Emerging and Indigenous Technology for Climate Change Adaptation in Southwest Nigeria

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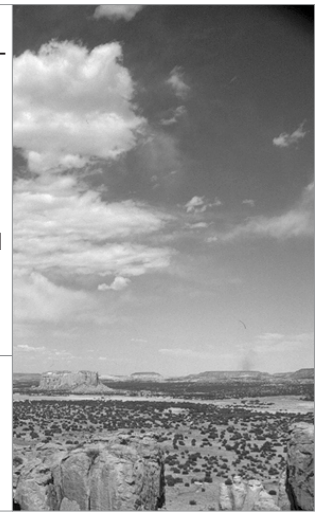

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Abstract

This study is premised on the high incidence of severe weather and the rate of climate change, its consequences and challenges among small-scale farmers. Primary data obtained from 362 farmers, 125 extension officers and 14 researchers from the three agro-ecological zones of southwest Nigeria were used to examine the technological and farming systems adaptation to climate change. The data obtained were organised in Microsoft Excel, cleaned and analysed on the Statistical Package for the Social Sciences (SPSS). Most of the farmers are married, formally educated, male Christians with an average age of about 49 years and a household size of 9 persons. The extension officers are mainly married, male, Christians holding a Higher National Diploma (HND) or a B.Sc. and working about 250 farmers each. Half of the researchers are based in Ibadan where most of the research institutes in southwest Nigeria have their main offices. There is a high level of climate awareness among farmers and extension officers. Only location (agro-ecological zone) provides a significant insight into the variability in farmers' observation among the variables tested. Most of the farmers (65.75%) opine that farming activities such as bush burning, use of agro-chemicals and deforestation contribute to climate change, and some other farmers (96.6% in the swamp zone, 60.8% in the rainforest and 68.3% in the savanna) opine that the main climate change effect on their personal lives is reduction in personal productivity. In terms of climate change effects on farming enterprises, reduction in crop yields was reported by 60% of the farmers. The main strategies and technologies promoted by extension officers to assist farmers to cope with the effects of climate change in southwest Nigeria are: tree planting (30%), timely planting of crops (6%) and avoidance of bush burning (6%) in the swamp zone. In the rainforest zone, it is provision of small scale irrigation (25%), mulching (16.7%) especially on yam farms, and avoidance of felling trees (8.3%). In the savanna zone the main coping strategies and technologies are: avoidance of tree felling (25.6%), avoidance of bush burning (23.1), small scale irrigation (5.15) and studying weather condition before planting crops (5.1%). The study concluded that there is a general conviction among farmers, extension officers and researchers that crops and forests management technologies are the main tools for adapting to climate change. It is noteworthy however that adapting to climate change is as much a technology issue as an attitudinal one.

1. Introduction

1.1. Background information

There are contrary opinions on the exact nature of climate change and its precise impact on human and other components of the ecosystem. However, most experts unanimously agree that climate variability will have drastic consequences on agricultural production and productivity (Watson, 2010). Smit et al. (1988) reported that changes in the chemical composition of the atmosphere are likely to alter the earth's climate, and that these alterations may have severe implications for agriculture and other economic activities. Several reports exists on the impacts of climate change on agriculture (Daniel, 1980; Benneh, 1996; IFPRI, 2009; Okoruwa, 2010; Bello, 2010) According to Smit et al. (1988) several analytical procedures have been employed in studying the impacts of climate change.

Recent studies have shown strong indications and evidence that the agricultural and food systems across the world are already experiencing major changes. According to IPCC predictions, areas suitable for agriculture particularly along the coastal margins, semi-arid and arid regions are expected to decrease including the length of growing season and yield potentials (IPCC 2007). In some African countries, yields from rain-fed agriculture could reduce by close to 50% by 2020. Studies by Apata et al, (2009) reveal that there are strong indications and already evidence that the agricultural and food systems as well as the rural areas across the world are experiencing major change. This change has drastically reduced soil fertility and poor agricultural outputs particularly in Sub-Saharan Africa.

Farmers in the Sudan-Sahel region have complained of drastic reduction in the soil fertility and that they can no longer predict the rainfalls, the soils are becoming drier and harder to cultivate and changes are causing very serious threats. In the coastal areas, there are evidences of the intrusion of salt water along communities that live along the coast. This has led to increased salinity in soils making life very hard for the people. Already, it is extremely difficult now for food to grow on the island (Apata et al, 2009), and the encroaching salt water that sweeps through the land has made it impossible for food crops to grow. Various studies have predicted the influence of climate change on crop and livestock production, hydrologic balances, input supplies and other components of agricultural systems. NIMET has reported that Nigeria's climate warming is resulting in variability and changes in the rainfall patterns (frequent late onset and early cessation of rain) which is affecting almost all socio-economic sectors especially agriculture and food security, biodiversity

and water resources. But agriculture is not innocent in the emission problem. Generally, agriculture is said to contribute 10-12 percent of Greenhouse gas (GHG) emission worldwide (USEPA, 2006). Developing countries such as Nigeria are already experiencing low crop yields as a result of extreme weather and climate change. These impacts are affecting ecological zones, causing shifts in their boundaries, altering animal and plant composition, increasing soil erosion and flooding activities in many areas due to higher rainfall, accelerating sea level rise and salt water intrusion along the coastal areas. While excessive flooding during the past decade has hurt farming in coastal communities, desertification is ravaging the Sudan-Sahel region.

In the northern region of Nigeria, there has been loss of arable farmlands from recurrent droughts which has affected agricultural activities and food security in the region. Tarhule and Woo (1997) have confirmed that rainfall droughts can be matched approximately 90% with (from) the famine events chronicled for northern Nigeria. Drought has rendered large swaths of previously arable land unusable particularly in the savannah region. According to Medugu (2009), desertification in the Sahel had earlier been blamed on overgrazing practices of the local population, but recent studies have discovered that the real problem is climate change. Climate change is predicted to worsen the incidence of drought and desertification and millions of people will be turned into refugees. This is already evident in the steady declining rainfall in the Sahel since 1960's. The result has been the loss of farmlands and conflicts between farmers and herdsmen over the ever decreasing land. Many different communities, including fishermen, farmers and herdsmen, are now confronted with difficulties arising from climatic changes. Peoples' livelihoods are being harmed, and poor people are becoming more impoverished. Climate refugees are being created, as the changes make some land unlivable and affect water supplies. Climate change is expected to affect agriculture very differently in different parts of the world (Parry et al., 2004). The resulting effects depend on current climatic and soil conditions, the direction of change and the availability of resources and infrastructure to cope with change.

1.2. Problem Statement

Throughout human history, societies are fundamentally adaptive and there are many situations in the past where local communities have used traditional technologies to cope with changes in climate and to similar risks. Traditionally, African farmers have used indigenous knowledge to understand weather and climate patterns and make decisions about crop and irrigation cycles. These have helped them to develop traditional and indigenous technologies to cope with the changes. Crop farmers in Africa are acknowledged to have been very highly adaptable to climate change in both short and long terms while at the same time have the ability to develop effective means of handling variability in weather climate. Farmers' main adaptation strategies include use of drought tolerant crop varieties. A classical case of this is switching from drought susceptible maize varieties to tolerant ones by Nigerian farmers. Other indigenous strategies that have emerged are changing planting dates, increased irrigation intensity and expansion in fadama farming, changing land use and management. Ecological farming based on principles and practices of biodiversity and soil conservation has enhanced adaptation to the changing climate. There is no universally applicable measure for adapting agriculture to climate change, hence managers in the agricultural industry should, therefore, have sufficient flexibility to deploy the adaptation measures most appropriate for their local situations.

Adapting to climate change will require that individuals change their practices, which, in turn, are likely to require changes in the rules under which agriculture industry operates, the lack of enforcement of such rules, and the lack of participatory and accountable decision-making mechanisms are likely to increase socioeconomic vulnerabilities and limit the adaptive capacity of communities and societies. Fortunately, farmers already have experience of many innovative technologies which have been adapted over the years that can be shared both within and outside countries. However, it is becoming increasingly important and urgent for all the stakeholders to devise national strategies for adaptation for both present and future changes outside their experienced coping range.

1.3. Objectives

This project is supported by a grant as part of the implementation of the ATPS Climate Sense Program. It seeks to examine the emerging and indigenous Technologies for Climate Change Adaptation in southwest Nigeria. It is contributing to the strategic objective of the ATPS Climate Sense Program: "to promote climate change adaptation research, innovation, and technology adoption, and make climate change science, economics, politics, and investment opportunities more comprehensible to the quadruple helix, including policymakers, scientists, the private sector and the civil society."

The specific objectives of the study are to:

1. Identify and document effective indigenous and emerging technologies and innovations for climate change adaptation in South West, Nigeria;
2. Enhance behavioural changes towards climate change adaptation measures at individual and institutional levels in the study area;
3. Build the capacities of farming communities in the study area to adapt to climate change impacts;
4. Make policy recommendations for building climate change resilience at the state and national levels in Nigeria;
5. Facilitate knowledge sharing for climate change adaptation; and
6. Stimulate the interest of young researchers in contributing to climate change research and capacity development, and policy discussion

1.4. Justification

Nigeria and all the developing countries are already experiencing low crop yields as a result of extreme weather and climate change. These impacts are affecting ecological zones, causing shifts in their boundaries, altering animal and plant composition, increasing soil erosion and flooding activities in many areas due to higher rainfall, accelerating sea level rise and salt water intrusion along the coastal areas. While excessive flooding during the past decade has hurt farming in coastal communities, desertification is ravaging the Sudan-Sahel region. Changes in fresh water flows will affect coastal wetlands by altering salinity, sediment inputs and nutrient loadings. Changed fresh water inflows into the ocean will lead to changes in turbidity, salinity, stratification, and nutrient availability, all of which affect estuarine and coastal ecosystems but consequences may vary locally.

1.5. Organisation/Structure of the Paper

This report contributes to the strategic objective of the ATPS Climate Sense Program by presenting the results of a full scale survey of technological and farming systems Adaptation to climate change in farming communities in the three agro-ecological zones of southwest Nigeria. This paper is organized in five main sections. The first section provides the background and direction to the whole paper. It defines the key problems addressed, the objectives of the paper and the basis for conducting the study. The second section contextualizes the research in the literature, It provides a comprehensive background documentation on technologies and adaptation to climate change impacts in Nigeria; profiles the history and changes in technology response to climate variability overtime through existing data in Nigeria and provides an analysis of links between technologies, farming systems adaptation to climate change problems in Nigeria and other parts of the world. In the third section, the research approach is explained. This section contextualizes southwest Nigeria, data collection, selection of respondents and statistical analyses applied to the data obtained. The fourth section presents the key findings of the research and discussed them in line with current thoughts in the field. The final section draws out the main conclusions and provides some suggestions and recommendations on ways to take the findings of the study forward.

2. Literature Review

Climate change generally refers to changes in the statistical distribution of weather over periods of time that range from decades to millions of years. It can be a change in the distribution of weather events around an average (Bello, 2010). Okoruwa (2010) referred to climate change as identifiable variability in climate that has brought about negative consequences to human survival. Climate change may be limited to a specific region or may occur across the whole planet earth. Although, climate change is not a new phenomenon, its recent usage, especially in the context of environmental policy, refers to changes in modern or prevailing climate, particularly since the 20th century. The increase in greenhouse gas concentrations in the atmosphere has led many scientists to conclude that the earth's temperature will increase by several degrees over the next century (Houghton et al. 1992, NAS 1992, Wigley and Raper 1992).

Some are beginning to conclude that the anthropogenic effect of increased greenhouse gas concentrations on global climate is already evident (Thomson 1995). According to PCGCC (2008), climate change may be caused by internal or external processes such as changes in solar radiation, volcanism, orbital variations, and human influences through industrial revolution, agriculture and deforestation resulting in green house gas emissions. Physical evidences of climate change can be seen from historical or archaeological changes, vegetation, insects, and sea levels. IPCC (2007) reported that mean atmospheric temperature increased by 1.3 degrees Fahrenheit over the past century with a predicted 3.2 to 7.2 degrees Fahrenheit increase in the 21st century. Increasing surface temperature has been linked with lengthening the growing season in temperate region while shortening the season in tropical environmental with very high chances of drought (Okoruwa, 2010).

Atmospheric circulation patterns arise primarily as a consequence of heating contrasts between the poles and the equator, modulated by seasonality, and because land and water absorb and release heat at different rates, resulting in a patchwork of warmer and cooler regions characterized by a number of patterns of atmospheric circulation with different persistence. According to Lehodey et al. (2006), the extent to which preferred patterns of variability can be considered true modes of the climate system is debatable, but certainly these patterns are used to explain physical and biological variability in the ocean, particularly at decadal scale.

Due to the long time scales of some natural climate patterns, it is difficult to discern if observed

decadal oceanic variability is natural or a climate change signal, and have to be treated separately from the gradual, linear, long-term warming expected as a result of greenhouse gas emissions. Furthermore, there may be impacts of gradual climate change on the intensity, duration and frequency of these climate patterns and on their tele-connections.

The El Niño Southern Oscillation (ENSO) is the most obvious driver of inter-annual variability is the climate. ENSO is an irregular oscillation of three to seven years involving a warm and a cold state that evolves under the influence of the dynamic interaction between atmosphere and ocean. Climate scientists have arbitrarily chosen definitions for what is and what is not an "ENSO event" (Trenberth, 1997), and today, warm phases of ENSO are called "El Niño" and cool phases "La Niña". Although ENSO effects are felt globally (Glynn 1988; Bakun 1996), the major signal occurs in the equatorial Pacific with an intensity that can vary considerably from one event to another. El Niño events are associated with many atmospheric and oceanic patterns, including abnormal patterns of rainfall over the tropics, Australia, Southern Africa and India and parts of the Americas, easterly winds across the entire tropical Pacific, air pressure patterns throughout the tropics and sea surface temperatures (Reaser et. al., 2000; Kirov and Georgieva, 2002).

Impacts of variability in climate properties differ from region to region and in magnitude. While some region may benefit locally, the overall effect of global climate change is generally negative, with the developing and the poorer nations being the hardest hit. In particular, agricultural sector, especially food production appears to be more affected than other sectors of the economy. Since food production will be affected globally, food security and the attainment of the United Nations (UN) Millennium Development Goals would be threatened because global agriculture will be under intense pressure to provide food for the world teeming population from the limited and often degraded soil and water resources that have been predicted to be further stressed (Okoruwa, 2010). Climate patterns play a fundamental role in shaping natural ecosystems, the human economies and cultures that depend on them, a change in climate can affect historically synchronized pollination of crops, food for migrating birds, spawning of fish, water supplies for drinking and irrigation, forest health, and more.

The issues on climate change and adaptation in the Federal Ministry of Environment (FMENV) begins with the activities leading to the green gas emission consequence of which is the global warming. This is followed by the impact of the global warming on different facet of life and lastly, the development of adaptation strategies for mitigating or ameliorating the impact (Figure 1). Thus, adaptation has become an important issue in international and domestic discussions on climate change.

Figure 1: Climate Change Activities

Although several models have been formulated and utilized in developed countries to measure impacts of climate change as well as assessment of strategies taken to ameliorate the negative consequences of climate change, such models are scarce or nonexistent in many developing countries including Nigeria. Since climate change will have many detrimental impacts in the country, there is the need to identify and analyze methods being adopted within the indigenous agricultural systems with the aim of determining their potentials as effective and efficient adaptation strategies to cope with extremities of the prevailing climate variability.

Nigeria is characterized by high temperature regimes throughout the year. Highest temperatures occur during the dry season; rains moderate afternoon highs during the wet season. In the south, mean maximum temperatures range between 30°C-32°C while in the North, it is between 36°C and 38°C. Mean temperatures for the country are between 27°C and 29°C. Although average temperature vary little from the coastal areas to inland areas, inland areas especially the northeast have greater extremes with temperatures reaching as high as 44°C before the onset of the rains or drop as low is 6°C during an intrusion of cool air from the north from December to February. Already average temperature increases of about 0.2°C and 0.3°C have been observed within regions of the country while drought persistence has characterized the Savanna region since 1960. Science shows that climate change will continue, and accelerate, in the years ahead, with significant and catastrophic impacts on everything from our coastlines and our health to water supplies, ecosystems, agriculture and other natural resources.

Climate change impacts depend on a range of climate parameters' ranges on a country's social, cultural, geographic and economic backgrounds. The location and size of, and the characteristic relief of Nigeria give rise to variety of climate ranging from tropical rain forest climate along the coasts to Sahel climates to the northern part of the country. From the coastal areas, Nigeria is characterized by wet and long rainy seasons with annual rainfall of more than 3500mm, while the Sahel region of north-western and north-eastern parts have annual rainfall of less than 600mm. Rainfall is highly variable, low (Moretimore and Adams 2000), and concentrated in few rainy months a year (May to October) and some areas may receive annual rainfall less than 75mm while at other times of the year, the area is separated by relatively long dry months.

According to IPCC projections, rainfall in the very humid regions of southern Nigeria is expected to increase. This may be accompanied by increase in cloudiness and rainfall intensity, particularly during severe storms, which may result in shifts in geographical patterns of precipitation and changes in the sustainability of the environment and management of resources.

However, recent studies have shown that there has been precipitation decrease in the humid regions of West Africa, including parts of southern Nigeria since the beginning of the century to between 10%-25% per decade. In the Sudan-Sahel regions of northern Nigeria, there have also been records of shortages and decrease in rainfall in the range of about 30%-40% or about 3%-4% per decade. These areas are already recording seasonal and inter-annual climatic variabilities, resulting in droughts and desertification processes.

There has been a progressive early retreat of rainfall over Nigeria for more than a century now. This

has been consistent with the pattern of significant decline of rainfall frequency i.e. the number of rain days in September and October which respectively coincides with the end of the rainy season in the northern and southern parts of the country, leading to a decrease in the annual rain days over the entire country. In fact studies have provided evidence that since 1968, the start of rains has been getting progressively delayed over southern Nigeria as corroborated by the significant decline in April rainfall (Apata et al; 2009). These have resulted in low and variable rainfall; short growing periods, scarcities of soil nutrients and deep water tables in the north (Mortimore and Adams, 2000). Yet, these constraints have not restricted the diversity of technologies available in the region.

Though some places in Nigeria are experiencing a decline in rainfall and droughts, some parts in the coastal and Guinea savanna belts are reported to be experiencing increase in August rainfall amount, without a corresponding increase in rainfall frequency. This has resulted in increase in rainfall intensity causing widespread floods. Floods have become a common feature of Nigerian climate and shows that the country is concurrently experiencing extreme rainfall conditions, one of drought and the other of floods. Recent studies have also shown that there has been precipitation decrease in the humid regions of West Africa, including parts of southern Nigeria since the beginning of the century to between 10-25% per decade. In Nigeria, this is evidenced by the late arrival of rains, drying up of streams and small rivers that usually flow year round, the seasonal shifting of the "Mango rains" and that of the fruiting period in the southern Oyo State and the gradual disappearance of flood-recession cropping in riverine areas of Ondo State are among the effects of climate change in communities in the southwest Nigeria. These inconsistencies in rainfall have made it generally difficult for farmers (Macchi, 2008) and scientists (IPCC, 2001) to predict precipitation patterns. This may also suggest that future climate change will bring about further extension of many trends.

3. Methodology

3.1 Study Area

Nigeria is broadly divided into six agro-ecological regions, namely North-North, North-Central, North-East, South-South, South-East and South-West. It is located between Latitudes 40N - 140N and Longitude 20E- 140E. It has a vast land area of 923,768km^2 of which 98.6% is terrestrial, and 1.4% (13,000km^2) is taken by water . According to the land use pattern, Nigeria land is covered by three types of vegetation (Earth Trends, 2003: Figure 2), namely: Forests (areas where there is significant tree cover); Savannah (areas that have insignificant tree cover, with grasses and flowers located between trees; and Montane land (This is the least common, and is mainly found in the mountains near the Cameroonian border.)

Both the forest zone and the savannah zone are divided into three parts. Some of the forest zones mostly in the southern part, especially around the Niger River and Cross River deltas are mangrove swamp. There is also fresh water swamp, containing different vegetation from the salt water mangrove swamps, and north of that is rain forest mostly found in the South western Nigeria (Earth Trends, 2003).

The savannah zones on the other hand are;

a. Guinean forest-savanna mosaic, made up of plains of tall grass which are interrupted by trees,
b. The most common across the country; Sudan savannah, similar but with shorter grasses and shorter trees; and
c. Sahel savannah patches of grass and sand, found in the northeast.

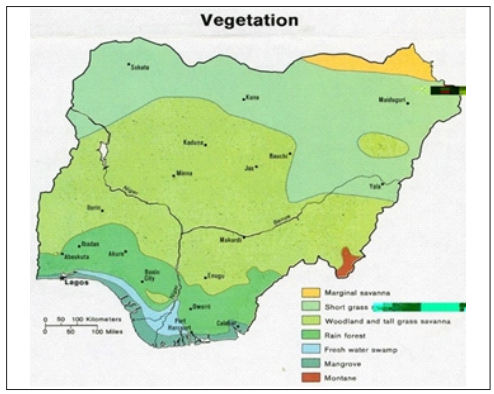

Figure 2: Vegetation Map of Nigeria

Southwest Nigeria is made up of Lagos, Ogun, Oyo, Osun, Ondo and Ekiti States (Figure 3). It is located in the coastal region of the country and is characterised by humid to sub humid eco-climate. The vegetation cover ranges from forest to savanna woodland or forest-savanna transition zones. Average annual rainfall is 1,200 to 1,500mm. Majority of inhabitants are farmers and practice farming enterprises ranging from crop production to livestock breeding, forestry practices, fisheries and aquaculture as well as agricultural processing.

A field survey was carried out in Southwest Nigeria to confirm the perspectives of farmers, extension officers and researchers on climate change issues and the efficacy of some emerging and indigenous technologies that farmers adopt and adapt to cope with the phenomenon of climate change. Southwest Nigeria is bounded in the north and east by the Kwara and Kogi States of Nigeria; in the West by the Republic of Benin and in the south by the Atlantic Ocean.

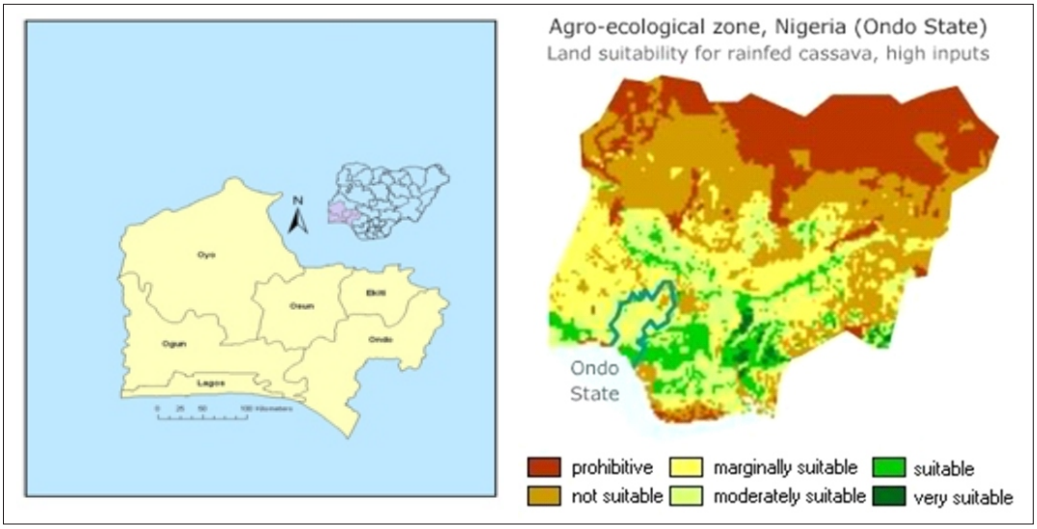

Figure 3: Map of South West Nigeria

3.2 Data Collection Procedure

The draft survey instruments were drawn up between December, 2009 and February, 2010. The draft survey instruments were then revised during an inception meeting of the project held on 13th February 2010 at the University of Agriculture, Abeokuta, Ogun State Nigeria. The comments and amendments made on the draft during this meeting were then used to prepare final versions which were then sent for comments to the ATPS Secretariat on Thursday, March 18, 2010. Comments and approval to proceed for pilot survey were received from the ATPS secretariat on April 08, 2010.

The main objectives of the pilot survey are to:

1. To pre-test the survey instrument for technical accuracy, coherence, relevance to overall objective of research and easiness of eliciting the desired information from the respondents
2. To simulate the field survey situation, have a firsthand experience, obtain preliminary information on the research topic from the respondent
3. To identify the likely hindrance to the success of the final survey exercise

4. To sensitize and prepare the target audience (Farmers, Researchers and Extension Officers alike) for the final field survey

The details of the conduct of the pilot survey are contained in a separate report. However, some preliminary findings are that farmers in the area are predominantly crop and livestock farmers, mostly middle aged, few educated male and female of varying faith and well organised into farmers and social groups. They have never participated in any climate sense programme before, but observed that industrial activity such as quarrying; transportation and deforestation resulting from urbanization are important known sources of climate change. They claimed that there is no evidence that their farming practices except bush burning which they fail to agree was having any significant contribution to climate change. In the same vein, the extension officers and researchers claimed some knowledge of climate change events, but have not undertaken and careful study of such events. It appears therefore that there will be a need for thorough training of the enumerators to elicit desired information especially from farmers to capture a broad range of outputs.

3.3 Sampling Method

The three main agro-ecological zones in the area are the swamp on the Atlantic coast, tropical rainforest in the middle and guinea savanna in the north. A random sample of three rural communities were selected from each of these agro-ecological zones from the village listing available with the Agricultural Development Programmes (ADPs responsible for field level agricultural extension services) covering the Ogun State for the swamp locations; Ondo State for the rainforest locations and Oyo State for the savanna locations. Southwest Nigeria is also home to the International Institute of Tropical Agriculture, (IITA) Ibadan; the University of Agriculture, Abeokuta, eight (8) conventional Universities with faculties of agriculture and four (4) National Agricultural Research Institutes (NARIs).

In each of the nine (9) locations selected for this study, a systematic sample of 41 farmers (taking into cognisance the variety of agricultural activities in each community) was selected from a list purposively compiled for this project. This way, 369 farmers were selected for interview by trained enumerators. These farmers cover the broad range of farming systems practices in southwest Nigeria and their perspectives on indigenous and emerging technologies and how these have or can help to cope with climate change. However, only 362 questionnaires were used for further analysis as shown in Table 1. Of these, 119 questionnaires from the swamp agro-ecological zone, 120 from the rainforest and 123 from the savanna zone giving a response rate of 98.1%. One questionnaire was rejected because many of the required information were missing.

Table 1: Response rate of the farmers' interview guides

Agro-ecological zone	Number administered	Number returned	Number used for further analysis	Response rate (%)
Swamp	123	120	119	96.7
Rainforest	123	120	120	97.6
Savanna	123	123	123	100.0
Overall	369	363	362	98.1

Furthermore, a sample 150 extension officers were systematically selected from the staff list of the Agricultural Development Programmes (ADPs) in three agro-ecological zones of Southwest Nigeria. Another sample of 30 researchers working on areas bordering climate change and agriculture were also purposively selected for this study. It was anticipated that these researchers and extension officers will provide further insights and perspectives into the farming systems in southwest Nigeria and their influence on climate change. The response rate for the extension officers' questionnaires varied between 72% in the rainforest to 100% in the swamp zone (Table 2). The low response rate to the researchers' questionnaire in the swamp zone (due mainly to the scarcity of researchers in the area brought the response rate of the researchers' questionnaire to 46.6% (Table 3).

Table 2: Response rate of the extension officers questionnaires

Agro-ecological zone	Number of questionnaires administered	Number of questionnaires returned	Number used for further analysis	Response rate (%)
Swamp	50	50	50	100.0
Rainforest	50	36	36	72
Savanna	50	39	39	78.0
Overall	150	125	125	83.3

Table 3. Response rate of the researchers questionnaires

Agro-ecological zone	Number of questionnaires administered	Number of questionnaires returned	Number used for further analysis	Response rate (%)
Swamp	10	2	2	20
Rainforest	10	5	5	50
Savanna	10	7	7	70
Overall	30	14	14	46.7

3.4 Data Analysis

The data obtained were organised in Microsoft Excel by trained data entry operators, cleaned by a member of the research team and analysed using the Statistical Package for the Social Sciences (SPSS). In addition to descriptive statistical tools to understand trends and patterns in the data, Chi square analyses was done to test a set of twenty hypotheses using data obtained at ordinal level.

Product Moment correlation analyses was used to test another set of twenty hypotheses using variables measured at interval level. The decision to reject or not to reject each hypothesis is based on the probability (p) less than 0.05. Finally, each of the 14 climate change related researchers interviewed were profiled in short case studies that attempt to showcase their climate change related credentials.

3.5 Stakeholders' workshop and policy dialogue

A one-day stakeholders' workshop and policy dialogue was held on 6th September, 2010 at the University of Agriculture, Abeokuta, Nigeria to share the preliminary findings of the study with stakeholders including policymakers, researchers, students and farmers. The aims of the stakeholders' workshop and policy dialogue are to:

1. Enhance behavioural changes towards climate change adaptation measures at individual and institutional levels in southwest Nigeria
2. Facilitate knowledge sharing for climate change adaptation; and
3. Stimulate the interest of young researchers in contributing to climate change research and capacity development, and policy discussions

The stakeholders' workshop and policy dialogue was attended by 24 participants. The key resolutions at the stakeholders' workshop and policy dialogue are:

1. The need to emphasize the negative impact of climate change
2. The cost benefit analyses of the indigenous and emerging technologies need to be determined or at least a recommendation towards this as a next step should be made.
3. Some participants wanted to know if survey instrument were done individually. Researchers explained that the instrument was jointly prepared
4. Expected specialists to document and draw salient indigenous technologies from the study e.g. the rain maker issue. The importance of not allowing personal biases to colour findings was emphasised especially as regards the religious implications of certain indigenous measures. It is important to state the facts as they were.
5. The response of researchers to the survey questionnaires focused only on their disciplines and their research foci. Only 14 questionnaires from researchers were included in the analysis. This is mainly because only researchers who claimed to have done some climate change related studies were included.
6. The full papers presented at the workshop should be refined and published in reputable academic journals to enable a wider audience have access to them.

4. Results & Findings

4.1 Description of farmers

Most of the farmers interviewed are male, married with an average 48.57 years (Table 4). A high proportion of the farmers in the savanna zone (46.34%) have had no formal education as opposed to the swamp and rainforest zones where 92.44% and 84.17% respectively have at least primary education. Christianity and Islam are the predominantly and openly declared religion in southwest Nigeria (Adebayo et al 2009b). More than 87% of the farmers declared these two religions.

Table 4: Modal classes for some socio-economic characteristics of farmers in the three agro-ecological zones of southwest Nigeria

	Agro-ecological zones			
Variables	**Swamp (n=119)**	**Rainforest (n=120)**	**Savanna (n=123)**	**Overall (n=362)**
Gender	82.35% male	68.33% male	73.98% male	74.9% male
Marital Status	90.76% married	83.33% married	63.41% married	79.0% married
Age (Mean = 48.57 years)	84.03% 41 -60 years old	66.67% 41 -60 years old	53.66% 41 -60 years old	68.0% 41 -60 years old
Highest level of formal education*	7.56% NFE	15.83% NFE	46.34% NFE	23.5% NFE
Religion	52.10% Christianity	66.67% Christianity	46.34% Christianity	55.0% Christianity
Household size (Mean = 6 persons)	45.38% 6 -10 persons	53.33% 3-6 persons	59.35% 3 - 6 persons	47.2% 3-6 persons

** NFE - No formal education*

As shown in Table 5, crop production is the dominant agricultural enterprise that farmers in southwest Nigeria engage in. It is practiced by over 90% in the savanna and rainforest zone, but only 37.82% in the swamp regions where the primary agricultural enterprise is fishing/fish farming. As with most small farmers, food processing, whether crop or fishes, takes a secondary position to farming, suggesting that value addition to primary farm products is not a primary concern of most small farmers. While tree cropping/forestry enterprise gets some mention (5.83% and 6.5%) in the rainforest and savanna zones respectively, livestock production gets mentioned in the swamp and rainforest zones only. It should be noted that the fact that no farmer in the savanna zone mentioned livestock production does not mean no livestock production takes place in the savanna zone. It

may only have reflected the general non-inclusion of migrant Fulani herdsmen who traverse this zone most part of the year as small farmers in the zone (Adebayo et al, 2008).

Table 5: Farmers' ranking of the enterprises they practice in the three agro-ecological zones of southwest Nigeria

Enterprise	Agro-ecological zones			
	Swamp (n=119)	Rainforest (n=120)	Savanna (n=123)	Overall (n=362)
Crop production	37.82	92.50	92.68	74.59
Fishing/fish farming	53.78	0.00	0.00	17.68
Tree cropping/forestry	0.00	5.83	6.50	4.14
Crop processing	2.52	0.00	0.81	1.10
Fish processing	5.04	0.00	0.00	1.66
Livestock production	0.84	0.83	0.00	0.55
Other enterprises	0.00	0.83	0.00	0.28

4.2. Description of extension officers

Majority (89.6%) of the extension officers are male with a mean age of 40.15 years (Table 6). Most of them (85.6%) are married. Christian officers dominate in the rainforest zone (88.9%), while the distribution between Christians and Muslims is almost even in the swamp and savanna zones. The mean household size is five (5) persons. The most common highest academic qualification held by 76% of the extension officers in the swamp zone, 91.7% in the rainforest and 92.3% in the savanna are the Bachelor of Science (B.Sc.) degree and Higher National Diploma (HND). In the swamp zone, an additional 14% of the extension officers hold a Master of Science (M.Sc.) and equivalent degrees. This confirms the findings of several previous studies that extension officers in southwest Nigeria hold much higher academic qualifications than their counterparts in other States of Nigeria (Akinbode, 1982; Idowu, 1988; Zaria and Omotayo, 1997; Agbamu, 2004). Extension recommendations are then expected to diffuse through these contact farmers to a minimum 800 farmers to enabling the country to achieve and extension ratio of 1:800 (Akinbode, 1982; APCU, 1999).

As shown in Table 6, the average number of contact farmers directly reached by extension officers is 246. The majority of extension officers in the savanna and swamp agro-ecological zones 97.4% and 72% respectively) reach less than 80 farmers, but only 27.8% of the extension officers in the rainforest reach less than 80 farmers. The implication of this finding is that the extension ratio in the rainforest is lower than those of the swamp and savanna zones suggesting the need to recruit more

extension officers to bridge this gap in the zone. The mean number of years spent on the job by extension officers interviewed is 10.12 years.

Table 6. Some socio-economic characteristics of extension officers in the three agro-ecological zones of southwest Nigeria

	Agro-ecological Zones			
Variable	**Swamp (n=50)**	**Rainforest n=36)**	**Savanna n=39)**	**Overall (n=125)**
Gender	94% male	86.11% male	87.18% male	89.6% male
Age (Mean = 40.15years)	54% 40-60 years old	63.89% 21-60 years old	89.74% 21 - 40 years old	62.4% 21-40 years old
Marital Status	82% married	86.11% married	89.74% married	85.6% married
Religion	56% Christianity	88.89% Christianity	46.15% Christianity	62.4% Christianity
Household size (Mean = 5.28 persons)	46% 3-6 persons	36.11% 3-6 persons	82.05% 3-6 persons	54.4% 3-6 persons
Highest academic qualification	42% HND	55.56% HND	66.67% BSc.	44.8% BSc.
Number of contact farmers (Mean = 246.12 farmers)	72% less than 80 farmers	33% more than 160 farmers	97.44% less than 80 farmers	67.2% Less than 80 farmers
Number of years on the job as an extension (Mean =10.12 years)	74% Above 10 years	38.89% Less than 3 years	43.59% 3-6 years	42.4% Above 10 years

Many of the agricultural extension officers in the swamp (34%) and the rainforest (50%) specialize in Agricultural Economics and Extension (Table 7). In the savanna, the commonest specialization among extension officers (30.8%) is Plant Science and Crop Production. Conversely, only 2% of the officers in the swamp zone and 2.8% in the rainforest compared to 12.8% in the savanna zone. It is noteworthy however that 24% of the extension officers in the swamp zone are general agriculturists and therefore could provide extension services to the fishery enterprise.

Table 7: Area of specialization of extension officers in the three agro-ecological zones of southwest Nigeria

Specialization	Agro-ecological Zones			
	Swamp (n=50)	Rainforest (n=36)	Savanna (n=39)	Overall (n=125)
General Agriculture	24.00	5.56	0.00	11.20
Agricultural Economics and Extension	34.00	50.00	12.82	32.00
Agricultural Mechanization	0.00	0.00	2.56	0.80
Animal Science and Livestock Production	8.00	8.33	33.44	16.00
Natural Sciences	2.00	5.56	0.00	2.40
Plant Science and Crop Production	20.00	25.00	30.77	24.80
Fishery	2.00	2.78	12.82	5.60
Forest management	2.00	0.00	2.56	1.60
Soil science	0.00	0.00	5.13	1.60
No Response	8.00	2.78	0.00	4.00

4.3. Description of climate related researchers

Only 14 researchers working on climate change related issues responded to the questionnaire survey (Figure 4). Of these, half are based in Ibadan (savanna zone) where most of the research institutes in southwest Nigeria have their main offices, five (5) are based in Akure (rainforest) and two (2) are based in Abeokuta (swamp). These locations (Ibadan, Akure and Abeokuta) are capital cities respectively in Oyo, Ondo and Ogun States and not necessarily located in the agro-ecological zones where the researchers carry out their work. For instance, Abeokuta is located in the transition ecology between the rainforest and the savanna, even though the study locations in Ogun State where the researchers interviewed conduct their fieldworks (Ogun Waterside LGA) is in the swamp agro-ecological zones.

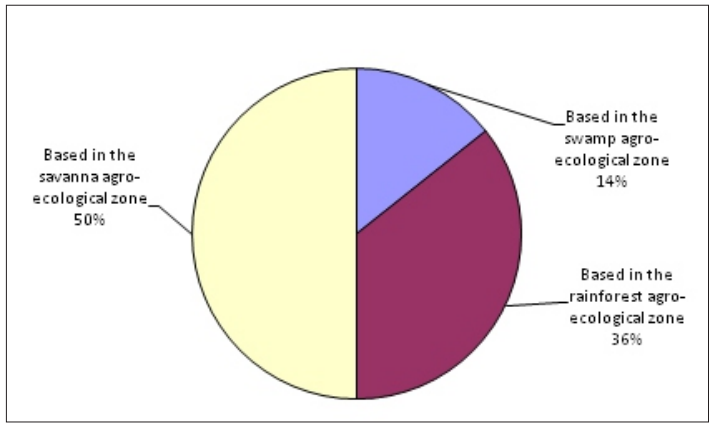

Figure 4: Distribution of climate related researchers by agro-ecological zones in southwest Nigeria

Due to this low response rate, a small part of the data obtained have been subjected only to frequency counts and presented in pictorially in pie and bar charts. The detailed response of each researcher was however used to present 14 short cases that show the range of researchers and the nature of research works that they are carrying out on climate change. As shown in Figure 5, six of the researchers hold a M.Sc. one had an M.Phil and five hold PhDs in their respective fields. The minimum number of years on the job as a researcher spent by any of them is 1.5years while the maximum is 30 years. As shown in Figure 6, half of them have spent less than five (5) years on the job. In terms of the agricultural enterprises on which their research is focused, 9 of them work on crop production related enterprises, six (6) work on tree cropping and forestry related issues, (four) 4 carry out their research on fishing and fish farming, and carry out their research on livestock enterprises (Table 8). All of them have noticed climate change phenomena in their vicinity. Unlike farmers and extension officers, researchers rely on external sources (not friends and family) for information on climate change. As shown in Figure 7, their major sources of information are personal observation, the internet, television, research institutes and radio.

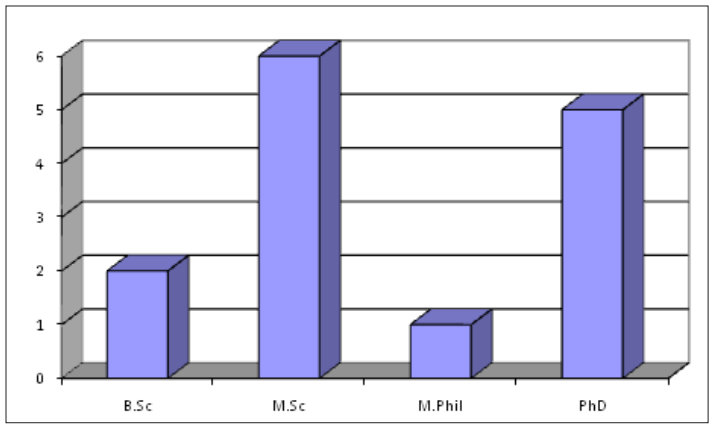

Figure 5: Highest academic qualification of climate related researchers in southwest Nigeria

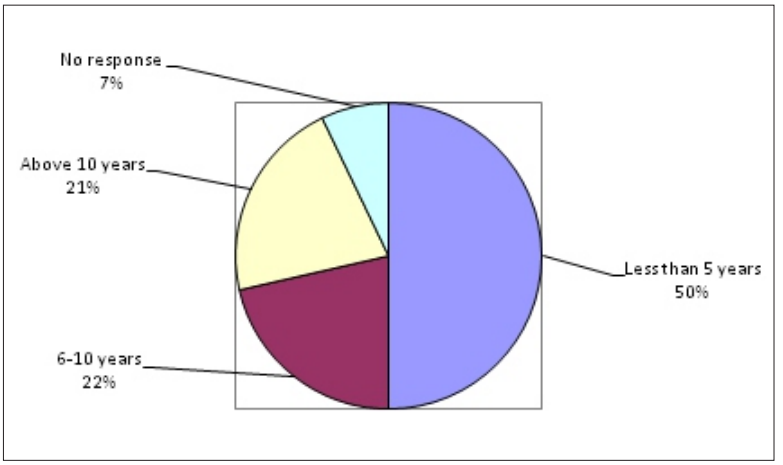

Figure 6: Number of years on the job by climate related researchers in southwest Nigeria as a researcher

Table 8. Ranking of agricultural enterprises on which climate related researchers focus in southwest Nigeria

	Frequency of Ranks						
Enterprise	**1st**	**2nd**	**3rd**	**4th**	**5th**	**Ranked Score***	**Overall rank**
Crop Production	7	1	0	1	0	41	1st
Crop Processing	0	1	1	0	1	8	6th
Livestock production	3	0	0	1	0	17	4th
Fishing and fish farming	2	2	0	0	0	18	3rd
Fish processing	0	1	1	0	0	7	7th
Tree cropping/Forestry	1	3	1	0	1	21	2nd
Other Enterprises	1	1	0	0	0	9	5th

** The ranked score is obtained by the sum of the products of frequency of rank and a matching score of 5 points for 1st, 4 points for 2nd, 3 points for 3rd, 2 points for 4th and 1 point for 5th.*

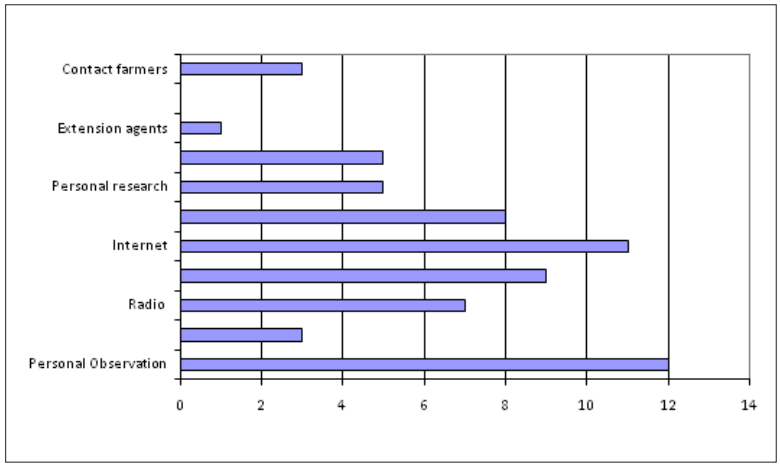

Figure 7: Climate related researchers' sources of information about climate change

4.4. Climate sense among Farmers and Extension Officers in South West Nigeria

Overall, there is a high level of climate awareness among farmers and extension officers in southwest Nigeria. In the three ecological zones, about 94% of the farmers claimed to be aware of climatic variability. More than 93% of them are in the swamp and rainforest zones perceived that temperatures have become higher while only 56% agree in the savannah zone. About 40% were certain that temperatures are yet stable (Figure 8). In the same vein, majority of the extension officers (about 90%, except in the rainforest where it is 61%) have observed higher environmental temperatures in southwest Nigeria. It is possible that the presence of many trees proving shades in the rainforest may have influenced the observation of extension officers in this zone.

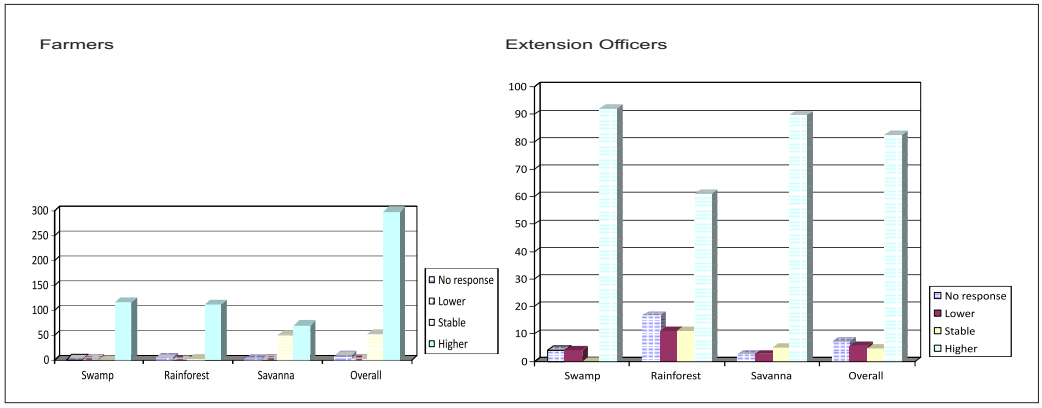

Figure 8: Changes observed in environmental temperature in the three agro-ecological zones of southwest Nigeria

Information on rainfall shows that 94% and 81% of farmers in swamp and rainforest zones respectively observed decline in rainfall while less than 20% of the farmers disagree and argued that rainfall was stable in the savanna zone. Similarly, more than 80% of the extension officers in the swamp and savanna agro-ecological zones concur that rainfall volumes have been lower (Figure 9). Only 55% of the officers in the rainforest appear convinced that rainfall volumes have been lower. Again, this may be the influence of particular micro-environments.

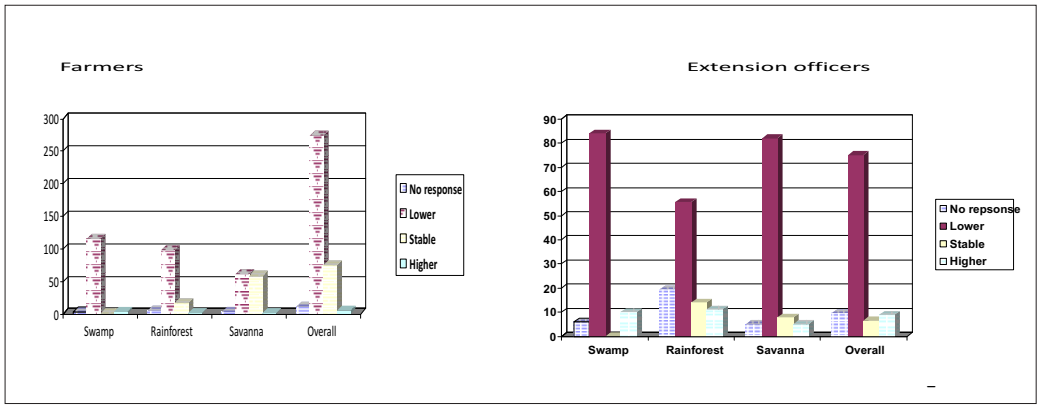

Figure 9. Changes observed in rainfall volume in the three agro-ecological zones of southwest Nigeria

While about 87% of the farmers generally agreed that there has been variability in wind patterns, further analysis present interesting scenarios in the zones. In the swamp zone for example, only half of the farmers acknowledged that there is higher winds while almost the same proportion argued otherwise. On the other hand, a very large proportion of 85% of farmers in the rain forest observed lower winds while almost the same proportion of farmers in savanna zone observed higher winds. Expect in the savanna agro-ecology, there is no clear-cut opinion among extension officers as to their observation of wind variability in southwest Nigeria. While more than 80% of the extension officers in the savanna zone concur that they have observed higher wind variability, only about 7% of the officers in the rainforest and 47% in the swamp claim to have observed higher wind variability (Figure 10). In fact, about 30% of the extension officers in the swamp zone claim to observe lower wind variability. The officers in the rainforest (55%) opine that wind variability have been stable. It is to be expected that the openness of the savanna agro-ecology will make variations in wind variability as opposed to a rainforest environment. In the swamp the differences of opinion would arise between farmers operating in the mangrove and those operating more in the open water bodies.

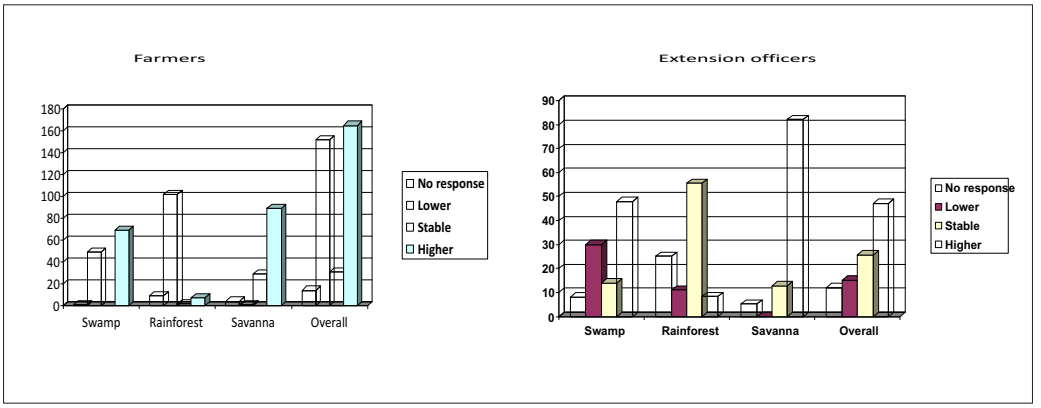

Figure 10: Changes observed in wind variability in the three agro-ecological zones of southwest Nigeria

4.5. Socio-Economic Factors influencing farmers' observation of general climate change phenomena

Of the 10 hypotheses tested using farmers' observation of general climate change phenomena as the dependent variables, only location, that is the agro-ecological zone where the farmer is located provides a significant insight into the variability in farmers' observation (Tables 9 and 10). Therefore, the hypothesis that framers' observation of general climate change phenomena is independent of their agro-ecological zone is rejected while all others were not. The import of this finding is that irrespective of farmers' socio-economic standing such as gender, marital status, level of formal education, religion, age, household size and income from various occupations; their opinion of what changes they observe in the general climatic phenomena is similar. This should be so; after all there are no specific climatic conditions for different socio-economic stations among human beings. This generalization may not however hold when farmers' observation of specific climate change variables are examined more closely.

Table 9: Results of Chi square analysis (Dependent variable = farmers observation of general climate change phenomena)

Independent variable	Chi square value	df[1]	Asymp. Sig. (2- sided)	Decision[2]
Agro -ecological zone	20.22	6	0.00	Reject H_{01}
Gender	2.24	4	0.69	Do not reject H_{02}
Marital status	8.81	6	0.19	Do not reject H_{03}
Highest level of formal education attained	18.80	14	0.17	Do not reject H_{04}
Religion	5.09	6	0.53	Do not reject H_{05}

1.df – Degrees of freedom
2.H01 – Farmers' observation of general climate change phenomena is independent of their agro-ecological zone
H_{02} - Farmers' observation of general climate change phenomena is independent of their gender
H_{03} - Farmers' observation of general climate change phenomena is independent of their marital status
H_{04} - Farmers' observation of general climate change phenomena is independent of their highest level of formal education attained
H_{05} - Farmers' observation of general climate change phenomena is independent of their religion

Table 10. Results of Correlation analysis (Dependent variable = farmers observation of general climate change phenomena)

Independent variable	Correlation Coefficient (r)	Sig. (2-tailed)	Decision*
Age (years)	0.03	0.59	Do not reject H_{01}
Household size (persons)	-0.01	0.92	Do not reject H_{02}
Annual Income from Primary Occupation (Naira)	0.06	0.24	Do not reject H_{03}
Annual Income from Secondary Occupation (Naira)	-0.02	0.74	Do not reject H_{04}
Annual Income from Tertiary Occupation (Naira)	-0.09	0.09	Do not reject H_{05}

** H_{01} – Farmers' observation of general climate change phenomena is not significantly related to their age*
H_{02} - Farmers' observation of general climate change phenomena is not significantly related to their household size
H_{03} - Farmers' observation of general climate change phenomena is not significantly related to their estimated annual income realized from primary occupation
H_{04} - Farmers' observation of general climate change phenomena is not significantly related to their estimated annual income realized from secondary occupation
H_{05} - Farmers' observation of general climate change phenomena is not significantly related to their estimated annual income realized from tertiary occupation

4.6. Farmers' observation of changes in environmental temperature

The results of Chi square and correlation analysis respectively for the 10 null hypotheses are shown in Tables 11 and 12. As expected, location (agro-ecological zone) remains a significant variable in indicating the variability in the farmers' observation of changes in environmental temperature. However, in addition to this, farmers' marital status, highest level of formal education attained, income from primary and tertiary occupations also contribute to the explanation of farmers' observation of changes in environmental temperature.

It is conceivable that farmers with higher levels of education would hold a stronger view of their understanding of changes in temperature than the less formally educated. More formally educated farmers would relate with and follow trends in temperature changes reported in written media and thus shape their observations in ways different from less formally educated farmers.

Table 11: Results of Chi square analysis (Dependent variable = farmers" observation of changes in environmental temperature)

Independent variable	Chi square value	df	Asymp. Sig. (2-sided)	Decision
Agro-ecological zone	105.67	6	0.00	Reject H_{01}
Gender	1.90	6	0.93	Do not reject H_{02}
Marital status	19.75	9	0.02	Reject H_{03}
Highest level of formal education attained	64.07	21	0.00	Reject H_{04}
Religion	12.66	9	0.18	Do not reject H_{05}

df – Degrees of freedom
H_{01} – Farmers' observation of changes in environmental temperature is independent of their agro-ecological zone
H_{02} - Farmers' observation of changes in environmental temperature is independent of their gender
H_{03} - Farmers' observation of changes in environmental temperature is independent of their marital status
H_{04} - Farmers' observation of changes in environmental temperature is independent of their highest level of formal education attained
H_{05} - Farmers' observation of changes in environmental temperature is independent of their religion

Table 12. Results of Correlation analysis (Dependent variable = farmers observation of changes in environmental temperature)

Independent variable	Correlation Coefficient (r)	Sig. (2-tailed)	Decision
Age (years)	0.02	0.68	Do not reject H_0
Household size (persons)	0.077	0.14	Do not reject H_0
Annual Income from Primary Occupation (Naira)	0.36	0.00	Reject H_0
Annual Income from Secondary Occupation (Naira)	0.00	1.00	Do not reject H_0
Annual Income from Tertiary Occupation (Naira)	0.24	0.00	Reject H_0

** H_{01} – Farmers' observation of changes in environmental temperature is not significantly related to their age*
H_{02} - Farmers' observation of changes in environmental temperature is not significantly related to their household size
H_{03} - Farmers' observation of changes in environmental temperature is not significantly related to their estimated annual income realized from primary occupation
H_{04} - Farmers' observation of changes in environmental temperature is not significantly related to their estimated annual income realized from secondary occupation
H_{05} - Farmers' observation of changes in environmental temperature is not significantly related to their estimated annual income realized from tertiary occupation

Furthermore, farmers earning higher income from their primary occupation may be expected to spend part of that income on environmental temperature management devices such as fans, air conditioners or warmers where changes are perceived or anticipated in environmental temperature. Farmers earning less income would however be constrained by availability of funds to respond as positively or promptly as their higher income colleagues. As such, over time or within a large group, these two groups may express their observation of changes in environmental temperatures in significantly different ways.

On the contrary, it is within reason that people who require a tertiary income source to augment their primary income sources would respond in a different way to changes in environmental temperature from those who do not require a tertiary income source. The result in Table 18 shows that the higher the income from a tertiary income source, the higher the tendency that a farmer would observe that environmental temperature is lower. This could be explained by a feeling of the need to justify the need for income from a tertiary source to cope with lower environmental temperature.

4.7. Farmers' observation of changes rainfall volume

Location (agro-ecological zone) is again significantly explains the variability observed in the observation of changes in rainfall volume by farmers in southwest Nigeria (Table 13). As with temperature, marital status, level of formal education attained, income from primary and tertiary occupations also come into play (Tables 13 and 14). The new variable significantly providing the insight into the variability in farmers' observation of changes in rainfall volume is age (Table 14).

The result shows that the older farmers tend to observe that rainfall volume is lower and younger ones tend to think otherwise. It is possible to explain this difference of opinion between old and young farmers to relative inexperience for the young farmers.

Table 13: Results of Chi square analysis (Dependent variable = farmers' observation of changes rainfall volume)

Independent variable	Chi square value	df	Asymp. Sig. (2-sided)	Decision
Agro-ecological zone	90.70	6	0.00	Reject H_0
Gender	7.54	6	0.27	Do not reject H_0
Marital status	26.15	9	0.00	Reject H_0
Highest level of formal education attained	84.13	21	0.00	Reject H_0
Religion	11.22	9	0.26	Do not reject H_0

df – Degrees of freedom
H_{01} – Farmers' observation of changes rainfall volume is independent of their agro-ecological zone
H_{02} - Farmers' observation of changes rainfall volume is independent of their gender
H_{03} - Farmers' observation of changes rainfall volume is independent of their marital status
H_{04} - Farmers' observation of changes rainfall volume is independent of their highest level of formal education attained
H_{05} - Farmers' observation of changes rainfall volume is independent of their religion

Table 14: Results of Correlation analysis (Dependent variable = farmers observation of changes in rainfall volume)

Independent variable	Correlation Coefficient (r)	Sig. 2-tailed)	Decision
Age (years)	-0.11	0.03	Reject H_0
Household size (persons)	-0.09	0.08	Do not reject H_0
Annual Income from Primary Occupation (Naira)	-0.26	0.00	Reject H_0
Annual Income from Secondary Occupation (Naira)	0.06	0.22	Do not reject H_0
Annual Income from Tertiary Occupation (Naira)	0.26	0.00	Reject H_0

** H_{01} – Farmers' observation of changes in rainfall volume is not significantly related to their age*
H_{02} - Farmers' observation of changes in rainfall volume is not significantly related to their household size
H_{03} - Farmers' observation of changes in rainfall volume is not significantly related to their estimated annual income realized from primary occupation
H_{04} - Farmers' observation of changes in rainfall volume is not significantly related to their estimated annual income realized from secondary occupation
H_{05} - Farmers' observation of changes in rainfall volume is not significantly related to their estimated annual income realized from tertiary occupation

4.8 Farmers' observation of changes in wind variability

As with other climate variables, location (agro-ecological zone), marital status, level of formal education and income from primary occupation (Tables 15 and 16) provide a significant insight into the differences in farmers' observation of changes in wind variability (Table 15). As with observation of changes in rainfall volume, age also contributed to the insights into farmers' observation of the changes observed in wind variability in southwest Nigeria. In addition to these variables, the hypothesis that farmers' observation of changes in wind variability is independent of their religion was also rejected.

Table 15: Results of Chi square analysis (Dependent variable = farmers' observation of changes in wind variability

Independent variable	Chi square value	df	Asymp. Sig. 2-sided)	Decision
Agro-ecological zone	223.78	6	0.00	Reject H_0
Gender	2.46	6	0.87	Do not reject H_0
Marital status	21.21	9	0.01	Reject H_0
Highest level of formal education attained	99.31	21	0.00	Reject H_0
Religion	38.91	9	0.00	Reject H_0

df – Degrees of freedom
H_{01} – Farmers' observation of changes in wind variability is independent of their agro-ecological zone
H_{02} - Farmers' observation of changes in wind variability is independent of their gender
H_{03} - Farmers' observation of changes in wind variability is independent of their marital status
H_{04} - Farmers' observation of changes in wind variability is independent of their highest level of formal education attained
H_{05} - Farmers' observation of changes in wind variability is independent of their religion

Table 16: Results of Correlation analysis (Dependent variable = farmers observation of changes in wind variability)

Independent variable	Correlation Coefficient (r)	Sig. (2-tailed)	Decision
Age (years)	-0.14	0.01	Reject H_{01}
Household size (persons)	0.008	0.88	Do not reject H_{02}
Annual Income from Primary Occupation (Naira)	-0.385	0.00	Reject H_{03}
Annual Income from Secondary Occupation (Naira)	-0.175	0.00	Reject H_{04}
Annual Income from Tertiary Occupation (Naira)	0.079	0.14	Do not reject H_{05}

** H_{01} – Farmers' observation of changes in wind variability is not significantly related to their age*
H_{02} - Farmers' observation of changes in wind variability is not significantly related to their household size
H_{03} - Farmers' observation of changes in wind variability is not significantly related to their annual income from primary occupation
H_{04} - Farmers' observation of changes in wind variability is not significantly related to their annual income from secondary occupation
H_{05} - Farmers' observation of changes in wind variability is not significantly related to their estimated annual income realized from tertiary occupation

4.9 Farmers' Perspectives on the Causes and Effects of Climate Change in Southwest Nigeria

Table 17 presents famers' perspectives on the causes of climate change in southwest Nigeria. Most of the farmers (65.75%) opine that farming activities such as bush burning, use of agro-chemicals and deforestation are the key causes of climate change. This is more so in the swamp agro-ecological zone where 84.03% of the farmers claim that farming activities are the main cause of climate change.

In addition to farming activities, about a quarter of the farmers interviewed (more than half in the rainforest zone) perceive urbanization as another key cause of climate change (Table 17). The examples given are: civilization (increasing numbers of vehicles, and other CFC emitting utilities, deforestation to make way for rapidly expanding urban areas, emission of gases and improper disposal of urban wastes especially in slums that tend to be an appendage of all major urban areas.

Table 17: Farmers' perspectives on the causes of climate change in the three agro-ecological zones of southwest Nigeria and their examples

	Agro-ecological zones*				
Causes	**Swamp (n=119)**	**Rainforest (n=120)**	**Savanna (n=123)**	**Overall (n=362)**	**Examples**
Industrial activities	9.24	30.83	3.25	14.36	Construction, Emissions of gases, Flaring of gases, Petroleum, Quarry, Smoke from diesel or petrol engines, Smoking, Use of Chemicals, Water Pollution
Farming activities	84.03	55.83	57.72	65.75	Bush burnin g, Chemicals (herbicides), Deforestation
Transportation	8.40	17.50	9.76	11.88	Emission of dangerous gases, Smoke from diesel or petrol engine
Agro processing	3.36	19.17	6.50	9.67	Agro Allied waste, Deforestation, Pesticides, Release of smokes, Smoking
Urbanization	4.20	55.00	17.07	25.41	Civilization, Deforestation, Emission of gases, Improper disposal of waste discharge

** Note multiple responses*

Even though only 14.36% of the farmers interviewed (30.8% in the rainforest zone) mentioned industrial activities as the main cause of climate change, the variety of examples of industrial activities given by the farmers were more varied (Table 17). These are: use of industrial chemicals, construction activities, emission of gases, flaring of gases, use of petroleum products, quarrying activities, smoke from diesels and petrol engines, smoking by industrial workers and water pollution. Transportation and agro-processing activities were identified as causes of climate change by 11.88% and 9.67% of the farmers respectively (Table 17). As in other identified causes of climate change, the proportion of farmers who pointed this out in the rainforest are more than those of the swamp and savanna agro-ecological zones.

Table 18 shows farmers' perspectives of the how climate change had affected them personally. The most common description of how climate change had affected farmers personally is reduction in their personal productivity. This opinion is expressed by 96.6% of the farmers in the swamp zone, 60.8% in the rainforest and 68.3% in the savanna. In addition, one-quarter of the farmers in the rainforest opine that climate change had created much personal discomfort for them.

Table 18: Farmers' perspectives on the main way has climate change affected them personally in the three agro-ecological zones of southwest Nigeria

Climate change effect	Agro-ecological zones			
	Swamp (n=119)	Rainforest (n=120)	Savanna (n=123)	Overall (n=362)
Reduce productivity	96.64	60.83	68.29	75.14
Create discomfort	0.00	25.00	1.63	8.84
Health hazards	0.00	6.67	5.69	4.14
Increased flooding*	1.68	0.83	0.00	0.83
Longer period of heat stress	0.00	0.00	2.44	0.83
Emergence of new diseases	0.00	0.00	0.81	0.28
More windstorms leading to property destruction	0.00	0.00	0.81	0.28
No response	1.68	6.67	20.33	9.67

** There is high occurrence of malaria fever when the villages are flooded*

In both rainforests and savanna zones, 6.7% and 5.7% respectively of the farmers reported health hazards due to climate change. Even though increased flooding affecting them personally was only reported by 1.7% of the farmers in the swamp zone and 0.83% in the rainforest, higher incidence of malaria was reported in villages that were flooded than those that were not suggesting longer term impact of labour availability and expenses on medical expenses. The difficulty with this analysis is that, we have not established a relationship between climate change and incidence of diseases. Malaria for example can be reported but we cannot in any way imply that it has any link with climate change.

In terms of climate change effects on their farming enterprises, reduction in crop yield were reported by 60% of the farmers interviewed (Table 19). Over 90% of the farmers in the savanna zone reported this. In the rainforest, in addition to about 40% noting reduction in crop yield as the major effect of climate change on their farming enterprises, 46.7% of the farmers also noted a general low level of farm productivity as a consequence of climate change. In the swamp zone, there was concern about increased incidence of storms damaging boats, nets and increased incidence of boats capsizing during storms.

Table 19: Farmers' perspectives on the main ways climate change has affected their farming enterprises

Climate effect	Agro-ecological zones			
	Swamp (n=119)	Rainforest (n=120)	Savanna (n=123)	Overall (n = 362)
None	0.00	0.00	4.07	1.38
Reduction in crop yield	47.06	39.17	93.50	60.22
Low productivity	0.00	46.67	0.00	15.47
Storms damage boats, nets, capsized boats	42.86	0.00	0.00	14.09
Windstorm damages buildings	5.04	0.00	0.00	1.66
Outbreak of diseases	0.00	3.33	0.00	1.10
Windstorms destroying processing sheds	2.52	0.00	0.00	0.83
Others (Evapotranspiration , Excessive rainfall damages roads , High livestock mortality , High temper ature led to migration of fishes Longer heat stress on crop plants	2.52	1.66	2.43	2.24
No response	0.00	9.17	0.00	3.04

4.10 Emerging and Indigenous Technologies for Climate Change Adaptation

Coping with climate change had become essential part of farmer's life in southwest Nigeria. The main strategies and technologies promoted by extension officers for farmers to cope with the effects of climate change in southwest Nigeria are presented in Table 20. The focus is on tree planting (30%), timely planting of crops (6%) and avoidance of bush burning (6%) in the swamp zone. In the rainforest zone, it is provision of small scale irrigation (25%), mulching (16.7%) especially on yam farms, and avoidance of felling tress (8.3%). In the savanna zone the main coping strategies and technologies are: avoidance of tree felling (25.6%), avoidance of bush burning (23.1), small scale irrigation (5.15) and studying weather condition before planting crops (5.1%).

It appears that farmers in the savanna agro-ecological zone may not be as advanced along this line as their counterparts in the swamp and rainforest zones. As shown in Table 21, 52.9% of the farmers in this zone have not yet adopted any strategy or technology to cope with climate change. Given that farmers in this zone earn less from their primary occupation (farming) than in the other two agro-ecological zones, one is tempted to attribute financial limitations as a key constraint in this regard.

Table 20: Strategies/technologies promoted by extension officers in coping with the effects of climate change

Strategies/technologies	Agro-ecological zone			
	Swamp (n=50)	Rainforest (n=36)	Savanna (n=39)	Overall (n=125)
None	0.00	0.00	2.56	0.80
Tree planting	30.00	0.00	0.00	12.00
Irrigation	8.00	25.00	5.13	12.00
Avoid fell ing trees	2.00	8.33	25.64	11.20
Avoid bush burning	6.00	0.00	23.08	9.60
Mulching	0.00	16.67	0.00	4.80
Studying the weather condition before planting	4.00	5.56	5.13	4.80
Belonging to a co -op society to get informed	6.00	0.00	0.00	2.40
Plant when rain i s steady	8.00	0.00	0.00	3.20
Prayer for God's intervention	8.00	0.00	0.00	3.20
Delaying in planting	4.00	0.00	2.56	2.40
Use of net in fish pond	4.00	0.00	0.00	1.60
Promote improve farming practices both in crop and livestock	4.00	0.00	0.00	1.60
Fadama	0.00	5.56	0.00	1.60
By using high resistant varieties	0.00	0.00	5.13	1.60
Others	12.00	0.00	2.56	7.2
No response	4.00	38.89	28.21	21.60

Table 21: Major strategies/technologies adopted by farmers in coping with effects of climate change

Strategies/technologies	Agro-ecological zones			
	Swamp (n=119)	Rainforest (n=120)	Savanna (n=123)	Overall (n=362)
No adopted strategy	0.00	0.00	52.85	17.96
Construction of drainages	86.55	0.00	0.00	28.45
Irrigation	0.00	48.33	16.26	21.55
Afforrestation	0.00	8.33	0.00	2.76
Channelization of beds	5.88	0.00	0.00	1.93
FADAMA	0.00	4.17	0.00	1.38
Planting date adjustment	3.36	0.00	4.88	2.76
Planting of drought tolerant crops	1.68	0.00	0.00	0.55
Fertilizer application	0.00	2.50	0.00	0.83
Use of pesticides	0.00	1.67	0.00	0.55
Mulching	0.00	2.50	0.00	0.83
Consult the rain maker	0.00	0.00	1.63	0.55
Prayers to God	1.68	0.00	0.00	0.55
Provision of shelter	0.00	1.67	0.00	0.55
Others	0.84	7.47	0.81	3.08
No response	0.00	23.33	23.58	15.75

4.10.1 Construction of simple drainages

The main coping strategy adopted by farmers in the swamp zone is the construction of drainages. This is done by 87% of the farmers in this zone (Table 21). Draining of swamps is usually done to restore previously unusable land into useful much-needed space for farming or even building. Lowering the level of the land to such an extent that it drains by gravity is not without its fair share of problems. For instance, draining can upset the natural habitat and threaten wildlife and plant systems.

In the swamp communities drainages are constructed as a communal activity. It involves the use of simple tools such as diggers and shovels to create a large open ditch near to the swamp. The ditch would be at least one metre below the surface of the land often with a gradient in the normal direction of water flow to allow for drainage. Sometimes, several smaller ditches of about 60-90cm deep are made to run between the swamp and the new open ditch. These will be the foundation for the drainage channels and should slope downwards towards the new ditch, allowing water to run off. These simple open drainages are used by farmers in the swamp zone to cope with incessant flooding sometimes attributed to changing climatic regimes.

4.10.2 Small-scale irrigation

In the rainforest and savanna agro-ecological zones, 48.3% and 16.3% of the farmers respectively

are coping with water shortage for farming activities by adopting small-scale irrigation systems (Table 21). These systems are usually on small plots, in which small farmers have the controlling influence, using a level of technology which they can operate and maintain effectively. Although some small-scale irrigation systems serve an individual farm household, most serve a group of farmers, typically comprising between 5 and 50 households. The range of technologies referred to as small-scale irrigation include a range of technologies to control water from floods, stream-flow, or pumping. In flood cropping, flood plains are managed by framers to raise crops during part of the growing season. In stream diversion (gravity supply) irrigation, small water reservoirs are made along streams and guided by open channels to farmlands. In lift irrigation (pump supply), water is pumped through channels leading to the farm from a water body which may be a reservoir, a well or other water sources.

4.10.3 Fadama Farming

Fadama is the Hausa (northern Nigeria where the agro-ecology is drier guinea and sahel savanna) name for irrigable land including flood plains and low lying areas underlined by shallow aquifers and found along Nigeria's river system. In the traditional farming systems of southwest Nigeria, fadama farming is new and is mainly adopted as response to changing climatic conditions. It is adopted by 4.2% of the farmers in this agro-ecological zone (Table 21). Fadama farming became more popular in southwest Nigeria in the 1990s when the National Fadama Development Project (NFDP) popularly called FADMA Project was introduced as a major instrument for achieving the government's poverty reduction objective in the rural areas of Nigeria (Adebayo, 2004).

4.10.4 Afforestation

Afforestation is planting seeds or trees to make a forest on land which has not been a forest recently, or which has never been a forest. It is adopted by 8.3% of the farmers in the rainforest zone to replace forest lands that are that are either no longer use for crop cultivation or as part of an improved fallow system (Table 21). In an improved fallow, fast growing plant species (usually legumes) are deliberately primarily for rapid replenishment of soil fertility. Other services provided by fallows include fuel wood production, recycling of nutrients other than nitrogen, provision of carbon supply to soil microorganisms, weed suppression, Striga control and improved soil water storage. Large-scale adoption of short-term improved fallows by farmers has been taken place in many tropical nations (Buckles and Tromphe, 1999; Bunch, 2000; Franzel, 1999; Kwesiga et al, 1999).

4.10.5 Integrated Pest management (IPM)

Integrated Pest management (IPM) is a knowledge intensive, food safety concern and agricultural environmental degradation reduction technique. It is a system of practices for minimizing the impact of pests on the environment by using a variety of control procedures and attempting to decrease the overall chemical inputs. IPM combines chemical, cultural and biological practices into one programme to manage pest populations. Pesticide applications are carefully timed and combined with other pest management practices to reduce the needs for frequent applications (Ooi, 2000). Various components of this practice is found in the three agro-ecological zones of southwest Nigeria. As shown in Table 21, 3.4% of the farmers in the swamp zone and 4.9% in the savanna zone have adopted adjustment of planting dates, 1.7% of the farmers in the swamp zone have adopted drought tolerant crops traditional grown only in the savanna zone. Fertilizer

application and use of pesticides have now been adopted by 2.5% and 1.7% of the farmers in the rainforest zones respectively. All these are reflection of changing farm practices as climate and its follow-on dynamics hit various agro-ecological zones of southwest Nigeria.

4.10.6 Mulching

Mulching is adopted by 2.5% of the farmers in the rainforest zone mainly as an important cultural practice in the cultivation of early yams (Table 21). Land preparation for early yam normally commences with the onset of dry season (November-December) in this humid tropical environment. Mulch is required to keep the micro-environment for yam setts optimum for germination and shoot formation. Since yams are planted on large heaps which require total clearing of land before construction. Mulching with cut grass or other vegetative matter improves nutrient and water retention in the soil and encourages favourable soil microbial activity and suppresses weed growth. When mulching is not done or available naturally, the living soil is easily robbed of its natural nutrient stores, becomes leached and often desiccates.

4.10.7 Rain making and praying to God

People's religious beliefs often influence their perception. As such 1.7% of the farmers in the swamp and 1.6% of those in the savanna are adopting prayer to God and consulting the rain maker as coping strategies for flooding and shortage of rain respectively (Table 7). Rain making is within the purview of traditional religious worship in many rural communities in southwest Nigeria. It had waned in popularity as Christianity and Islam took hold as the major religions in the area. Rain making involves the use of some concoctions along with incantations to induce rain. The believers of rain making claim that when used, rain would fall in the farm(s) of adherents alone, but if it is a demand by the community or its king, rain would fall in the supplicant community only. The efficacy of this coping strategy or its best practice formula has not been documented.

As shown in Table 22, only 5.6% of the extension officer sees farmers' refusal to adopt extension message as a key constraint to implementing climate change adaptation strategies in southwest Nigeria. Financial constraints is seen by 74% of the officers in the swamp zone, 38.9% in the rainforest and 10.3% in the savanna as the key constraints to implementation climate change adaption strategies in southwest Nigeria. The only other major constraint mentioned by the extension officers in the swamp (2%) and rainforest (11.1%) zones is illiteracy.

Table 22: Extension officers' perspectives of the constraints for implementing climate change adaptation strategies

Constraints	Agro-ecological zone			
	Swamp (n=50)	Rainforest (n=36)	Savanna (n=39)	Overall (n=125)
None	0.00	0.00	53.85	16.80
No response	10.00	38.89	33.33	25.60
Financial incapability	74.00	38.89	10.26	44.00
Refusal to adopt extension messages	8.00	5.56	2.56	5.60
Illiteracy	2.00	11.11	0.00	4.00
Others	6.00	5.56	0.00	4.00

4.11 Case Studies of 14 Climate Related Researchers in Southwest Nigeria

The distribution of the 14 climate related researchers interviewed according to their areas of specialisation are presented in Table 23. Three of them are agricultural economists; two each are fisheries and soil scientist while other areas of specialisation such as agro-metrology, animal science, crop management, entomology, forest ecology and conservation, forestry and wildlife as well as plant pathology are represented by one respondent each. This may be an indication of the overall dearth of climate related researchers in Africa. It may also reflect the fact that the relevance of the influence of climate change issues to various areas of specialisation in agriculture is only beginning to gain ground in southwest Nigeria despite the predominance of agricultural research institutes and higher institutions of learning offering courses in agriculture and related fields.

The remaining of this section is dedicate to stating the response of the 14 researchers as case studies of climate related researchers in southwest Nigeria

Table 23: Area of specialization of climate related researchers in southwest Nigeria

Area of Specialization	Frequency	Percent
Agricultural Economics	3	21.4
Agro_meteorology	1	7.1
Animal Science	1	7.1
Crop Management	1	7.1
Entomology	1	7.1
Fisheries Management	2	14.3
Forest Ecology and Conservation	1	7.1
Forestry and Wildlife	1	7.1
Plant Pathology	1	7.1
Soil Science	2	14.3

Case One

Case One is based in Ibadan North West Local Government of Oyo State. He is a Christian married man of about 30 years of age with a household size of four. He is a research officer with the Forestry Research Institute of Nigeria, Ibadan, Oyo State. He has a master's degree with specialization in Forest Ecology and Conservation with three years job experience as a civil servant. He has no secondary occupation and is a member of Forestry Association of Nigeria (FAN); and Forests and Forest Products Society (FFPS) of Nigeria but not a member of any cooperative/ farmers' group nor any Social Organization. This researcher claimed that he is aware of change in climate in his vicinity through Research Institutes and Personal Researches; he has noticed increase in temperature, long dry season and dust in the atmosphere. He has participated in Climate Change and Forest Resources Management workshop and Enrichment Planting of Degraded Part of Onigambari Forest Reserve. In his opinion, he believes that industrial activities, farming activities, transportation, agro processing activities and urbanization are the major causes of climate change via the release of effluents into the atmosphere, pollution through waste products, water pollution, bush burning, deforestation and smoke from processing machines. This will in turn affect crop enterprise by changing the crop season for harvest. He suggested shifting cultivation; use of biological means to prevent insects and kill weeds; and practice of organic agriculture as coping strategies in possible effects of climate change. He saw land competition as a major constraint in the coping strategy. The following programs: “OUR CLIMATE and EROYA (Sunday program) are the predominant climate intervention programs available in his locality. Other practical measures he suggested are environmental education; and awareness conservation clubs in primary and secondary schools.

Case Two

Case Two is also based in Ibadan North West Local Government, an Islamic single male of about 30 years with a household size of three who is also a research officer with the Forestry Research Institute of Nigeria, Ibadan, Oyo State. He has bachelor's degree with specialization in Soil Science with three years job experience as a civil servant with no secondary occupation. He is a member of the Soil Science Society of Nigeria and also a member of the Forestry Association of Nigeria (FAN); a member of ASURI Social Organization but not a member of any cooperative/farmers' group. He is a soil scientist whose research focuses on crop production, crop processing and tree cropping. He is aware of climate change through personal observation, family and friends, radio, internet, research institutes, personal researches and government agencies. He has noticed hot weather condition, low humidity and low rainfall intensity as climate changes in his environs. He attended the 32nd Conference of Forestry Association of Nigeria, Umuahia 2008 and the 5th National Conference of Organic Agriculture Project in Tertiary Institutions in Nigeria (OAPTIN), Owerri 2009 and he has published three papers on climate change effects, which are Climatic Change: A Threat To Food Security And Environmental Protection; Organic Agriculture: A Panacea To Climate Change And Food Security. This researcher believes that industrial activities, farming activities and transportation are just the main causes of climate change unlike the first researcher who believes that there are other causes of climate change. Climate change to this researcher, affects forestry, soil fertility and growth performance of the crops. The coping strategies suggested by this researcher are planting of trees; use of agro forestry practices like agro silviculture and hedge roll planting. Longer gestation of trees is the major coping strategy constraint he saw and there are no climate intervention programs in his vicinity.

Case Three

Case Three is also Ibadan-based. She is a Senior Research Officer with the National Horticultural Research Institute (NIHORT); Federal Ministry of Agric And Water Resources. She is an Islamic married woman whose age was not provided and has a household size of five persons. She is a master's degree holder whose area of specialization is Agricultural Economics and her major occupation is civil service. She is a member of Horticultural Society of Nigeria (HORTSON) and does not belong to any cooperative society or social organization. Her research is based mainly on livestock production. She is aware of change in climate through the internet and no personal observation and the only climate change she is aware of is instability in rainfall. She has neither attended any climate change workshops nor conferences. She believes that farming activities, transportation and urbanization are the main causes of climate change through deforestation, fumes from poisonous gases and cutting of trees. She believes that these activities will reduce crop production and increase windstorm. Unlike the first two researchers, she was not able to suggest any climate change intervention or any coping strategy possibly because she has no personal observation on climate change.

Case Four

Case Four, like the third researcher is also based in Ibadan North of Oyo State. He is a research officer with Forestry Research Institute of Nigeria, Ibadan, Oyo State. He is a Christian married man whose age was also not provided and has a household size of four. He holds a bachelor's degree in Forestry and Wildlife Management. His major occupation is civil service and he is a member of International Society for Tropical Forests (ISTF) and also a member of Forestry Association of Nigeria (FAN), and Forests and Forest Products Society (FFPS) of Nigeria but not a member of any cooperative/ farmers' group nor any Social Organization. His research is based on livestock production and tree cropping. He got his awareness in climate change through research institute and personal research and the climate changes he is aware of are changed rainfall pattern, unstable dry season making the issue of harmattan becoming a forgotten issue in November and December. He has attended conferences of FAN and Ecological Society of Nigeria and a special climate change workshop titled Climate Change and Forest Resources Management: The Way Forward. He has published a paper on Agro forestry. He believes industrial activities, farming activities; transportation, agro processing activities and urbanization are the causes of climate change, and all these affect the climate through industrialization, cutting of trees, bush burning, combustion and using of concrete blocks which does not allow percolation of water drops. The effects of all these could be felt in the forestry enterprise and has an effect on biodiversity. The coping strategy suggested by this researcher is afforestation and the constraint that could be encountered is problem of getting viable tree seedlings.

Case Five

Case Five is an Ibadan North based Animal Scientist working with Institute of Agricultural Research and Training (IAR&T) Ibadan, Oyo State. He is a married Christian research fellow whose age was not provided as at the time of survey. He has a household size of six with PhD as his highest qualification. He has ten (10) years working experience as a researcher with no secondary occupation. His estimated annual income was given as 1,500,000 naira. He is a member of Animal Science Association of Nigeria and Nigerian Society for Animal Production. He does not belong to any cooperative/farmer's group or any social organization. His research in recent times is based on

all areas of agriculture ranging from crop production, crop processing, livestock production, fish farming, fish processing and tree cropping/forestry. He is aware of change in climate in his vicinity through personal observation, radio, television, research institutes, government agencies, extension agents and contact farmers. He noticed unstable climatic variables in his vicinity. He has participated in a climate change conference held at the International Institute of Tropical Agriculture. In his opinion, he believes that, industrial activities, farming activities, transportation, agro processing and urbanization are the major causes of climate change. This affected research experience by creating discomfort, creates health hazards, reduce productivity, causing outbreak of diseases and loss of biodiversity. He was not able to produce any coping strategy in climate change. He is aware of the following climate change intervention programs: prohibition of deforestation and radio enlightenment programs on climate change. He suggested encouragement of planting of trees in homestead farms and public houses; enforcement of laws that will protect environmental degradation. He noted that climatic change is a global problem that needs attitudinal changes from all and sundry to address.

Case Six

Case Six is also based in Oyo state. She is above 30 years of age, a single Islamic woman whose household size is eight. She works with the National Horticultural Research Institute (NIHORT) as a senior research officer whose area of specialization is Agricultural Economics with Ph.D. as her highest qualification. Her years of experience is a little above one year as a researcher. She is a member of Nigerian Association of Agricultural Economist and African Association of Agric Economist. She is also a member of two social groups- Centre for Mass Action against Destitution and Crime (CEMADEC) and Federation of Muslim Women Associations of Nigeria (FOMWAN). Her research work is only based on crop production. She is aware of change in climate in her vicinity through personal observation; family and friends; radio, television, internet and research institutes. She has also noticed that planting periods are changing and cannot be predicted again like before. She has neither attended any conference/meetings nor any workshop in climate change but she has a research work- effect of climate change in women, which is under review. She observed that industrial activities, farming activities, transportation, agro processing, and urbanization are the causes of climate change through emission from machines, soil tillage, emission from cars and tractors, waste disposals etc. She also observed that change in climate could cause reduction in crop yield; create discomfort; health hazards; increase flooding; longer period of heat stress; outbreak of diseases and even emergence of new diseases. She noted that diversification in farming activities can be a coping strategy against climate change and the only constraint that could be faced in this is, land problem and farm size. She has participated in climate change intervention program that focused on diversified cropping and she suggested that there should be better education on climate change issue through advocacy from different quarters.

Case Seven

Case Seven is based in Ibadan North East local government of Oyo State. He is a single man who is above 30 years of age. He practices Islam as a religion and has three member household. He is a research officer with the National Horticultural Research Institute (NIHORT). He holds a master's degree in Agrometeorology, has two years job experience as a researcher with no secondary occupation. He is a member of the Nigerian Meteorological Society of Nigeria. He is not a member of any social organization and his income was not provided. His research is solely on crop

production. He has been informed of climate change in his vicinity through his personal observation, internet and research institutes. He noticed general increase in temperature, unstable rainfall, increase dryness and draught. He participated in Nigerian Meteorological Society, International Conference on Climate Change, Osogbo 2010 and an on-going project titled Effect of Climate Change on the Incidence of Malaria. Like his other counterparts he believes that industrial activities, farming activities, transportation, agro processing, urbanization are the causes of climate change through emission from machines, soil tillage, emission from cars and tractors, waste disposals etc. He noted that change in climate could cause reduction in crop yield; create discomfort; health hazards; increase flooding; longer period of heat stress; outbreak of diseases and even emergence of new diseases. He is not aware of any climate change intervention programme in his vicinity and has no possible suggestions on any strategy/ technology that could be useful to farmers per adventure there are adverse effects of climate change to farmers' enterprises.

Case Eight

Case Eight is from Akure North of Ondo State. She is a Christian married woman whose household size is three. She works with the Federal University of Technology, Akure as a technologist, her age was not provided. She holds a master's degree in soil science and she has been working a technologist with the university for 10 years. She is a member of the Nigerian Institute of Science Technologists (NIST) and the secretary of the Catholic Development Association. Her research work is based on crop production. She has noticed a range of change in climate like low rainfall and high temperature within her vicinity, a proper knowledge of which she gets through personal observation, radio and internet. She never attended any conference on climate change but has researched on Effect of Climate on Soil Fertility, though there are no publications on this. She noted that industrial activities, farming activities and transportation are the causes of climate change through emission from machines, soil tillage, emission from cars and tractors etc. She noted that reduction in crop yield and increased pests and diseases could be a result of climate change in his vicinity. She suggested reforestation as a coping strategy to the identified and possible effects of climate change. Environmental protection agency campaign on use of organic chemicals was the only climate change intervention program she has participated in.

Case Nine

Case Nine is a professor at the Federal University of Technology, Akure, in Akure North of Ondo State. He is a Christian married man whose household size was not given. He has thirty (30) years working experience. He is a professor of plant pathology who doesn't have any other occupation apart from lecturing. He is the Vice President/ Editor in Chief of Nigerian Society of Plant Protection; Nigerian Representative to the International Congress of Plant Pathologists; Editor-in- Chief of the Mycological Society of Nigeria; and member, Progressive Group Christ Apostolic Church. He is fully aware of changes in climate in his vicinity, and the awareness is through personal observation, radio, television, internet and personal researches. He noticed irregularity in rainfall and high temperature. He never attended any conferences or workshops on climate change but he has researched on Plant pathology as it relates to climate. The professor noted that climate change was caused by industrial activities, farming activities, transportation, agro processing activities and urbanization through emission of gases, deforestation, ozone layer depletion, population increase, careless attitude, ignorance, refuse dumping and toxic discharge. He also noted that climate

change could cause reduction in crop yield, drying well, and lower water table. Afforestation, re-forestation, reduction of use of inorganic fertilizers and biological control of pests and diseases are the coping strategies suggested by this researcher, though he saw ignorance and funding as the constraint that could be faced in these strategies. Environmental protection agency campaign on use of organic chemicals was the only climate change intervention program she has participated in.

Case Ten

Case Ten is a Senior Lecturer in the department of Fisheries and Management, University of Agriculture, Abeokuta, located in Odeda Local Government of Ogun State. She is a Christian married woman with household size of six and 25 years working experience. Her highest educational qualification is PhD and earns about 1,500,000 naira annually. Apart from lecturing which is her primary occupation, she is into consultancy and fish marketing. Her reason for being engaged in secondary occupation is to increase income and remain relevant in her field. She is a member of the Fisheries Society of Nigeria; Farm Management Association of Nigeria and Nigerian Institute of Food Science and Technology. She doesn't belong to any social group or a cooperative society. Her research work is based on fishing/fish farming; fish processing; crop production and livestock production in that order. She has noticed change in climate in her vicinity and she has been properly informed through personal observation, internet and contact farmers. She noticed higher temperatures; more frequent disasters (Earthquakes, Landslides, Tornadoes; rising sea levels and flooding. She claimed to have attended various conferences on climate change, for example: Lagos State Climate Change Conference (2010); ATPS Climate Sense Project (2010); and ATPS Climate Sense Project. She published a paper on Mitigating and Adapting to Climate Change Effects in Aquaculture and Fisheries. This researcher observed that climate change could be caused by industrial activities, farming activities, transportation, agro processing activities and urbanization through Gas flaring, Use of fossil fuels, use of chemicals that emit green house gases and use of fossil fuels to drive equipment. She believes that change in climate affects fisheries production and processing through rising sea levels, loss of biodiversity and crop production through flooding and destroy crops thereby reducing productivity. She is aware of the provision of solar panels for rural electrification and measurement and control of emission from motor vehicles as climate change intervention programs in her vicinity. She therefore submitted that reduced dependence on hydropower is a practical measure for policy intervention to improve adaptation to climatic change.

Case Eleven

Case eleven is also a lecturer in the department of Fisheries and Management, University of Agriculture, Abeokuta, located in Odeda Local Government of Ogun State. He is a Christian married 48 year old man whose household size is also six. His highest educational qualification is PhD, he has 10 years job experience and earns about 1,000,000 naira annually, his primary occupation is lecturing and also into consultancy and fish marketing. He is a member of Fisheries Society of Nigeria; chairman, Agbekunle Fish Cooperative; and secretary, Ikofa Community Development. His research is on fishing/fish farming and crop processing in that order. He has noticed change in climate in her vicinity and she has been properly informed through personal observation, television and internet. The only climatic change he noticed is reduced rainfall. He participated in the OGADEP Group Discussion on Climate change and Mitigation and Climate change in Nigeria: A review. He believes that farming activities are the main causes of change in

climate through indiscriminate tree felling and uncontrolled bush burning. He observed that there could be reduction in yield in crop production, Flooding leading to loss of stock with attendant psychological effects in fishing as a result of climate change. He suggested Drilling borehole for irrigation and proper citing of ponds off potential flood path as coping strategies in possible effects of climate change. He is not aware of any climate change intervention program in his vicinity and has no possible suggestions on any strategy/ technology that could be useful to farmers per adventure there are adverse effects of climate change to farmers' enterprises.

Case Twelve

Case Twelve is an assistant lecturer in the department of Crop Management, at the Federal University of Technology, Akure, in Akure North of Ondo State. He is a Christian married man whose household size is four and his age was not given. He has two years working experience, with highest qualification of M.Sc. His income is about 8 million naira annually. He is a member of the Agronomical Society of Nigeria, Weed Science Society of Nigeria, Agro Bio Forum, Ese Development Association and a group leader Ajinde Group Christ Apostolic Church (CAC) - a religious group. His research is based on crop production and tree cropping. In climate in his vicinity and the awareness is through personal observation, radio, television, internet and personal researches. He noticed Change in rainfall regime, high rate of insulation and declining water bodies. He participated in a Workshop on Climate Change by START and researched on Trade out poverty through Jathropha Production through which he published papers on Shade and Water Management: an Important Tool in Solving Climate Change Problem in Southwest Nigeria; Effect of Intercropping Jathropha curcas and Arable Crops on Soil Physical and Chemical Properties; and Shade and Water Management: a Viable Means of Improving Cacao Production in Nigeria. He noted that climate change was caused by industrial activities, farming activities, transportation, agro processing activities and urbanization through emission of gases, deforestation, conversion of forests to industrial park, Settlement and urban encroachment, ozone layer depletion, population increase, careless attitude, ignorance, refuse dumping and toxic discharge. He believes that climatic change could lead to reduction in crop yield, emergence of new diseases and outbreak of diseases. The coping strategy he suggested is reduction in the rate of deforestation; follow meteorological information and early planting. The constraints he pointed out were unavailability of tree seedling and unavailability of planting materials. He has no has no possible suggestions on any strategy/ technology that could be useful to farmers per adventure there are adverse effects of climate change to farmers' enterprises.

Case Thirteen

Case Thirteen is also an assistant lecturer department of Entomology at the Federal University of Technology, Akure, in Akure North of Ondo State. He is a 34 year old single with a household size of 7 people. His highest educational qualification is M. Phil and almost two years working experience and an income of about 8 million naira annually. He is a member of the Entomology Society of Nigeria and does not belong to any social group or cooperative society. His research is solely on crop production. In climate in his vicinity and the awareness is through personal observation, radio, television, internet and personal researches. He noticed uncommonly excessive heat, erratic weather conditions and declining water bodies. He participated in a workshop on Jathropha Production and published a paper on using Jathropha plant for Soil remediation. Like his previous researcher from the same university, he noted that climate change was caused by industrial

activities, farming activities, transportation, agro processing activities and urbanization through emission of gases, deforestation, conversion of forests to industrial park, Settlement and urban encroachment, ozone layer depletion, population increase, careless attitude, ignorance, refuse dumping and toxic discharge. He opined that climate change automatically cause reduction in crop production. Increase campaign on climate change and its impact on farmers' livelihoods is his suggestion in measures for policy intervention to improve adaptation to climatic change.

Case Fourteen

Case Fourteen is a married man of 45 years who is a Christian and a lecturer in the department of Agric Economics, Federal College of Agriculture, Akure, (FECA) in Akure North of Ondo State. He has 13 years working experience and his qualification is M.Sc. Apart from lecturing where he earns 1.2 million naira annually, he is also into fish farming, an occupation he does to increase income. He is a member of the Agricultural Extension Society, Horticultural Society of Nigeria and Efik Indigenous Association. His research is on crop production, fish farming and tree cropping. He is aware of various climatic change in his vicinity through personal observation, family and friends, internet, TV, radio, NGO, Research Institutes, Extension Agents and Contact Farmers. He noticed delayed rainfall, excessive heat and dryness. He has neither attended any conference nor workshop on climate change. He agreed with other researchers that, climate change was caused by industrial activities, farming activities, transportation, agro processing activities and urbanization through emission of gases, deforestation, conversion of forests to industrial park, Settlement and urban encroachment, ozone layer depletion, population increase, careless attitude, ignorance, refuse dumping and toxic discharge. He proposed that rain harvesting is a coping strategy in climate change and the constraint could be lack of enough storage tanks and reservoirs. The climate change intervention program he is aware of are Radio announcements against bush burning, wind breaks and shelterbelt program, more education on climate change and reduce gas emission.

5. Conclusions & Recommendations

5.1. Conclusions

There is a general conviction among farmers, extension officers and researchers that crops and forests management technologies are the main tools for adapting to climate change. It is noteworthy however that adapting to climate change is as much a technology issue as an attitudinal one. This study has shown that unless peoples' general attitudes to climate change issues are altered, the decision to adopt relevant adaptation techniques (emerging or indigenous will follow a very slow path.

It can also be concluded that the number of researchers working on climate change related issue are few in southwest Nigeria. There is a need to consciously raise awareness of climate change issues in the shot-run among early career researchers and in the long run a deliberate campaign in schools and universities to focus young minds into investigative enquiries on the climate and how best society should adapt as change occur that are most often irreversible.

The influence of location (agro-ecological zones) on the he observation of climate change phenomena by farmers and extension officers is staggering. While farmers in the swamp and rainforest appear to have a basket of emerging and indigenous technologies to cope with climate change, farmers in the savanna zone seem to have lesser opportunities to cope. Unfortunately, the most vivid climate change impact for visitor to southwest Nigeria, especially in the transition zones between agro-ecological zones is that as rainforests become savanna-like (derived savanna), savannas becomes desert-like (desert encroachment). It is important therefore that location specific strategies need to be developed to raise the profile of climate change awareness and the urge to adopt emerging and indigenous technologies to cope with climate change in the various agro-ecological zones.

Furthermore, given that farmers in this zone earn less from their primary occupation (farming) than in the other two agro-ecological zones, it can be concluded that financial limitations is a key constraint to adopting emerging and indigenous technologies for climate change adaptation at least in the savanna zone of southwest Nigeria. But it is not enough to throw money at problems. A deliberate attempt at raising farm productivities and improving return to farming as a business would help in the long-run to facilitate uptake of relevant climate change adaption strategies.

Even though farmers, extension officers and researchers appear to have very high levels of awareness of changes in climate change phenomena, their sources information differ markedly from personal contacts among farmers to a bit of personal contact and mediated sources such as radio and television among extension officers and to internets and other non-personal and external sources among researchers. It is also noteworthy that many farmers and extension officers did not consider research institutes and government agencies as their main sources of information on climate change adaption. This finding suggests that media campaigns designed to reach farmers, extension officers and researchers need to be audience-specific.

The major technologies adopted by farmers to adapt to climate change are agro-ecology specific. Construction of drainages is popular in the swamp zone. Small scale irrigation, mulching and IPM are common in the rainforest and afforestation is the leader in the savanna. While fitting technologies to location could address climate change in the short run, the fact that the observable change is continuous suggests that farmers need to be empowered with a range of technologies that may not be applicable to their agro-ecology toady in anticipation of future changes and therefore ability to cope when such changes eventually manifests. The farmers who will be better able to cope are those who already know what to do when the change actually manifests, not those who wait to be informed after the change is manifest. Therefore efforts to improve the general levels of formal educational attainments among farmers and improve their ability to obtain information from more external and wide-ranging sources than personal circles will contribute in this direction.

5.2 Recommendations

It is evident from this study that future relevant work would be in three broad categories. These are:

1. Study of attitudinal change required among farmers and extension officers for addressing climate change in various agro-ecologies

Attitudes have strong influences on peoples' decision-making. It is important therefore to further explore how farmer's attitude to climate change influences their response to the uptake of climate change adaptation technologies. It should also reveal how their attitude could be positively influenced to attain higher levels of adoption of climate change technologies and improve that overall ability to make conscious and responsive decisions to climate change.

2. Develop and apply models for linking farmers, extension officers and researchers to exchange climate change information using appropriate combination of media

Farmer-Extensioner-Researcher linkage models as encapsulated in the Research-Extension-Farmer-Inputs Linkage System (REFILS) has been used in southwest Nigeria to promote the uptake of technologies targeted at improving the productivity of arable crops. Similar models can be used to develop farmer's response system to adopting appropriate and responsive climate change adaptation systems. Investigations to make this happen are required to properly focus research investments and direct the attention of the research community currently engrossed in yield-increasing models to more sustainable climate sense approaches to agricultural production.

5.3 Development of appropriate curricular for schools and universities to inculcate climate awareness

The power of the school system to unleash societal change have been demonstrated in the 1960s when the government of Western Nigeria used the school systems under its Free education System as the fulcrum of social change. This potential of the school system is recognised and used in a haphazard manner in very small pilot level projects such as Plant a Tree Today in Nigeria (PATTIN). A bolder approach similar to the social change approach of the 1960s is required to fully utilize the school system to promote a more lasting climate sense in southwest Nigeria. This should be done with conscious investments in research to fully understand the changes that the school system have undergone over the years and how it can be best used as a long term climate change response system at all levels (farming extension services, research, inputs delivery and other ancillary requirements).

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