and are capped at an annual aggregate limit.

The sum insured is determined on a tiered basis with young plantations valued at establishment cost, medium aged plantations at the lower of establishment cost or commercial value and mature plantations at commercial value. Losses are frequently capped at an annual aggregate limit to avoid large exposures in high risk areas (Loster .T, 2003)

Premium rates range from 0.2 percent to 1 percent of the total sum insured, depending on the species, location and measures in place to prevent or suppress fires. Deductibles are common with a standard deductible of 10 percent of the loss subject to a minimum of between 0.3 percent and 1 percent of the sum insured. The terms and conditions of forestry insurance contracts are comprehensive and complex. This reflects the nature of the risk being underwritten and the possible risk of moral hazard.

(m) Greenhouse insurance

Greenhouse insurance contributed 1% to the total written premium in agricultural insurance in 2008. Greenhouse production is a very capital-intensive activity and relies heavily on the serviceability of the infrastructure that the producer has put in place. In insuring the infrastructure, insurers typically provide comprehensive cover for material damage to structures, glass, equipment, stock and other contents. Infrastructure is insured against damage from storm (including hailstorm), water, fire, smoke, lightning, explosion, malicious acts, aircraft impact and earthquake. Cover may also be extended to business interruption, machinery breakdown, and electronic equipment. The sum insured is determined on either an agreed value or production cost basis. Indemnities are calculated as a percentage of damage to both the structures and the contents. A deductible of 10% of the loss subject to a minimum of 1% of the sum insured is usually applied. Rates for greenhouse insurance vary from 0.3% to 0.7% of the total sum insured depending on the construction of the greenhouse (World Bank. 2009 Insurance for the Poor Program; Public Intervention for Agricultural Insurance)

2.2.1 Agricultural Reinsurance

An earlier section noted the complexities of agricultural insurance that arise from the characteristics of the risks covered; the asymmetries of information and potential moral hazard. The section noted that these complexities have promoted the development of specialized underwriters and loss adjusters who have the skills and expertise to practice in this market. The design of suitable agricultural reinsurance programs is subject to the same complexities and requires skill and expertise. Only a selected group of not more than twenty reinsurance companies worldwide are currently providing reinsurance capacity for agricultural risks.

The public sector plays a role in agricultural reinsurance through public private partnerships. Governments play a part where the private sector cannot offer reinsurance at affordable rates. The private sector has proven more cost effective than the public sector in providing reinsurance for other than catastrophe cover, while the government, through the establishment and administration of catastrophe funds, can offer catastrophe cover effectively (Mills E, 1996).

The role of reinsurers in agricultural reinsurance is not limited to providing reinsurance capacity for insurance companies. The agricultural insurance industry requires services that go beyond the provision of financial capacity. Reinsurers that are involved in agricultural reinsurance assist insurance companies in providing advisory services in risk assessment, risk modeling, pricing, and risk structuring; as well as in the design of loss adjustment and operational manuals, risk rating and risk accumulation control software, and the wording of insurance contracts.

Several forms of reinsurance cession are used by the insurance industry to cede agricultural risks. Quota share reinsurance cessions and stop loss reinsurance protections are the most common forms. For aquaculture and forestry reinsurance it is also common to find surplus share cessions and catastrophic excess of loss protections in use. (Swiss Re. 2005. Reinsurance Matters: A manual of the non-life branches. Swiss Reinsurance Company, Zurich)

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2.2.2 Meteorological indices

To minimize the basis risk, the chosen meteorological index has to be a good predictor of yields, and especially of bad yields. While products insure against cold temperatures or frost (South Africa), others against excess water during harvest (India, Nicaragua, Rwanda and Tanzania) or against floods (Indonesia and pilots in Vietnam and Thailand), but most of them insure against a lack of rain (Hazell *et al*. 2010).

2.2.3 Basic rainfall indices

The cumulative rainfall during the growing season (which, in the tropics, typically corresponds to the rainy season) is the simplest quantifier of water availability. However, the impact of a lack of rain depends on its importance and the crop growth phase. Hence, in practice, the growing season is split in several sub-periods and an indemnity is paid whenever a lack of rain occurs in one of these sub-periods, or only in the sub-periods considered the most important for plant growth. It was the case in Malawi and India The amount of rainfall that triggers the payouts (the "strike") as well as the amount of indemnity differ across the sub-periods and are based on agro-meteorological knowledge (Hazell *et al*. (2010)

Moreover, very light daily rains (typically < 1 mm/day) and daily rains exceeding a given cap (60 mm/day in most of the World Bank insurance schemes) are generally not taken into account in the cumulated rainfall. Indeed, very light daily rains generally evaporate before being used by the plant, while rains exceeding a given cap run off and cannot be used either.

Such simple indices were applied in India and during the first Malawian experiment. They were also used in the Ethiopian scheme where payments were triggered by a low cumulative rainfall from March to October, compared to the 30-year average. Crop specific indices were calculated by weighting 10-days periods cumulative rainfalls according to their relative impact on yields.

The Available Water Resource Index (AWRI; Byun *et al.*, 2002), based on effective precipitations of the previous days, is a slight improvement on the cumulative rainfall. In short, available water is estimated by simulating reduction of soil water stocks due to runoff, evapo-transpiration and infiltration. Reduction is represented as a weighted sum of previous rains on a defined period (often 10 days) with time-decreasing factors.

Both indices are better predictors of yields if they are determined using the actual sowing date (or a sowing window) to trigger the beginning of the growth cycle. Imposing an arbitrary sowing date or window in the insurance policy increases the basis risk hence reduces the benefit of the IBMI.

However, inquiring after actual sowing date would be very costly. Hence, in practice, especially in India and Malawi, the sowing date used to determine the crop growth phases is imposed by the insurer (a fixed period in Malawi and triggered by the occurrence of a precise cumulative rainfall level in India).

2.2.4 Water stress indices

Water stress indices are based on the idea that crop yields are proportional to the satisfaction of crop needs for water resource. The WRSI (Water Requirement Satisfaction Index) is the reference water stress index. It is defined as the ratio of actual evapotranspiration to maximum evapotranspiration corresponds to an estimation of the quantity of water actually evaporated while evapotranspiration corresponds to the quantity of water that would evaporate if the water requirements of the plant were fully satisfied. This index was developed by the FAO and used in different IBMI schemes in India and in Malawi. Since crop sensibility to water stress depends on its growth phase, most of the insurance contracts consider those phases and take in account different references values of WRSI as triggers, depending on the phase considered. For groundnut and maize, contract parameters are defined on three growing phases. For tobacco, the growing period was divided in 17 blocks of two weeks. Rainfall level of each block is compared to the crop requirement for this particular growth stage and included in the weighted sum in order to compute the index corresponding for the whole period (Mills E, 2009).

2.2.5 Drought indices

Those indices use temperatures and rainfall to determine air and/or soil dryness. The Selyaninov drought index, also called Selyaninov Hydrothermal Ratio, and the PED index only captures the air dryness. Both have been used by Breustedt *et al*. (2004) in an ex-ante

IBMI scheme study designed for Kazakhstan. Their calculus has the convenience of only requiring rainfall and temperatures data. The Palmer Drought Severity Index (PDSI: Palmer, 1965) was used for the study of an insurance scheme in Morocco (Skees, 2001). It requires temperature, latitude, water retention capacity of soils and precipitations data, usually on a ten day basis

2.3 Mechanistic crop models

Mechanistic dynamic models simulate crop physiological growth depending on available environmental factors. Their precision in yield estimation is greater in theory, but they need very detailed input data. Such data are rarely available for large areas especially in developing Countries. The DSSAT model is used by Osgood *et al*. (2007) in East Africa and Diaz Nieto *et al*. (2006) in Nicaragua. It is however difficult to use such complex models (Osgood *et al*., 2007) because of a high sensitivity to parameter calibration. Nevertheless they can be used to assess the shortcomings of other methods. They also allow yield simulation under higher levels of inputs than those actually used by the farmers, which is useful since IBMIs may create an incentive to increase the level of inputs that cannot be observed ex-ante

2.3.1 Index choice criteria

Minimizing the basis risk, particularly cases in which farmers endure losses without receiving an indemnity (which we will referred to hereafter as the type II error basis risk), is the main criterion to compare those indices. The correlation between yields and index values is the simplest way to deal with such a choice. In order to improve the attractiveness for farmers it is fundamental to evaluate the correlation between yields and index values for low yields, i.e. for situations in which an indemnity should be paid. In many situations there is not enough historical data about observed yields of the farmers, the only way to assess the interest of an index is thus using simulated yields data by a crop model (Kapphan, 2011).

However, complexity limits the transparency and acceptability of IBMIs and data availability is also often limited, especially in developing countries. Thus there is a trade-off between index transparency, readability for farmers, data availability and simplicity on the one hand, and the index ability to reflect low yields (or minimize the type II error basis risk) on the other hand. If the insurance target is the farmer, simplicity is important, but if the target is a financial institution willing to insure its agricultural portfolio exposed to weather shocks, the product can be more complex.

2.3.2 Insurance policy design

The typical indemnity schedule can be defined by three parameters (Vedenov and Barnett, 2004). The threshold level of the meteorological index, called the strike (S), triggers payouts for insured farmers. A slope related parameter (λ with $0 < \lambda < 1$) determines the exit, i.e. the index level: $\lambda.S$, from which payouts are capped to a maximum (M). The contract shape is based on the fact that crop growth depends positively on the weather index (e.g. water availability), from a maximum stress meaning zero yield to a point where water is no longer a limiting factor of crop growth.

2.4 Usual shapes policies

In many IBMI experiments, the indemnity schedule is more complex partial payouts are calculated for each crop growth phase, and the total indemnity is the total of these partial payouts. This is the case in Malawi (Osgood *et al*., 2007) and Senegal (Mahul *et al*., 2009) and many schemes in India. A maximum insurance payout is defined for each growth phase and the sum of insurance payouts can also be capped for the whole growing period

2.4.1 Optimization of policy parameters

Due to the complexity of the relation between yields and water availability, in most cases, the indemnity schedule and the parameters are set without a formal mathematical optimization process. They are based on expert knowledge, simulations and sensibility analysis. Typically, strike is set according to agronomists' views of under what level rainfall starts to be a limiting factor for crop yield, and the maximum payment may be set at the value of inputs (fertilizers, seeds, pesticides…) or at the value of the crop in a normal year. For instance, the strike is set according to an agronomic relation linking yields and water availability (Vedenov and Barnett, 2004). In certain cases, some of the parameters are explicitly optimized. The objective function differs among authors. Some maximize an expected utility function featuring risk aversion, more precisely a Constant Relative Risk Aversion (CRRA) function (Berg *et al*., 2009). Others minimize the semi-variance of income after insurance (Vedenov and Barnett, 2004). Income after insurance is the value of observed yield plus the indemnity minus the premium, and the semi-variance is the squared difference of yields inferior to the long-run average yield, relative to this average. Finally, Osgood *et al*. (2007) minimize the square of the difference between payouts and expected losses, the latter being defined as yields under the first quartile of simulated yield distribution.

2.4.2 Computing the expected value and distribution of the indemnity

The insurance premium depends on the expected value of the indemnity and on a measure of the probability distribution of payouts. There are two methods to determine these values; Historical Burn Analysis (HBA) and Historical Distribution Analysis (HDA) also called index modeling. HBA is the simplest method. Index realizations, for instance the cumulative rainfall or the length of the rainy season in days, are calculated from meteorological historical data (possibly cleaned and detrended and converted into payouts. HBA gives a first indication of the mean and range of possible payouts of a weather contract, from which parameters such as the expected value and the standard deviation of the payouts can be calculated. Moreover, HBA does not require an assumption on distribution function parameters, in contrast to HAD, the disadvantage of HBA is that it provides a limited view of possible index outcomes: it may not capture the possible extremes, and it may be overly influenced by individual years and measurement errors in the historical dataset (World Bank, 2005).

HDA consists in fitting a statistical distribution function to the index historical values and converting values from this distribution to payouts. This distribution and the contract parameters have to be assumed. The expected payout and the measures of the risk such as standard deviation and VaR99 can be calculated either by Monte- Carlo simulations from the distribution or, in the case of simple distributions and indemnity schedules, analytically (World Bank, 2005). Even if not present in the historical series, rare events are handled in a better way with this method. Moreover outliers and measurement errors have less impact on results than with HBA.

The only formal comparison of the accuracy of the two methods seems to be a working paper by Jewson (2004) who concludes that HDA is significantly better than HBA when there is little uncertainty on the statistical distribution assumed in the HDA method

2.5 Empirical Literature on Nigeria Climate Change

A review of current literature on climate change impacts in Nigeria shows that very little work has been carried out at the country level. Studies that directly or indirectly address climate change issues in Nigeria include those by Awosike (1992), Awosika et al. (1992); French et al. (1990). Others are Ibe and Quelennac (1989); Nicholas et al. (1993); and Ojo (1988, 1998). Consequently, understanding of the significant issues of the environment and particularly the problems related to global warming and climate change in Nigeria is severely limited. Nevertheless, many climate impacts on the Nigeria environment are known well enough (at least qualitatively) to facilitate the identification of areas particularly at risk from climate change impacts (Nwafor, 2006).

Nigeria's average temperature has risen by 1.7 degrees in the period 1901-2005 (Adefolalu, 1999). The increase has been higher in the semi- arid regions and lower in the coastal zone.

Adefolalu's paper also demonstrates that the rate of change has increased since 1970's. The consequence for the Nigeria people is a geographical pincer threat from desertification in the north and coastal erosion in the south. Through a combination of overgrazing, abuse of woodland for fuel and increasingly unreliable rainfall, the Sahara is advancing at an estimated rate of 600 meters per annum and over 55 million people in 10 northern states could be affected (NEST, 1991).

Similarly, rising sea levels threaten Nigeria's coastal regions. The Niger Delta may be the source of oil wealth but its low-lying terrain problem, crossed with waterways makes it extremely vulnerable to flooding and salinisation. The protective mangroves of this coastline have been largely lost to human intervention. Half of the 15 million population of the 15 million population of the city of Lagos lives less than six feet above sea level (One world Guides, 2008). The wealthiest areas of Victoria Island are in the front line, alongside the Mushroom slum settlements. In the rural economy, almost all small farms presume stable rainfall patterns in their choice of seeds and planting times and are therefore, at risk of the vagaries of climate change in addition to more familiar social and economic pressures. Another factor that is encouraging climate change in Nigeria is deforestation. According to the 2010 MDG progress report, Nigeria's forest cover has dropped from 18.9% to 9.9% in two decades since 1990, one of the highest rates of deforestation in the world (One World Guides, 2008). The main cause is the demand for wood fuel. In the absence of affordable alternative energy sources, charcoal is popular even the cities, boosting its uncontrolled production. Clearance for agriculture, roads and other development are further implacable drivers of deforestation. Current laws to protect forests are weak and poorly enforced.

Major industries in the country's coastal zone include three refineries, two petrochemical plants, liquefied natural gas plants (LNG), a fertilizer plant, a major steel and gas and fuel oil fired electricity generating plants around which numerous other economic activities revolve. Above all, there is the on-shore and rapidly expanding offshore petroleum and gas operations which have seen the entire delta crisscrossed by oil and gas pipelines and riddled with wells (World Bank, 1996). The sector accounts for 96 percent of the country's external earnings. For Nigeria, climate change will have a severe impact on its coastal system which is already under stress.

2.6 Climate Change Adaptation Attempts In Nigeria

According to climate funds update database, Nigeria has not yet received any adaptation funding from external bilateral or multilateral sources. This may in part be attributable to the country's slow- moving institutional response to climate change (One World Guide, 2010).

The focal point for coordination of government policies is intended to be a National Climate Change Commission. At community level, adaptation strategies are largely consistent with existing responses to poverty and hunger. The fight to halt desertification involves tree planting, the use of alternative fuels such as biogas, and the adaption of more versatile livestock. In more conventional farming regions, smallholders are encouraged to diversify their crops and adopt more efficient rainwater harvesting and irrigation techniques. The coastal regions approach adaptation through management of existing resources. Building and environmental regulations are enforced but poorly due to corruption inherent in the country.

The challenges posed by adaption to climate change are increasingly being recognized. Such challenges are usually framed in terms of 'resilient' buildings designed to recover quickly from the impact of flooding through ensuring that essential services (power, water and sanitation) experience minimal disruption (such as by placing power sockets above likely flooding levels; building passive low-energy building or smart buildings (Roaf et al., 2005; Adaptive Building Initiative, 2009). However, these options may be too expensive for a developing country like Nigeria that is already under economic stress. Another design option suitable for Nigeria cities particularly those with exceptionally high temperature is the use of local bricks (mud) in building construction. This design option has been corroborated by the works of (Bianco, 2002; Alagbe, 2011).

Shaw et al. (2007) outlined some adaptation strategies that could be a guide for building sustainable cities in the face of a changing climate. These design options are less expensive, requires no special skill, nor high technology which may not be available in the country, thus can easily be utilized in Nigeria cities.

CHAPTER THREE

3.0 METHODOLOGY

3.1 The Study Area

Oyo state is located in the south-west geopolitical zone of Nigeria. It is one of the three states carved out of the former western states of Nigeria in 1976. Oyo state consists of thirty three (33) local government areas. The states cover a total of 27,249 square kilometer of land mass and it is bounded in the south by Ogun state and partly by the Republic of Benin while in the east by Osun state. The land scape consist of old hard rocks and dome shaped hills, which rise gently from about 500 meters in the southern part and reaching a height of about 1,219 meter above sea-level in the Northern part.

The topography of the state is gentle rolling low land in the south, rising to a plateau of about 40 meters. The state is well drained with rivers flowing from the upland in the North-south direction. Oyo state has an equatorial climate with dry and wet seasons and relatively high humidity. The dry season last from November to March while wet season starts from April and ends in October. Average daily temperature ranges between $25°C$ $(77.0°F)$ and $35.0°C$ $(95.0°F)$ almost throughout the year. The vegetation pattern of Oyo state is that of rain forest in the south and guinea savannah in the North. Thick forest gives way to grassland interspersed with trees in the North. There are a number of government farm settlements in Ipapo, Ilora, Sepeteri, Ogbomoso, Iresaadu, Ijaiye, Akufo and Lalupon.

Oyo state is one of the seriously affected state like Kogi, Niger and Anambra state in the year 2011 by the variability in climatic conditions (especially irregular weather conditions) with excessive rainfall which led to flooding as well as wind storm in the year that led to loss of human life, properties, crops, livestock etc which has not been given adequate attention (Tribune

;August 10 2011). Agricultural activities follow the traditional system of mixed cropping. This condition made the state to be agrarian suited for the production of permanent crops. Farmers are predominant small scale that still depends on traditional method of farming. Besides farming, the inhabitants also engage in other occupations like trading, manufacturing and commerce. The climate in the area favours the cultivation of crops like maize, yam, cassava, millet, rice, plantain, cacao tree, cowpea, mango, palm tree, cashew and so on.

3.2 Population and Sampling procedure

To achieve the broad objectives of the study, two broad categories of respondents were surveyed to obtain the data required for the analysis. A sample of 120 insured and 120 uninsured farmers were randomly selected and interviewed using structured questionnaires. While the insured farmers were randomly selected from the insurance policy register, the uninsured farmers were selected from the OYSADEP farmer's register.

3.3 Sources of Data

Both primary and secondary data are used for this study. The primary data include socio-economic characteristics of both insured and uninsured farmers' their production and insurance information. This information was obtained through interview schedule and administration of a structured questionnaire. The secondary data cover Climate related data such as rainfall and temperature as well as state-level data on food crop production in Oyo state from 1990- 2010. Data on climate variables were be obtained from Nigerian Meteorological Station while food production data were be obtained from Oyo State Agricultural Development Programme (OYSADEP). The table below shows the descriptive statistics of secondary data

	Unit	Mean	St .Dev	Min	Max
Cassava yield	Tons/ ha	9.69	1.22	7.03	11.87
Cowpea yield	Tons / ha	0.69	0.17	0.28	0.99
Cocoyam yield	Tons /ha	3.85	1.46	0.42	5.70

Maize yield	Ton/ha	1.54	0.41	0.61	2.76
Melon yield	Ton/ha	0.59	0.29	0.23	1.41
Okro yield	Tons /ha	1.37	0.49	0.5	2.45
Sorghum yield	Tons /ha	1.05	0.28	0.68	1.89
Pepper yield	Ton /ha	1.71	0.57	0.1	2.31
Tomato yield	Tons /ha	2.55	0.83	0.97	4.68
Yam yield	Tons /ha	13.24	2.57	9.37	18.89
Vegetable yield	Tons /ha	1.62	0.69	0.54	3.49
Trend		11	6.20	1	21
Temperature	^{0}C	31.75	0.47	30.9	33.3
Rainfall	mm	114.5	37.3	75.4	221.1

3.4 Model Specification

The Just-Pope production function was estimated from panel data relating yield to exogenous variables. This procedure estimates the impacts of the exogenous variables on yield levels and the variance of yield. Following Just and Pope (1979) and Saha et.al this study estimate production functions of the form:

$$Y = f(X,\beta) + h(X,\alpha)\varepsilon$$

Where Y is crop yield (cowpea, sorghum, cassava, maize, cocoyam, okro, pepper, cassava, vegetable, melon and yam), *f(≅)* is an average production function, and X is a set of independent explanatory variables (climate, location, and time period). The functional form h(≅) for the error term u_i, is an explicit form for heteroskedastic errors, allowing estimation of variance effects. Estimates of the parameters of f(≅) give the average effect of the independent variables on yield, while h(≅) gives the effect of each independent variable on the variance of yield. The interpretation of the signs on the parameters of h(≅) are straightforward. If the marginal effect on yield variance of any independent variable is positive, then increases in that variable increase the standard deviation of yield, while a negative sign implies increases in that variable reduces yield variance.

the basic model is thus specified as:

$$y_{it} = \exp(\alpha_0 + \sum_{k=1}^{k} \alpha_k x_{kit}) + \varepsilon_{it}\sqrt{\beta_0 + \sum_{m=1}^{m} \beta_m x_{mit}}$$

Where y_{it} is the crop output in region i at time t; x_{kit} is the input quantity of factor k in region i at time t, and $\alpha_j, j = 0,1........k$,, are the parameters to be estimated. x_{mit} denotes a factor which can influence the risk level and β_m is the corresponding coefficient. ε in turn is a stochastic disturbance term following the standard normal distribution. Thus, we find that the expected output (often also referred to as mean output) and the variance of output are determined by separate functions, which can algebraically be denoted as

$E(y_{it}) = \exp(\alpha_0 + \sum_{k=1}^{k} \alpha_k x_{kit})$ and $V(y_{it}) = \beta_0 + \sum_{m=1}^{m} \beta_m x_{mit}$ respectively.

Given the assumption that production risk in this framework takes the form of heteroskedasticity in the production function, the second term on the right-hand side of equation (2) can be interpreted as a heteroskedastic error term for the purpose of estimation.

Another important stage of the analysis is the calculation of the costs or benefits of climate change because of its relevance to policy making. From equation 3 the shadow prices of climate variables can be computed as follows:

$$wc = \frac{\partial E(y)}{\partial c} p_y$$

$$= \alpha_c \frac{p_y * E(y)}{c}$$

Where wc, is the shadow price of climate variable c (e.g. annual average temperatures), $E(y)$ is the expected output and p_y is the output price. α_c in represents the estimated output elasticity with respect to the climate factor c, is obtained from the mean production function of the Just-Pope procedure. This equation thus quantifies the economic impacts of a marginal change in climate.

The model was estimated for each of the major staple crops in Oyo state Nigeria. As the production function is specified in a log-linear way, the coefficient estimates for on this stage will be elasticities of output with respect to the respective input factors. Usually, production risks in terms of heteroskedasticity error structure are present in most parts of agricultural production (Just and Pope, 1979).

3.4.1 Model for insurance payout estimation

A simple insurance scheme (Ray 1967; Hazell et al. 1986; Abbaspour 1994) was used to simulate the insurance payout in the state. The insurance payout in the *i*th state in *j*th year, is as follows:

$$Payout_{i,j} = \nabla Y_{i,j} \times Area_{i,j} \times P\_crop$$

Payout *i*, *j*, is given by the functions of the insured yield loss, $\nabla Y_{i,j}$ insured acreage of crop $Area_{i,j}$ and price of crop, P crop

3.4.2 Descriptive statistics

This method of analysis was used to compare the socio economic characteristics of insured farmers and uninsured farmers. It include: mean, median, mode frequency, charts, figures, etc

3.4.3 Model of production practices by insured and uninsured farmers

To assess the operation of Nigerian Agricultural Insurance corporation this study use econometric analysis as a basis to compare production practices between insured and uninsured farmers in the study area. Production functions project a physical relationship between inputs or factors of production and the resulting farm output represented as the dependent variable. A typical production function can be implicitly represented as ***Q = f(X)*** where Q is the homogeneous output representing the endogenous variable and X, then-dimensional vector of homogeneous inputs represented as explanatory variables. For this study different functional forms were tested on the cross-sectional data collected, but the **Cobb-Douglas** function was chosen as the basis of result presentation because it enjoys a wider application in this type of study and because of the added information implied by its parameter estimates. It has been emphasized that linear and quadratic functions which were commonly used as alternatives are better suited to the analysis of experimental data than to the analysis of cross-sectional data

The statistical estimates obtained were used to compare production performance between the identified groups of respondents. The function is thus used to examine production performance and resource productivity between insured and uninsured farmers.

The Cobb-Douglas function can be implicitly presented as:

$$Q = AX^{b}X^{(1-b)}$$

Where **A** is a positive constant term and *b* a positive fraction. **Q** and **X** are the variables, the relationship between which are examined by the equation. However, in order to specify the equation, the above implicit equation must be explicitly expressed by taking the log transformation of both sides as shown below;

$$\ln Q = \beta_0 + \beta_1 \ln X1 + \beta_2 \ln X2 + ...\beta_9 \ln X9 + \mu$$

where the respective variables in the equation are represented as follows:

Q is the dependent variable is the value of the farm output; value of planting seeds, ***X1*** and capital borrowed or used (***X2***), fertilizer ***(X3)*** and farm size ***(X4)*** and value of labour employed on the farm ***(X5)***. Other variables include expenditure on agro-chemicals such as herbicides and pesticides ***(X6)***, expenditure on value added ***(X7)***, value of farm assets ***(X8)*** and ***(X9)***, a dummy variable used to represent the holding of an insurance policy. β_0**,** β_1 **…** β_9**,** are the parameters (coefficients) to be estimated, that respectively measured the relationship between the inputs and output in the production process, for the ninth inputs. μ is the error term which is assumed to be normally distributed with mean zero and constant variance. ***ln*** is the natural logarithm of the respective variables included in the equation. The essence of the log transformation is in recognition of the existence of error in the included variables, by the transformation the error is made to be nearly and normally distributed without any pattern in its relationship

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Socio-Economic Characteristics of both insured and uninsured farmers in Oyo State

This section discusses the socio-economic characteristics of the respondents.

4.1.1 Distribution of Respondents by Age

The age distribution of the respondents is presented in Table 1. It is observed from the table that majority of the insured and uninsured farmers are between 45-54 years in the study area respectively. This is the most productive age range of the farmers. The mean age of both insured and uninsured are 51 and 48 years respectively, this is because most of the youth have their attention from farming to other source of livelihood. The t value of 8.36 indicates that age is a determining factor through which farmer's insurance decision is made.

Table 1: Age Distribution of Respondents

	Insured		**Uninsured**	
Age	**Frequency**	**%**	**Frequency**	**%**
25-34	14	11.6	3	2.5
35-44	27	22.5	20	16.7
45-54	41	34.1	44	36.7
55-64	36	30.4	42	34.6
$\geq$65	2	1.4	11	9.5
Total	**120**	**100**	**120**	**100**

Mean	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**
51.5	**8.71**	**32**	**66**	**48.2**	**10.0**	**24**	**63**

t= 8.36* (sig at 1%)

Source: Computed From Field Survey Data, 2012.

4.1.2 Distribution of Respondents by Level of Education

Table 2 shows the distribution of the educational level of the respondents. The level of education attained by a farmer is known to influence the decision of farmer to take an insurance cover, better adaptation strategies including efficient use of climate information. The study showed that majority of the insured (36.7 %) and uninsured (61.7 %) farmers had about 6years of formal education respectively in the study area. The finding implies that literacy level is moderately high among the insured and uninsured farmers as expected in the study areas and this (t= 2.19) indicates that level of education of farmers as a great influence in their choice of insurance

Table 2: Educational Level Distribution of Respondents

	Insured		**Uninsured**	
Educational Level	**Frequency**	**%**	**Frequency**	**%**
Non-formal/adult	21	17.5	11	9.2
Primary	44	36.67	74	61.7
Secondary	32	26.67	30	25.00
ND/NCE	22	18.33	5	4.1
HND/B.Sc	1	0.83	-	-
Total	**120**	**100.0**	**120**	**100.0**

Mean	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**
1.5	**1.01**	**0**	**4**	**1.24**	**0.67**	**0**	**3**

t= 2.19 (sig at 5%)**

Source: Computed From Field Survey Data, 2012

4.1.3 Distribution of the Respondents according to their Farming Experience

It is expected that the number of years farmers spent in their farm operations, the more experienced they should have become. Table 3 shows the distribution of farming experience of respondents. It could be seen in table 4.4 that majority of the insured (67.1%) and uninsured (70.25%) crop farmers had experience of more than 10 years in the study area. In crop insurance unit, the rest 32.9% of them had less than 10 years of farm experience while the rest 29.74% of the uninsured crop farmers also had less than 10years of farming experience. The results show that the insured and uninsured crop farmers are well experienced in crop production in the study areas. This also have a very strong significant influence on their decision.

Table 3: Distribution of Respondents According to their Years of Farming Experience

	Insured		Uninsured	
Years	**Frequency**	**%**	**Frequency**	**%**
≤5	14	13.7	17	14.04
5-10	24	19.2	19	15.7
>10	82	67.1	84	70.25
Total	**120**	**100.0**	**120**	**100.0**

Mean	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**
24.5	**9.00**	**8**	**45**	**22.1**	**10.17**	**5**	**40**

t=6.00* (sig at 1%)

Source: Computed From Field Survey Data, 2012.

4.1.4 Distribution of the Respondents by Sex

Table 4 shows the distribution of the male and female crop insurance farmers according to their sex in the study area.

Table 4: Sex Distribution of Respondents According To ADP Zone

	Male		Female	
Zone	**Frequency**	**%**	**Frequency**	**%**
Ibadan/Ibarapa	24	20	21	17.5
Oyo	21`	17.5	25	20.8
Ogbomoso	20	16.7	18	15
Saki	55	45.8	56	46.7
Total	**120**	**100**	**120**	**100**

Mean	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**
1.275	**0.448**	**1**	**2**	**1.25**	**0.435**	**1**	**2**

t= 0.298 (not sig)

Source: Computed From Field Survey Data, 2012.

4.1.5 Distribution of Respondents by Marital Status

Table 5 presents the distribution of respondents by marital status. It is shown in the table that majority of the respondents were married. About 76.7 % of the insured and 78.3% uninsured crop farmers were married in the study area. These results have implications on crop production in the study area. Married men and women are likely to be relatively stable and focused in carrying on their farming activities and the likelihood that they will have more people in the household who contribute to labour input, hence, availability of more family labour.

Table 6: Distribution of Respondents by Marital Status

	Insured		**Uninsured**	
Marital Status	**Frequency**	**%**	**Frequency**	**%**
Single	8	6.7	2	1.7
Married	92	76.7	94	78.3
Widowed	11	9.1	13	10.8
Divorced	9	7.5	11	9.2
Total	**120**	**100.0**	**120**	**100.0**

Mean	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**
1.23	**0.74**	**0**	**6**	**1.42**	**0.97**	**0**	**4**

t= 1.41 (not sig)

Source: Computed From Field Survey Data, 2012.

4.1.6 Distribution of Respondents by Household size

The family members represent those being fed, clothed and housed by a farmer. This can be an important indicator of his productivity on the farm if the farmer has no other occupation apart from farming. The size of the household affects the amount of farm labour, determines the food and nutritional requirement of the household, and often affects household food security. Table 6 shows the distribution of respondents according to household size. Results in the table showed that majority of the insured (70.8%) and uninsured (47.5%) crop farmers in the study area have household size of between 6-8 members respectively. About 12.5 % of the insured and 37.5% of the uninsured crop farmers have less than or equal to 5 members per family respectively, only 16.7% insured and 15% uninsured crop farmers have more than 8 household members. It is expected that the family members of a farm operator will contribute labour to farm work, thus, the farmers' household member in the study area are involved in the farming operations

Table 7: Distribution of Respondents According to Household Size

	Insured		Uninsured	
Household size	**Frequency**	**%**	**Frequency**	**%**
≤ 5	15	12.5	45	37.5
6-8	85	70.83	57	47.5
9- 11	19	15.84	18	15
>11	1	0.83	-	-
Total	**120**	**100.0**	**120**	**100.0**

Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
7.27	**1.49**	**4**	**12**	**3.24**	**1.22**	**4**	**12**

t= 1.27 (not sig)

Source: Computed From Field Survey Data, 2012.

4.1.7 Distribution of Respondents According to their Occupation

Table 7 shows the analysis of the distribution of the insured and uninsured crops farmers in the study area according to their major occupations. It showed that about 55% of the insured farmers have no other occupation except farming and 45% have other occupation apart from farming. 45.8% uninsured farmers in the study area have no other occupation apart from farming where 54.2% have some other occupation.

Table 8: Distribution of the Insured and Uninsured Crops Farmers According to other Occupation Type.

	Insured		Uninsured	
Occupation	**Frequency**	**%**	**Frequency**	**%**
Farming	65	54.2	55	45.8
Business /Trading	24	20	42	35
Artisans (Driving, Tailoring, Mechanic)	21	17.5	12	10
Public/Civil Servant	10	8.3	11	9.2
Total	**120**	**100.0**	**120**	**100.0**

Source: Computed From Field Survey Data, 2012.

4.1.8 Distribution of Respondents According to Farm Size

The crop output of any farmer depends on the size of farm he/she operates. The distribution of farm size cultivated by the respondents is presented in Table 8. It could be seen from the table that majority of the insured (89.2%) and uninsured (91.7%) crops farmers in the study area cultivated farm size of between 1-5 hectares respectively. About 6.7% of the insured and 5% uninsured crop farmers cultivated a farm size of between 6-10 hectares while about 4.2 % of the insured and 3.2% uninsured crop farmers cultivated farm size of 10 hectares and above. The findings with respect to farm size in this study are in congruent with the findings of Olayide (1980) that stated that generally majority of the farmers are into small scale production in Nigeria. The result indicate that farmer size has a positive impact on farmer's decision

Table 9: Farm Size Distribution of Respondents

	Insured		Uninsured	
Farm Size (Ha)	**Frequency**	**%**	**Frequency**	**%**
1 - 5	107	89.1	110	91.7
6- 10	8	6.7	6	5
≥10	5	4.2	4	3.3
Total	**120**	**100.0**	**120**	**100.0**

Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
9.85	**4.09**	**3**	**20**	**9.06**	**3.69**	**3**	**20**

t= 3.10* (sig at 1%)

Source: Computed From Field Survey Data, 2012.

4.1.9 Distribution of Mode of Land Acquisition for Crop production

The nature of access gained to a particular parcel of farmland largely determines the extent and magnitude of use right and privileges of the farmers. Table 9 showed the mode of land acquisition predominant in the study area. It could be seen that majority of the insured (34.2%) crop farmers gained access to their land by inheritance while only 15% of the uninsured farmers had land by inheritance.

Majority of the uninsured (32.5 %) crop farmers in the study area had land leased to them either by their husbands or by extended family members of the husband, 27.5% of the uninsured crop farmers had land given to them as gift mostly from their husbands, most of which are not as productive as before and this is consistent with the findings of Karl (1983). While 26.7% insured and 25% uninsured acquired their land through purchase.

Table 10: Distribution of Respondents by Mode of Land Acquisition

	Insured		**Uninsured**	
Mode	**Frequency**	**%**	**Frequency**	**%**
Owned (Inheritance)	41	34.2	18	15
Leased	31	25.8	39	32.5
Purchased	32	26.7	30	25
Gift	16	13.3	33	27.5
Total	**120**	**100.0**	**120**	**100.0**

Source: Computed From Field Survey Data, 2012.

4.1.11 Distribution of Respondents by Access to Extension Services

The respondents' access to extension services is presented in Table 10. The extension services involve the dissemination of proven agricultural techniques, production innovations and climate change information to crop farmers with the aim of improving their production capacity. The table showed that majority of the insured (60%) and uninsured (55%) crops farmers in the study area had access to extension services respectively. This had a significant influence on their output and puts them on the same level playing field to be better producers of crops. This finding is incongruent with the findings of Seyoum et al., (1998); Bindlish and Evanson (1993) who attested to the fact that inadequate access to extension services hampers the productivity of the farmers.

Table 11: Distribution of Respondents' Access to Extension Services in Relation to Climate Change Information

	Insured		**Uninsured**	
Access to Extension Services	**Frequency**	**%**	**Frequency**	**%**
Yes	72	60	66	55
No	48	40	54	45
Total	**120**	**100**	**120**	**100**

Source: Computed From Field Survey Data, 2012.

4.1.11 Distribution of Respondents According to Sources of Loan

Availability of credit helps in the procurement of inputs on a timely basis. It also helps in the adoption of yield increasing innovation thereby increasing the efficiency of farmers.

Table 11 indicates the sources of credit available to the insured and uninsured crop farmers in the study area. It is shown by the table that majority of the insured (28.3%, 55% and 16.7%) and uninsured (25%, and 11.7%) crop farmers obtained their funding from formal sources like Agricultural credit cooperative, Commercial banks, Cooperative banks and Bank of Agriculture while only 38.3% and 25% of the uninsured farmers financed their crop production through personal savings and family member's assistance. This indicate that most of the insured farmers obtained credit from a formal financial institution and this implies that it is only those farmers that obtain loans from those institution that has an insurance cover.

Table 12: Distribution of Respondents by their Sources of Credit Facilities

	Insured		Uninsured	
Sources of Credit	**Frequency**	**%**	**Frequency**	**%**
Personal savings	-	-	46	38.3
Family members	-	-	30	25
Friends/Relatives	-	-	-	-
Cooperative society			30	25
Agric Credit Cooperation	34	28.3	14	11.7
Commercial Banks	66	55	-	-
Bank of Agriculture (BOA)	20	16.7	-	-
Total	**120**	**100.0**	**120**	**100.0**

Source: Computed From Field Survey Data, 2012.

4.1.12 Distribution of Respondents by the Amount of Credit Obtained

It is expected that the larger the amount of credit available to crop farmers, the greater the farmers' tendencies of increasing crop productivity and mitigates the effects of climate change. Table 12 shows the distribution of amount of credit obtained by the respondents. Many of the Insured (36.7%) and uninsured (30.8%) crop farmers obtained credit of between ₦101,000-₦150,000 respectively. The results show that most of the uninsured crop farmers (50.8%) obtained loan ≤ ₦50, 000. It is understandable that it is only the insured farmers that collected loans of more than ₦150, 000

Table 13: Distribution of Respondents by the Amount of Credit Obtained.

	Insured		**Uninsured**	
Amount (₦)	**Frequency**	**%**	**Frequency**	**%**
≤ 50,000	20	16.7	61	50.8
51,000-100,000	16	13.3	22	18.3
101,000-150,000	44	36.7	37	30.9
151,000- 200,000	22	18.3	-	-
> 200,000	18	15	-	-
Total	**120**	**100.0**	**120**	**100.0**

Source: Computed From Field Survey Data, 2012.

4.1.13 Distribution of Respondents by Damages caused to farm through climate

The distribution of the respondents is presented in Table 13. It is observed from the table that majority of the insured crop farmers (92.5%) experienced damage to their crops due to change in the climatic condition in the study area and only (7.5%) don't experience any damage while all, (100%) of the uninsured crop farmers experienced damage in their crop farms.

Table 14:

	Insured		**Uninsured**	
Damage	**Frequency**	**%**	**Frequency**	**%**
Yes	111	92.50	**120**	100
No	9	7.50	-	0
Total	**120**	**100**	**120**	**100**

Source: Computed From Field Survey Data, 2012.

4.1.14 Distribution of Respondents base on Crops Affected

Table 14 shows the distribution of the respondents' base on the crops affected. The level of education attained by a farmer is known to influence the adoption of innovation, better farming decision making including efficient use of inputs. The study showed that majority of the male (31.2 %) and female (37.2 %) cassava farmers had about 6years of formal education respectively in the study area. The finding implies that literacy level is moderately high among the male and female cassava farmers as expected in the study areas.

Table 15: Respondents Crop Affected

	Insured		Uninsured	
Crop Affected	**Frequency**	**%**	**Frequency**	**%**
Cassava	5	4.2	39	32.5
Yam	40	33.3	9	7.5
Maize	4	3.3	20	16.7
Sorghum	16	13.3	31	25.8
Cowpea/ bean	32	26.7	9	7.5
Cocoyam	-	-	2	1.7
Melon	-	-	-	-
Okro	-	-	-	-
Pepper	-	-	-	-
Tomatoes	4	3.3	-	-
Vegetables	19	15.9	10	8.3
Total	**120**	**100**	**120**	**100**

Source: Computed From Field Survey Data, 2012.

4.1.15 Distribution of the Respondents according to their adaptation strategies

It is expected most of the farmers have an alternative means of adapting to adverse climatic condition. Table 13 shows the distribution of farmers based on the alternative ways of adapting or mitigating the effect of climate change.

Table 16: Distribution of Respondents According to their Adaptation Strategies Experience

	Insured		Uninsured	
Fertilizer application	**Frequency**	**%**	**Frequency**	**%**
Used	32	26.7	93	77.50
Not used	88	73.3	27	22.50
Total	**120**	**100.0**	**120**	**100.0**

Source: Computed From Field Survey Data, 2012.

Use of organic manure	Insured		Uninsured	
	Frequency	**%**	**Frequency**	**%**
Used	69	57.50	58	48.3
Not Used	51	42.50	62	51.7
Total	**120**	**100.0**	**120**	**100.0**

Source: Computed From Field Survey Data, 2012.

	Insured		Uninsured	
Diversification	**Frequency**	**%**	**Frequency**	**%**
Used	96	80	104	86.7
Not Used	24	20	16	13.3
Total	**120**	**100.0**	**120**	**100.0**

Source: Computed From Field Survey Data, 2012.

	Insured		Uninsured	
Fallowing	**Frequency**	**%**	**Frequency**	**%**
Used	93	77.50	85	70.8
Not Used	27	22.50	35	29.2
Total	**120**	**100.0**	**120**	**100.0**

Source: Computed From Field Survey Data, 2012.

	Insured		Uninsured	
Crop Rotation	**Frequency**	**%**	**Frequency**	**%**
Used	74	61.7	96	80
Not Used	46	38.3	24	20
Total	**120**	**100.0**	**120**	**100.0**

Source: Computed From Field Survey Data, 2012.

4.2 TREND OF CROP PRODUCTION IN OYO STATE

Over the entire analysis period (1990 – 2010), the crops produced in Oyo- state are yam, cassava, sorghum, cowpea, cocoyam, melon, maize, tomato, vegetable, Okro and pepper. with 9.37-18.89 tonnes per hectares and 7.03-11.87 tonnes per hectare respectively. A higher yield of yam and cassava with 9.37- 18.89 tonnes per hectares and 7.03- 11.87 tonnes per hectare respectively was recorded in Oyo-State in the year 1991 and 1992 with an average rainfall of 114.1mm and 31.6^{o}C temperature.

Many research work has shown that there is remarkable increase in crop yield around 1987 and 1988 and it is said that all crop's production showed consistent increase after 1987, and the overall trend of decline in food production since 1960 switched to increase which is never experienced since independence, and this is quoted from the effect of S.A.P. This implies that the influence of the S.A.P. was far greater than that of any other agricultural policy of the earlier periods. If we look more carefully to the figures, however we can see some different trends between crops since 1990 to 2010. They are as follows:

The rate of increase of root crops such as yam and cassava is much higher than that of cereal crops such as millet and sorghum.

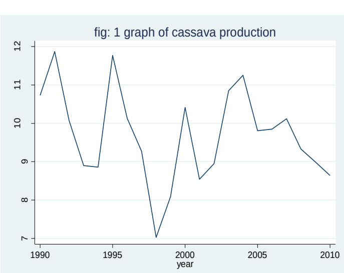
fig 1 shows that S.A.P still has greater influence on Cassava production until 1992, but rapidly decline thereafter and begin to fluctuate because of poor sales due to price instability. The trend reveals that Sorghum continued to rise and fall between 1990 to 2004, hoping that it increase during the period 2005 will be maintained but a drastic fall was experienced which is still fluctuation up till today probably because of high cost of human labour, lack of fertilizer or lack of modern farming equipment.

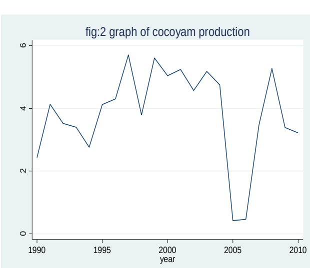
Cowpea increased after the mid-1995, and its average production became unpredictable since then because of crop damage and poor storage facilities, poor sales of food stuff due to price fluctuation, or government interventions

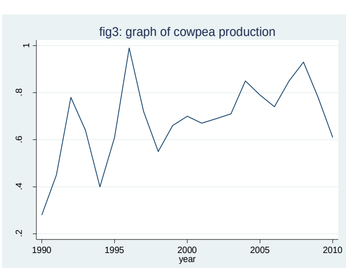
Maize also showed a high rate of increase, but it started only at the end of the 2008. Some variables which are responsible for this might are high cost of human labour, high cost of transport to the market/urban centers, and lack of fund/credit facilities. Olatunbosun (1995) emphasized that transportation, information dissemination, storage, food processing, and standardization problems are the main constraints and causes of fluctuation of food production especially in the rural areas of the country.

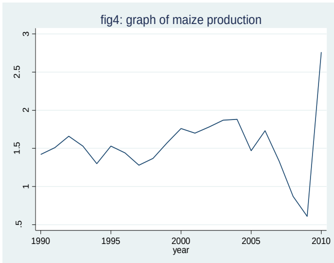
More recently, Fatulu,(2007), Tunde, (2007) and Yahaya, (2009) indicated that transportation, poor credit accessibility, insecurity and high cost of human labour and farm inputs represent the most serious constraints to agricultural development in Nigeria. So varied are the reasons advanced for the instability of food crop production in the study area.

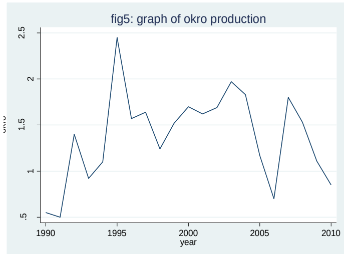
Olatona, (2007) explained that the bulk of food crop production in Nigeria takes place under the traditional system without the use of mechanical power. Such a peasant agricultural system is usually characterized by poverty. Holdings are small, simple implements are used to cultivate hectares of land and land fragmentation is on the increase. The existing fragmentation and fractionalization are not only due to land tenure system, but also to soil catena characteristics (Olawepo, 2008)

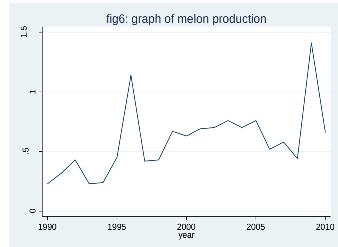


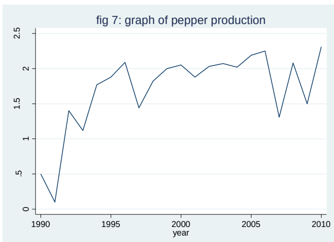


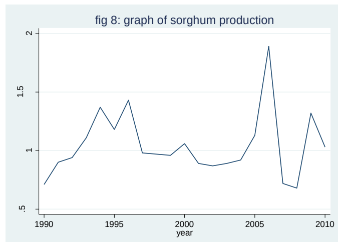


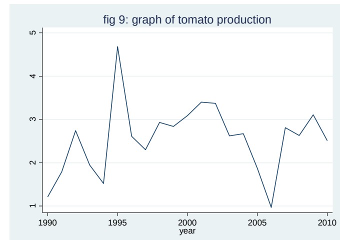


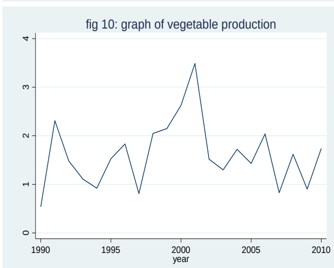


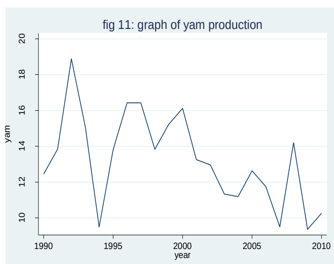












In view of these, it has been variously observed that the trend of food production appears to increase or decrease with increasing or decreasing gap between the rural and urban sectors of the economy which in turn is related to the increasing trend of rural-urban migration. In as much as a large proportion of food consumed in the urban centers are being produced in the rural areas, migration to the urban area will drastically decrease food crop production. In summary, most of the fluctuation of food crop production experienced in Oyo state is as a result of inadequate modern farming equipment, scarcity of human labour or high cost of human labour, inadequate fertilizer, lack of funds or credit facilities, variation in climate variables like rainfall and temperature, high crop damage due to poor storage system, high cost of transport to urban centres, poor sales of food stuff due to price fluctuation, problems of pests and diseases, poor accessibility to extension services etc.

4.3 THE REGRESSION OF CLIMATE VARIABLE AND CROP PRODUCTION IN OYO STATE

Estimated Parameter for average crop yield production (f(X,) under linear function

Crop	Temperature	Rainfall	Year	Constant
Cassava	-0.7102* (-0.1674)	0.40433 (0.5225)	0.34459 (-1.043)	9.8511 (0.7120)
Cocoyam	0.33951 (1.578)	0.8122* (3.242)	0.13226* (3.250)	-9.4102 (-1.310)
Cowpea	-0.2760 (-1.040)	0.1909* (2.312)	0.1962* (4.053)	1.1226 (7.169)
Maize	0.13529 (1.256)	0.32788* (4.265)	0.12455** (1.840)	-3.2360 (-0.9340)
Melon	0.8935 (1.113)	0.1472** (1.852)	0.2313* (2.951)	3.0453 (0.5467)
Okro	0.50283 (0.5325)	0.78550** (2.730)	0.39616** (2.662)	-1.5479 (-0.4749)
Pepper	0.2769 (1.196)	0.49785* (3.582)	0.62799* (3.906)	-3.6299 (-1.007)
Sorghum	-0.4120* (-71.38)	0.15304 (0.1038)	0.14014 (0.1444)	2.0861 (1.450)
Tomato	0.33199* (1.610)	0.14560* (4.447)	0.70559* (4.208)	-10.433 (-1.472)
Vegetable	0.19374 (1.059)	0.2285 (0.8280)	0.1850 (0.7591)	-5.0972 (-0.8158)
Yam	0.27603* (0.5119)	-0.94700 (-0.8529)	-0.30241* (-4.111)	15.73 (0.8139)

*indicates significant at 5% while ** indicates significant at 10% level. In bracket are t-value

Table 17

From the result above, the significant sign on temperature is negative for three crops (cassava, cowpea and sorghum), this indicates that this crop yield increases with more rainfall. Yam and tomato has a positive significant for temperature which implies more yield with more temperature. For rainfall, the results shows that cocoyam, cowpea, melon, Okro, pepper and tomatoes has a high positive response to rainfall which means with more rainfall, the yield of these crops will increases. It is also observed that that crops have a positive response with time trend, which indicates that if the amount of rainfall supply increases with time, there is tendency for increase in yield of the specified crops in the region.

RESULTS OF YIELD VARIABILITY OVER TIME

The results below involve the way crop yield variability responds to changes in temperature and rainfall. In these cases increases in rainfall also increases yield variability for cocoyam, melon and tomatoes but decreases for yam, vegetables and pepper simultaneously, higher temperatures increase the variance of yam yields, but decrease variability for cocoyam, cowpea melon, Okro and pepper. Such results are not surprising if one looks at the characteristics of the physical locations of these crops coupled with common crop cultural conditions. Vegetable are grown best in more temperate zones and has high water requirements. Sorghum is generally grown in higher temperature and lower rainfall conditions, and the results show lower temperatures or more rainfall increase variability. A fact is not inconsistent with the finding that variability increases as temperature and rainfall are reduced.

Estimated yield variability (h,(x, α)

Crop	Temperature	Rainfall	Year	Constant
Cassava	1.1502** (2.356)	0.117 (1.541)	-0.402 (-1.289)	-36.386 (2.303)
Cocoyam	-1.3994* (-3.058)	0.8316* (3.001)	0.20763) (2.813)	45.438 (3.065)
Cowpea	-0.9038* (-2.009)	-0.1292 (-0.9489)	0.2425 (-0.3102)	0.30324 (1.859)*

Maize	-0.2652 (-0.8661)	-0.1522 (-1.061)	-0.8573* (3.014)	0.85443 (0.8666)
Melon	-0.2204* (-0.2952)	0.1048* (2.086)	0.1728 (0.8230)	0.71184 (1.912)
Okro	-0.7232** (-1.916)	0.11899 (0.7147)	0.74088 (0.9683)	2.2500 (1.682)
Pepper	-0.11687 (-2.385)	-0.15855* (-2.302)	-0.79846 (-0.9897)	4.1166* (2.379)
Sorghum	-0.65024 (-0.2844)	-0.72089 (-0.2510)	0.7208 (-0.1266)	2.2407 (0.3901)
Tomato	-0.11493 (-0.9143)	0.51878* (2.497)	0.24552* (1.974)	-0.13923 (-0.3456)
Vegetable	-0.49283* (-3.052)	-0.7497* (-2.949)	-0.63607* (-2.909)	17.695* (3.061)
Yam	-4.8763* (-2.82)	-0.57300* (-2.379)	-0.54874* (-2.6841)	172.18* (2.799)

*indicates significant at 5% while ** indicates significant at 10% level. In bracket are t-value

Table 18

CROP YIELD PRODUCTION FUNCTION ESTIMATES

The sign on rainfall is positive for all crops and is negative on temperature. This indicates that crop yields increase with more rainfall and decrease with higher temperatures, holding acreage constant and after controlling for a deterministic time trend that may serve as a proxy for the non-stochastic portion of the advance of agricultural technology.

Higher temperatures positively affect sorghum yields (Cobb-Douglas estimate insignificant). The coefficients on the deterministic time trend are positive and significant as expected for all crops, except the Cobb-Douglas estimates for sorghum and cassava. This may come from the tendency of Cobb-Douglas functional forms to pick up curvature because they are nonlinear over a wide range of parameter values, and may indicate a declining rate of increase in the effect of technology on yield rather than an actual negative impact of technology._

The coefficients for rainfall and temperature can be converted to elasticities by multiplying by sample average climate and dividing by average yield. Elasticities for the other crops are mixed, with uniformly high elasticities being measured for both rainfall and temperature on sorghum.

4.5 REGRESSION OF PRODUCTION PRACTISES FOR INSURED AND UNINSURED FARMERS

Variable	Insured	Uninsured	Pooled Result
Constant	3.4167 (2.60)	9.096 (11.18)	5.1724 (12.72)
Value of Seed (X1)	0.886 (0.84)	0.760*** (5.51)	0.1569*** (3.38)
Capital Borrowed or Used (X2)	0.0982*** (4.94)	$5.4X10^{-4}$ (0.98)	0.049 (0.972)
Fertilizer (X3)	0.0550** (2.04)	0.875*** (4.78)	0.1842** (2.661)
Farm Size (X4)	0.1316*** (3.41)	0.121 (0.61)	0.4855* (1.814)
Labor (X5)	0.0374* (1.94)	0.881** (2.78)	0.1275** (2.331)
Agro- chemical used (X6)	0.727 (0.40)	0.374 (0.84)	0.0815 (0.381)
Value of farm Asset (X7)	0.1072*** (5.96)	0.743 (0.24)	0.0641 (0.287)
EXP on Adaptation Technique (X8)	0.136 (0.671)	0.875** (2.29)	0.0537*** (5.180)
Dummy Variable			0.4866* (1.87)
R^2	0.9352	0.8438	0.9066
R^{-2} (adjusted)	0.9293	0.9007	0.6416

*
indicates significant at 5% while ** indicates significant at 10% level. In bracket are t-value

Table 20

When considering the result above, it is observed that for the insured farmers, value of assets owned by the farmer and the labor employed on the farm was significant. It is also observed that output obtained by the farmer is directly influenced by the input exerted. Likewise, the value of fertilizer also has a significant impact on crop production among the insured farmer. All other variable included has a significant influence on crop production by an insured farmer except the use of agro chemical, value of seed and expenditure incurred on adaptation techniques adopted.

Some of the included explanatory variable like value of expenditure incurred on adaptation technique, the value of seeds, fertilizer, and value of labor use were significant for the uninsured farmer. This implies that they exert a great impact or influence on the level of production achieved by the uninsured famer.

The pooled result shows that the value of seed used for planting, labor, the value of expenditure on adaptation technique, use of fertilizer and the holding of insurance policy were significant. The result shows that they contribute positively to the output of farmer but at a different rate. It is also observed that agrochemical used is not found to be significant in any of the result specified.

The R^2 indicated the proportion of the variation in output of both insured and uninsured farmers. An R2 value of 93.52% was obtained for the specify function of the insured farmer as compare to 84.38% of the uninsured farmer and 90.66% R^2 was obtained for the pooled result of the two groups of farmers. The adjusted R^2 value was obtained allow us to compare the R^2 value of the different result obtained from each group of farmers. We can generate the efficiency of the result used among the farmers group from the pooled result. As we know that the higher the efficiency the more efficient the farmer is. This study use the sign of the parameter estimate of the dummy variable in the pooled result to measure the efficiency of resources used between the farmers group. The sign of the dummy reveal a positive sign coefficient which indicates that the efficiency moves toward the insured farmer which has the largest integer of coded variables, were a negative coefficient measure tends towards the uninsured farmer. The negative sign of the coefficient in this result shows that uninsured farmers were more efficient in resource use than the insured farmers. But it is noted that insurance policy have no significant relationship between insured farmer and the crop output obtained. Therefore insurance decision does not guarantee higher output level of crop productivity.

Surprisingly, apart from the fact that insured farmers embraced modern Farming practices, possibly because of their accessibility to farm credit, their farm Output does not make them better farmers than the uninsured farmers. The operation of agricultural insurance should not be limited to climatic variability but the government should complement their operations by making farm inputs readily accessible to farmers and that farmers are enlightened about their use. There are times when many of the Farm input are scarce and difficult to obtain in the open market. As a result of these problems, it may be difficult for an average peasant farmer to safeguard the correct use of these inputs that are time and quality specific for best performance

The impact of insurance is worthy to be noted here because this study reveals that it does not contribute substantially to farm output. Even among the insured farmers that used more of input, it actually contributed negatively to farm output. The two groups of farmers sampled for this study operate in a similar and contiguous area and they displayed some striking differences in their farm operations. The insured farmers are more commercially oriented in the choice of their enterprise combinations and in the inputs they used on the farm. They used more modern farm inputs and choose enterprises that are more market oriented than the uninsured farmers.

However, the uninsured farmers are found to be more productive and efficient in the use of their farm inputs.

The majority of the Oyo state farmers are illiterate and with large scale poverty they have little knowledge about an insurance markets. It is on the basis of this understanding that farmers are encouraged to patronize agricultural insurance and with the assurance that it will increase their accessibility to a range of farm inputs and a further help to share the burden of risks so that they would still meet their basic obligations.

4.6 CROP INSURANCE PAYOUT ESTIMATION

Equations frequently used as a simple insurance scheme (Ray 1967; Hazell et al. 1986; Abbaspour 1994) were used for the module for the crop insurance payout estimation to simulate the crop insurance payout in a prefecture. The insurance payout in the *i*th prefecture in *j*th year, Payout*i*, *j*, is given by the functions of the insured yield loss, *Yi*, *j*, insured acreage of crops, Area *i*, *j*, and price of crop, as follows:

$$Payout_{i,j} = \nabla Y_{i,j} \times Area_{i,j} \times P\_crop$$

The crop insurance program provided by the Japanese government is designed with the assumption that all farmers must participate. An objective of the program is to establish full participation by farmers (Yamauchi 1986). With this consideration, i used the total planted acreage as the insured acreage . On the other hand, the insured yield loss, *Yi*, *j*, is given by

$$\nabla Y_{i,j} = \phi \bar{Y}i - Y_{i,j} \text{ if } Y_{i,j} < \phi \bar{Y}i$$

$$\nabla Y_{i,j} = 0, \text{ if } Y_{i,j} \geq \phi \bar{Y}i$$, Area= production / yield

Where $Y_{i,j}$ is the yield in a given year, $\bar{Y}i$ is the standard yield, and ϕ is the insurance coverage.

Crop insurance payout estimation

year	Cassava	Yam	Maize	Sorghum	Cowpea	cocoyam	Melon	Okro	Pepper	Tomato	Vegetable
1990	39900	56000	720	1425	2040	10200	1260	225	2600	2900	4425

1991	63000	201600	1200	300	3960	3660	1540	4050	8450	4750	2075
1992	40950	152800	1040	1275	1680	720	2800	2160	1820	3950	925
1993	1400	222400	1840	1950	2880	3840	140	810	4225	2150	475
1994	101850	172000	1840	1425	2520	8160	2940	6075	715	15800	1525
1995	57400	104800	720	1875	4560	1080	9660	3960	1365	10350	750
1996	30100	0	1280	3375	3240	8400	10080	315	4225	1550	2550
1997	78400	103600	720	75	2040	11460	140	1800	2470	3150	3100
1998	37100	55200	1600	75	1320	10920	3360	1260	1170	450	250
1999	81200	36000	1520	750	480	3420	560	810	325	1250	1200
2000	65450	114400	480	1275	360	1200	840	360	1105	1550	2150
2001	14350	11600	640	150	240	4020	140	315	975	150	4925
2002	66500	65200	720	150	240	3660	840	1260	260	3750	550
2003	14000	6000	80	225	1680	2580	840	630	325	250	1050
2004	50400	58000	3280	1575	720	25980	840	2970	1105	4000	725
2005	1400	35200	2080	5700	600	240	3360	2125	390	4500	1525
2006	9450	90000	3200	8775	1320	18060	840	4950	6110	9200	3025
2007	27650	187600	3680	300	960	10800	1960	1215	5005	900	1975
2008	11900	193200	2080	4800	1800	11280	13580	1890	3770	2400	1800
2009	12250	35600	17200	2175	2040	1020	10500	1170	5265	3000	2100
2010	302400	410400	22080	0	7320	19320	9240	3825	15015	12550	4350

Table 19

The more the crop yield loss to climate change indices, the more the insurance payout which will help the farmer to get back to business.

The insurance coverage varies depending on the prefecture and ranges from 0.7 to 1.0 in the National Agricultural Insurance Association (NAIA) insurance program (NAIA 2004).

For simplification herein, i took the value of 1.0 for all prefectures.

There were three difficult issues for simulating the crop insurance payout: (i) the standard yield, (ii) the insured acreage of crops, and (iii) the price of crop.

In the insurance program, the standard yield is defined as the yield trend curve assuming normal climate conditions. The standard yield for a prefecture is calculated by the nonparametric regression method that uses the climate indices and the number of years as the explanatory variables (MAFF 1998). The calculated standard yield of a prefecture is broken into the municipalities with due consideration of their yield histories. However, because the future climate dataset for this study i used a simple method for calculating the standard yield instead of the existing method. The second issue is the insured acreage of crops. I was compelled to use the current values of planted acreage for the future period, although i believe that the planted acreage changes year by year as a result of the change in price under future conditions of demand and supply.

The third issue is the price of crops. Price is affected by economic factors, that is, demand and supply, including exports and imports; thus, the price in the future is perhaps unequal to the current one.

However, I was compelled to use the mean price of crops. My future projection of the crops insurance payout had the limitations mentioned above for the treatments of future economic factors (i.e., planted acreage and price). In future studies, the inclusion of applied general equilibrium models will help develop a framework and achieve a more realistic simulation

4.7 Test of hypothesis

The results of this project work ascertained that hypotheses below

$Ho_{1:}$ There is no significant different between the socio- economic characteristics of insured and uninsured farmers in the study area therefore the null hypothesis is accepted

$Ho_{2:}$ There is no structural difference between the production function of the insured an uninsured farmers. The null hypothesis is accepted.

Ho_{3}: Productivity of the farmers does not have any significant impact on their crop insurance decisions; therefore the null hypothesis is accepted

Ho_{4}: Climate change have a significant impact on payout of agricultural insurance corporation in Oyo state, therefore the null hypothesis is rejected

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

The evaluation of the estimated results over climate change projections reveals how climate change has influence yield variability. This study has developed quantitative estimates of the effects of annual average climate condition on crop yield production. The results shows changes in average climate conditions which causes alterations in crop yield levels and variability which need urgent attentions in the study area.

One of the most important objectives of the Nigerian Agricultural Insurance Corporation is to encourage farmers by motivating them and helping them to bear the uncontrollable risks of climate change indices but evidence from the study of the operation of the corporation in the study area indicates that there is no significant different between insured and uninsured farmers

NAIC was established for farmers to have more access to essential farm resources that would motivate them to embrace the use of modern farming practices with the assumption that such practices will lead to increase the quality and quantity of farm production and food supplies to the market and help them face the challenges experience through climate variability.

NAIC has neither made farmers better managers and organizers of available resources for increased productivity nor able to assist farmers to adapt to the effect of climate change. Despite the fact that more insured farmers adopted improved production practices, the level of production achieved did not justify any difference of production practices between them and the uninsured farmers.

5.2 Conclusion

The results are found to be different by crops. For examples like maize, vegetables, tomatoes, melon and pepper, high temperature are found to have positive effects on yield levels and variability. More rainfall causes more yields to these crops while decreasing yield variance. As a results of yield variability due to loss through climate change an analysis of crop insurance to mitigate the risk suggest that the insured farmers suppose to generate more output greater net profit by the assistance of an insurance cover to reduce risk. It is observed that most of the insured farmers do not took an insurance cover to bear losses but as a pre-requisite to obtain financial assistance from a financial institution and in clear sense, most of the farmers did not have a direct access to their insurer. There has not been any evidence of adequate and prompt payment of insurance payout of any crop yield loss incurred by the insured farmers in the study area.

5.3 Recommendation

Based on the information obtained through this study, the following recommendation is inevitable for a greater crop yield response despite the incidence of climate change and its risk.

1. The government must understand that there is a great loss of crop yield as a result of climate change variability and should help the crop farmers with effective adaptation strategies like providing irrigation facilities to cope with the challenges of inadequate rainfall
2. The Nigerian Agricultural Insurance Corporation should restructured their policies and used the simple crop insurance payout techniques employed in this study to assist farmers to cope with the challenges of climate change and help those that are badly affected to get back to business

3. In order to achieve the agenda of adequate food security, the government must provide incentives and financial assistance to farmers in other to eliminate the extortion of farmers by the financial institution.
4. Apart from this insurance planned adaptation strategies, the extension agent should also help farmers with vital information on improved seed, planting dates, improved technologies and help provide markets during surplus harvest seasons to minimize loss of crop produce.
5. The farmers should also embrace the modern method of crop productions practices introduced to them by the extension agent and ignore their traditional ways of farming in other to get ahead of their so-called insufficiencies in production practices

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